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BACHELOR OF MEDICAL SCIENCES (BMSc) PROGRAM: SCHULICH SCHOOL OF MEDICINE & DENTISTRY and FACULTY OF SCIENCE

VISION:
To be the leader in providing undergraduate education in the basic medical sciences in preparation for employment, graduate studies and professional schools

MISSION:
In keeping with Western’s mission to provide the best student experience among Canada’s leading research-intensive universities, our role is to:

- Provide an outstanding educational experience in a broad spectrum of basic medical science disciplines
- Enhance the classroom lecture experience with associated laboratories which use state-of-the-art technologies
- Provide opportunities for excellent students to perform novel research under the mentorship of award-winning scientists
- Ensure that our graduates are well-informed regarding further educational opportunities and career development

BACKGROUND
The BMSc program was introduced in 2001 as a joint venture between the Faculty of Medicine & Dentistry (since renamed the Schulich School of Medicine & Dentistry) and the Faculty of Science. This four-year degree program was designed to provide students training in the basic medical sciences. In April of 2005, an agreement was signed by the deans of the two faculties, describing the basic features for the operation of the program.

Due to the interest in the BMSc Program and the limited availability of Year 4 undergraduate research projects and advanced laboratory opportunities, the BMSc Program began limiting the enrolment into Year 2 of the program in September 2006.

OVERVIEW
Registration in the BMSc Program begins in Year 2, usually following Year 1 in the Biological and Medical Sciences First Entry Program. Students may, however, apply for entry into Year 2 of the BMSc Program from a different first-year program provided they satisfy the admission requirements and criteria (Appendix A1).
To meet a goal of 300 students in Year 4, approximately 370 students are admitted to each of Years 2 and 3, and only those students registered in Year 3 can progress to Year 4 of the BMSc Program. Students must meet minimum mark requirements and satisfy certain criteria to be granted admission to each of Years 2 and 3.

BMSc degrees must contain one of the following modules or combinations of modules:

- an Honors Specialization module offered by a Basic Medical Science Department (BMSc Honors)
- a Specialization module offered by a Basic Medical Sciences Department (BMSc), or
- two Major modules, both offered by Basic Medical Sciences Departments (BMSc or BMSc Honors).

A unique feature of the BMSc Program at Western is the option to either concentrate on one basic medical science discipline or undertake an interdisciplinary study by selecting a Medical Sciences module. The signature course in the discipline-specific Honors Specialization modules is the Year 4 undergraduate research project whereas students in Year 4 of the Honors Specialization in Medical Sciences module complete an advanced laboratory half course and an associated special topics lecture course.

### Honors Specialization

- Biochemistry
- Biochemistry & Cell Biology
- Biochemistry of Infection & Immunity
- Clinical Biochemistry
- Medical Biophysics (Medical Sciences Concentration)
- Medical Cell Biology
- Medical Sciences
- Microbiology & Immunology
- Pathology & Toxicology
- Pharmacology
- Physiology
- Physiology and Pharmacology

### Specialization

- Biochemistry
- Medical Biophysics
- Medical Sciences
- Microbiology & Immunology
- Pathology & Toxicology
- Pharmacology
- Physiology
- Physiology and Pharmacology

### Major

- Biochemistry
- Medical Biophysics
- Medical Cell Biology
- Medical Sciences
- Microbiology & Immunology
- Pharmacology
- Physiology

### Minor

- Biochemistry
- Medical Biophysics
- Medical Cell Biology
- Medical Sciences
- Microbiology & Immunology
- Pharmacology
The Departments of Biochemistry, Medical Biophysics, and Physiology and Pharmacology offer Honors Specialization modules in cooperation with other faculties, leading to BSc Honors degrees (currently 26 students registered in Year 4). There are currently 243 Year 4 students registered in basic medical science Majors and Minors in non-BMSc degrees (200 students registered in a Major offered by the basic medical science department; 43 students in a basic medical science Minor).

**ENHANCING THE ACADEMIC EXPERIENCE**

For students wishing to enhance their undergraduate academic experience, a 5-year combined BMSc/HBA program is available leading to two degrees: BMSc Honors (Honors Specialization in Medical Sciences) and BA Honors (Business Administration). The Science/BMSc Internship Program allows qualified students to enhance their academic education with a relevant "hands on" work experience ranging from 8-16 months. The Scholar’s Electives Program provides an intellectually stimulating learning environment for exceptional students wishing to undertake an interdisciplinary and/or laboratory research experience. By participating in the International Exchange Program, students expand their academic horizons gaining valuable skills for success in a global economy.

**ENROLMENT**

The table below displays the enrolment in the BMSc Program and illustrates the impact of the limited enrolment policy beginning in 2006 (high-lighted).

<table>
<thead>
<tr>
<th>Year</th>
<th>2005/06</th>
<th>2006/07</th>
<th>2007/08</th>
<th>2008/09</th>
<th>2009/10*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 2</td>
<td>566</td>
<td>327</td>
<td>356</td>
<td>347</td>
<td>344</td>
</tr>
<tr>
<td>Year 3</td>
<td>545</td>
<td>490</td>
<td>320</td>
<td>287</td>
<td>350</td>
</tr>
<tr>
<td>Year 4</td>
<td>291</td>
<td>538</td>
<td>471</td>
<td>359</td>
<td>300</td>
</tr>
<tr>
<td>Total</td>
<td>1402</td>
<td>1355</td>
<td>1147</td>
<td>993</td>
<td>994</td>
</tr>
</tbody>
</table>

*as of October 20, 2009*
### Year 4 Enrolment in the BMSc Program

<table>
<thead>
<tr>
<th>Module</th>
<th>capacity*</th>
<th>2005/06</th>
<th>2006/07</th>
<th>2007/08</th>
<th>2008/09</th>
<th>2009/10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honors Specialization (HSP) Biochemistry</td>
<td>30</td>
<td>39</td>
<td>37</td>
<td>24</td>
<td>23</td>
<td>30</td>
</tr>
<tr>
<td>HSP Biochemistry and Cell Biology</td>
<td>10</td>
<td>0</td>
<td>12</td>
<td>9</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>HSP Biochemistry of Infection and Immunity</td>
<td>12</td>
<td>--</td>
<td>2</td>
<td>3</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>HSP Clinical Biochemistry</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>HSP Medical Biophysics</td>
<td>20</td>
<td>7</td>
<td>18</td>
<td>12</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>HSP Medical Cell Biology</td>
<td>6</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>0</td>
</tr>
<tr>
<td>HSP Medical Sciences</td>
<td>120*</td>
<td>65</td>
<td>109</td>
<td>98</td>
<td>102</td>
<td>99</td>
</tr>
<tr>
<td>HSP Medical Sciences / HBA</td>
<td>8</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>HSP Microbiology and Immunology</td>
<td>32</td>
<td>33</td>
<td>30</td>
<td>17</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>HSP Pathology and Toxicology</td>
<td>10</td>
<td>5</td>
<td>12</td>
<td>10</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>HSP Pharmacology</td>
<td>70</td>
<td>12</td>
<td>13</td>
<td>16</td>
<td>13</td>
<td>9</td>
</tr>
<tr>
<td>HSP Physiology</td>
<td>43</td>
<td>26</td>
<td>35</td>
<td>40</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>HSP Physiology and Pharmacology</td>
<td>5</td>
<td>33</td>
<td>19</td>
<td>13</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Totals in Honors Specialization Modules</td>
<td>212</td>
<td>299</td>
<td>248</td>
<td>252</td>
<td>257</td>
<td></td>
</tr>
<tr>
<td>Specializations</td>
<td>77</td>
<td>114</td>
<td>126</td>
<td>37</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Double Majors - Honors</td>
<td>1</td>
<td>74</td>
<td>84</td>
<td>50</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Double Majors - 4-year</td>
<td>1</td>
<td>51</td>
<td>13</td>
<td>20</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Total Year 4 Enrolment</td>
<td>291</td>
<td>538</td>
<td>471</td>
<td>359</td>
<td>300</td>
<td></td>
</tr>
</tbody>
</table>

*capacity in Year 4 research projects  
*includes spaces for BMSc/HBA students

### BMSc GRADUATES
The table below displays the number of graduates obtaining BMSc degrees for the years 2005 to 2009. The majority of students graduating with Honors BMSc degrees have completed an Honors Specialization module.

<table>
<thead>
<tr>
<th>Year</th>
<th>Honors BMSc</th>
<th>4-year BMSc</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>154</td>
<td>23</td>
<td>177</td>
</tr>
<tr>
<td>2006</td>
<td>203</td>
<td>38</td>
<td>241</td>
</tr>
<tr>
<td>2007</td>
<td>335</td>
<td>54</td>
<td>389</td>
</tr>
<tr>
<td>2008</td>
<td>305</td>
<td>61</td>
<td>366</td>
</tr>
<tr>
<td>2009</td>
<td>265</td>
<td>18</td>
<td>283</td>
</tr>
<tr>
<td>Totals</td>
<td>1262</td>
<td>194</td>
<td>1456</td>
</tr>
</tbody>
</table>
GRADUATE SURVEY RESULTS

Graduates from the BMSc Program in 2008 and 2009 were asked in a very informal survey what their career plans were for the upcoming September of each year. The following table summarizes their responses.

<table>
<thead>
<tr>
<th></th>
<th>Class of 2008</th>
<th>Class of 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Graduates</td>
<td>366</td>
<td>283</td>
</tr>
<tr>
<td>Number of Respondents</td>
<td>235</td>
<td>199</td>
</tr>
<tr>
<td>Medicine</td>
<td>56</td>
<td>62</td>
</tr>
<tr>
<td>Dentistry</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>Graduate Studies</td>
<td>61</td>
<td>58</td>
</tr>
<tr>
<td>Other professional schools*</td>
<td>40</td>
<td>33</td>
</tr>
<tr>
<td>Working Health/Science field</td>
<td>20</td>
<td>11</td>
</tr>
<tr>
<td>Other**</td>
<td>47</td>
<td>30</td>
</tr>
</tbody>
</table>

* Other professionals includes: Pharmacy, Optometry, Education, Law, Nursing, MBA, Applied Health (Respiratory Therapy, Radiation Technology, Medical Laboratory Technology)
** includes working, volunteering, traveling, special student

STUDENT INPUT

Students in Year 4 of the various Honors Specialization modules were invited to participate in focus group sessions at the end of the academic year. Five focus group sessions were held, four of which were comprised of 4-7 students in the Honors Specialization module(s) offered by a particular department and one of which was comprised of 4-7 students in the Honors Specialization in Medical Sciences. The following questions were posed to each group and the responses were discussed. See Appendix A2 for a summary of the responses.

- What led you to choose this program and how are you hoping to use it in your career?
- What’s working well for you, in this program?
- What’s not working well for you, in this program?
- What’s missing in the program that you would have liked to see?
- To what degree did your 2nd and 3rd year courses prepare you to handle the content of your 4th year courses?
- What guidance did you receive in selecting and progressing through this program, and who provided it?

ADMINISTRATION

The program is administered jointly by the Associate Dean, BMSAA, Schulich School of Medicine & Dentistry, and the Associate Dean, Academic, Faculty of Science. Administrative support for Basic Medical Sciences Undergraduate Education (BMSUE) is provided by the Administrative Assistant and BMSUE Coordinator. The BMSUE administrative staff oversees information provided to students about the BMSc program (website, pamphlets, information sessions and presentations), eligibility and adjudication of students requesting the BMSc program, and the
coordination of the centralized graduate student assistantship (GTA) assignments for basic medical science courses.

The Basic Medical Sciences Undergraduate Education Program Committee meets monthly during the academic year to review various aspects and initiatives of undergraduate education in the basic medical sciences. The committee consists of the Associate Deans of BMSAA and the Faculty of Science, and the undergraduate chairs of the seven basic medical science departments, BMSUE Coordinator, BMSUE Administrative Assistant, the Academic Manager of the academic counselling unit, and the BMSc representative on the Science Students’ Council. See Appendix A3 for the Terms of Reference for the BMSUE Program Committee.

LIBRARY SERVICES
Students in the Bachelor of Medical Sciences program have access to the resources provided by Western Libraries, the fourth largest research library in Canada. The libraries, and more specifically the Allyn & Betty Taylor Library due to its subject coverage, supports these students at many levels. They have access to a very rich collection of books and journals, available both in print and electronically, as well as alternate formats. Electronic resources are accessible from off campus locations through the library’s proxy service. The library further supports the students through various information literacy initiatives many of which are integrated into their course schedules and supplemented by online materials. The goal of these activities, besides supporting the immediate coursework requirements, is to set the foundation for lifelong learning. There are many online self-serve functions available to the students to make the information seeking process more effective and efficient.

It is recognized that the support to BMSc students also represents the interplay of resources and services provided by the library to the basic medical sciences departments. With this in mind, a brief overview of areas where the library provides support to the individual departments will be presented. More detailed information can be obtained by referring to Appendix A4 - Report on Western Libraries Support for the Bachelor of Medical Sciences Program.

CORE FACILITIES
Students involved in undergraduate thesis projects have access to the Core Facilities of the Schulich School of Medicine & Dentistry, as appropriate. A listing of the core facilities is outlined in Appendix A5.
1. OVERVIEW OF THE MICROBIOLOGY AND IMMUNOLOGY UNDERGRADUATE PROGRAM

1.1 INTRODUCTION TO THE MICROBIOLOGY AND IMMUNOLOGY PROGRAM

The Department of Microbiology and Immunology actively participates in the BMSc program. We offer the following modules, which allow students at the University of Western Ontario to combine their interests in Microbiology and Immunology with subjects from other Departments and Faculties:

- Honors Specialization in Microbiology and Immunology
- Honors Specialization in Biochemistry of Infection and Immunity
- Specialization in Microbiology and Immunology
- Major in Microbiology and Immunology
- Minor in Microbiology and Immunology

All modules include foundation courses in Biology, Chemistry and Biochemistry, to complement the discipline-specific courses.

Key features of our program are:

1. Microbiology and Immunology 2100A, a course in the fundamental properties of the prokaryotic cell, with a weekly laboratory session. Offered in Year 2, this course allows students to learn about microbiology early in their university program and thus draws students to our program.

2. Microbiology and Immunology 2500B, Biology of Infection and Immunity, is a service course offered to students outside our modules. It is very well received and definitely attracts students to our program.

3. Microbiology and Immunology 3600G, a laboratory course in techniques in immunology and molecular biology. This is a unique, comprehensive laboratory course, where students use animal models to study basic immunological concepts. They then have hands-on experience with molecular biology techniques and bioinformatics.

4. Students in either Honors Specialization have an opportunity to develop excellent skills in analysis, critical thinking, writing and oral communication via the fourth year Research Project and Seminar Course (Microbiology and Immunology 4970E). This is an academic experience totally different from a standard, weekly laboratory course. The course provides good mentoring opportunities and often motivation to continue with research.

Our program is somewhat unique in that programs in microbiology or immunology are offered at many Canadian universities, but integrated programs such as ours are offered at only a few other universities.
1.2 DEPARTMENT OF MICROBIOLOGY AND IMMUNOLOGY: ACADEMIC PLAN

The primary mandate of our program is to provide a high-quality education in microbiology and immunology to the several populations of students served by our Department. The modular degree structure at the University of Western Ontario allows students to design their program according to their future career goals. Our program is designed to ensure that all our students have a broad knowledge of biology and chemistry, to serve as a foundation for specific courses in our disciplines. Our aim is to include courses in our modules that provide interest, utility and current information. Students who aspire to pursue research in microbiology and immunology are provided with courses that are current, challenging and comprehensive in Year 4 of the Honors Specialization, via a BMSc degree. Students in other programs can avail themselves of a Minor or Major in Microbiology and Immunology, via a BSc or other degree.

Our immediate challenge is to adapt our curriculum to the rapidly evolving disciplines of microbiology and immunology and incorporate new, emerging areas of research and development. To assist the department in this task we are advertising a Faculty Position in Undergraduate Education at the Assistant Professor level, who will play a major role in curriculum development for all courses in the Microbiology and Immunology undergraduate program.

1.3 OBJECTIVES OF THE MICROBIOLOGY AND IMMUNOLOGY PROGRAM

1.3.1 Training in the Discipline

The majority of research and teaching in the Department of Microbiology and Immunology is dedicated to the study of microorganisms, the association of pathogens with the immune system, and the molecular and cellular biology of the immune system. Students in our program explore basic through complex principles in the structure, chemistry, genetics, and behaviour of bacteria, viruses, protozoa, and cells of the immune system. They apply the techniques of microbiology, immunology, molecular biology, and cell biology to fundamental, medical and applied problems.

Our Department has a strong and broad-based research presence in the area of Infection and Immunity, and our undergraduate program is a reflection of this research expertise. Thus we do not offer courses in applied and environmental microbiology, microbial ecology, biotechnology, nor do we offer courses in eukaryotic microbiology. The selection of the program objectives are based on the current state of the field and the mandate to prepare students adequately for future success in microbiology and immunology or related disciplines. As our professors actively conduct research in the field and participate in academic, medical and industrial aspects of the disciplines, our faculty members fully understand the objectives that are critical for the success of the program and preparation of students for the future. As such, our courses consistently reflect the current state of the discipline and are constantly updated as novel scientific and clinical discoveries are made.
One of the strengths of our program is a long-standing association with the Biochemistry program. In most of the Microbiology and Immunology modules, students are required to take two Biochemistry courses, as this is such a fundamental component of our disciplines. For many years, students have been able to choose a supervisor in the Departments of Biochemistry or Microbiology and Immunology for their fourth year research project. We now offer a module (an Honors Specialization) in the Biochemistry of Infection and Immunity, jointly offered by the two departments.

The courses in our program are well structured and suited for the undergraduate level. Entry-level courses focus on subject material fundamental to the discipline in order to build a strong foundation of basic knowledge. These courses build upon existing scientific and biological knowledge learned at the secondary school and first year undergraduate levels. As students progress through the program, courses steadily increase in difficulty and depth of subject material and encourage more independent learning and critical thinking. We have an excellent laboratory course on Techniques in Microbiology and Immunology (Microbiology and Immunology 3600G). The first half of the course involves experiments in immunology and the second half of the course has experiments in molecular biology and bioinformatics. Students have already been taught fundamental techniques in bacteriology in laboratory sessions in Microbiology and Immunology 2100A (Biology of Prokaryotes).

One of the unique features of our program is that our department is the only one of the Basic Medical Sciences departments that offers a laboratory course to second year students (Microbiology and Immunology 2100A). We thus provide the opportunity for students to take a practical course in bacteriology before they are halfway through their university program, thus exposing them early to this discipline.

Standard methods of evaluation are used as assessment tools in our courses. The large second and third year courses (enrolment > 150 students) have multiple choice tests and exams. In Microbiology and Immunology 3400B (enrolment maximum of 100 students) the instructors insist on a short answer written format, as they believe that this method better tests the acquisition of concepts than a multiple choice format. Students are also required to do a 10 minute group oral presentation on a prokaryote or virus. A similar assignment is included in the Advanced Virology course. Microbiology and Immunology 3600G is strictly a laboratory course, not a didactic lecture course, and students are evaluated on the writing of complete laboratory reports. In advanced courses in fourth year, the evaluation methods vary. In Advanced Immunology the instructors use midterm tests and a final exam, with a combination of multiple choice and one to three short answer questions. In Bacterial Pathogenesis, each instructor has a quiz in a regularly-scheduled lecture period (thus four quizzes) and there is no final exam. The tests are a mixture of short answers, which probe knowledge of applying concepts to problem-solving, and a few multiple choice questions. The other two courses (Microbiology and Immunology 4200B and 4700B) have traditional written tests and exams.
1.3.2 The Intellectual and Creative Training of Students

The curriculum strongly promotes student development of critical perspectives both in the field and in general. Courses are structured to continually apply their subject matter to the world at large, encouraging students to visualize how the material relates to everyday life and how this knowledge can be utilized to positively impact human health, industry and the environment.

Our program stresses the importance of core areas within the discipline by requiring students to complete several mandatory core courses that teach fundamental topics and subject matter critical to the advanced courses within the program.

Students are introduced to independent analysis in several ways. In the two laboratory courses in second and third year, students conduct and analyze experiments independently and write scientific reports on these exercises. From these, students learn to think logically and critically through experiments, to troubleshoot problems that arise and to write scientifically. The hallmark of our program is the fourth year Research Project and Seminar course, available to students in an Honors Specialization. Under the tutelage of a laboratory member, students develop the skills to plan their own experiments, to solve problems and to interpret results. This is the opportunity for students to ‘think outside the box’. The final assignment is to write a research report in the format of a scientific paper. This involves a literature review of the field and a discussion of how their results contribute to the knowledge in that field.

In two of our courses (Microbiology and Immunology 3400B and 4200B) students must prepare and present in groups of 3 and 5 students respectively an oral presentation on a prokaryote or virus. This assignment provides an opportunity for students to focus on a topic and put that information into context with regard to the discipline. We no longer have an essay requirement per se in any of our courses.

The structure of the modules at the University of Western Ontario allows students in each year of a program to have room in their schedules for elective, out-of-discipline courses.

1.3.3 Toward an Expanded Approach to the Student Experience

As mentioned in section 1.3.2, students in each year of a program have room in their schedules for elective, out-of-discipline courses. The selection of elective courses is encouraged by the department counselors, as students should enhance their education in areas of other interests while at university.

The program offers Microbiology and Immunology 2500B (Biology of Infection and Immunity) as a service course to students outside our modules. This course is very well received and often encourages students to change their registration to one of the modules offered in our program. It is only included as a required course in the Minor in Microbiology and Immunology, as it offers an introduction to infectious diseases, but students in our other modules may take it. However, they may not take this course concurrently or following completion of the advanced courses in our disciplines.
We offer an independent course in immunology (Microbiology and Immunology 3300A), separate from microbiology topics, so that students in other disciplines (e.g. biology, anatomy, physiology, pathology) may learn about the immune system. Some of these students may not be interested in microbiology, or microbiology is not relevant to their academic goals. Similarly, our courses in microbiology are available to students in biology. This is important, as the Biology department does not offer any course in bacteriology, and students interested in ecology and the environment need to have an understanding of the fundamental properties of bacteria and the role that bacteria play in the biosphere.

1.4 THE UNIVERSITY’S OBJECTIVES

1.4.1. The University’s Strategic Plan and the Microbiology and Immunology Undergraduate Program

See Disk 1 for:

- The University’s Strategic Plan “Engaging the Future”,
- The 2008 update to the Strategic Plan
- The Strategic Plan for Research
- The Strategic Plan for Internationalization
- The Schulich School of Medicine and Dentistry’s Strategic Plan, “Shaping the Future of Health Care”.

As part of The University of Western Ontario’s strategic plan, “It is central to Western’s identity that the best student experience takes place in the context of a major international research university.”

Our department places a major focus on our undergraduate students achieving a broad background of fundamental knowledge in microbiology and immunology coupled with laboratory courses covering bacteriology, virology, molecular genetics and immunology. Our Honors students cap off their experience in fourth year with a full year Thesis course, conducting cutting-edge research under the supervision of a faculty member. The high level of satisfaction that is consistently indicated by our graduating students and alumni is “the feeling of students that faculty and staff take a personal interest in them” and it is clear that this contributes to our students’ positive experience at Western.

1.4.2. The Schulich School of Medicine & Dentistry’s Strategic Plan and the Microbiology and Immunology Undergraduate Program

As part of the Strategic plan for the Schulich Medicine & Dentistry Bachelor of Medical Sciences program, Schulich will “ensure that students in the Bachelor of Medical Sciences Program are prepared for graduate programs as well as professional career choices”.
Our undergraduate program in Microbiology and Immunology clearly meets this goal and provides students with a solid training and educational background such that they are competitive for future placements in professional schools or graduate programs.
2. IDENTIFYING STUDENT NEEDS

2.1 UNDERGRADUATE CURRICULUM

2.1.1 Program Modules
The Department of Microbiology and Immunology offers the following Undergraduate Modules:

- Honors Specialization (HSP) in Microbiology and Immunology
- Honors Specialization (HSP) in Biochemistry of Infection and Immunity
- Specialization (SPZ) in Microbiology and Immunology
- Major in Microbiology and Immunology
- Minor in Microbiology and Immunology

For a listing of the admission requirements for each module, as well as the courses required in each module, see Appendix B1

Enrolment numbers in these modules over the last 5 years are displayed in the chart on the next page (2.1.2). The years of limited enrolment for modules that can only be completed within the BMSc Program are high-lighted.
### 2.1.2. Modular Enrolment

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**Honors Specialization in Microbiology and Immunology**

In addition to foundation courses, this module includes all the courses offered by the Department of Microbiology and Immunology (except for Microbiology and Immunology 2500B) as well as Biochemistry 3381A. These required courses provide students with a comprehensive knowledge of theoretical and practical techniques in the disciplines. With the fourth year thesis project and seminar, students develop strong laboratory, writing and presentation skills. This module can lead students to graduate studies, professional programs, a teaching career, or work in government or industry.
**Honors Specialization in Biochemistry of Infection and Immunity**
In addition to foundation courses, this module offers a selection of courses in microbiology, immunology and biochemistry. Core second and third year courses from each department are required. Students may take either the Biochemistry (3380G) or Microbiology and Immunology (3600G) laboratory course to satisfy the requirements for this module. In Year 4, students must take two core courses in Biochemistry, and two of the four 4000-level Microbiology and Immunology courses. For the fourth year research project and seminar course, students may register for the course in either department. These required courses provide students with a comprehensive knowledge of theoretical and practical techniques in the disciplines. With the fourth year thesis project and seminar, students develop strong laboratory, writing and presentation skills. This module can lead students to graduate studies, professional programs, a teaching career, or work in government or industry.

**Major in Microbiology and Immunology**
The design of the Major was a challenge, as we had to keep this module to 6.0 courses. That was more of a limitation than taking into consideration needs of students with different interests. As it stands, students are only required to take 1.0 of our 2.0 4000 level courses. This module does not include the fourth year research project and seminar course, and thus is often taken by students who are not planning on pursuing a research career. In combination with another Major, a student will receive an Honors degree and thus has the same career options as a student with an Honors Specialization. These students are not excluded from graduate school because they did not take a project course, but would be considered on a case-by-case basis for graduate school.

**Minor in Microbiology and Immunology**
Students with different interests were certainly taken into consideration in the design of the Minor in Microbiology and Immunology. We believe that a Minor should provide an introduction to a discipline and thus our fundamental courses are included in this module (Microbiology and Immunology 2100A and 3300A). We offer one survey course in Microbiology and Immunology (2500B) for students interested in infection and immunity, and this course may be included in the Minor (but not in any of our other modules). To complete a survey of the bacterial world, and to provide an introduction to virology, Microbiology and Immunology 3400B is included in the Minor. We do not include advanced, 4000-level courses in our Minor module.

**BSc (Honors) degree:**
It is mainly students in Biology modules of the BSc degree who choose to take courses in microbiology and immunology, though we have had chemistry students in these courses. As long as students have the prerequisite courses to take the microbiology and immunology courses, students may be from any discipline. Many students who take microbiology and immunology courses generally have an interest in medicine, and they can proceed towards that goal from a Biology degree (a route often selected by students not eligible for the BMSc program). Some students may also be interested in the genetics and developmental biology of microorganisms, or require more background in bacteriology for studies in geomicrobiology.
This year, fourth year Chemistry student aiming for Pharmacy has registered for Microbiology and Immunology 2100A. We do not tailor our courses to the needs of students in other programs. We define a number of places in our second and third year courses for students in Biology modules. Once these are filled, students must wait until constraints on registration are lifted before they can try to register (a Chemistry student would have to wait until such time).

2.1.3 Program Courses
The course descriptions (below) have been taken from the 2009 Academic Calendar. A sample of course outlines for Microbiology and Immunology 2100A, 3300A and 4200B can be found in Appendix B2. Samples of assignments for Microbiology and Immunology 2100A are available in Appendix B3. Samples of midterm tests and final examinations for Microbiology and Immunology 2100A, 3300A and 4200B are available in Appendix B4.

1. Microbiology and Immunology 2100A – Biology of Prokaryotes
This course examines the fundamental aspects of the structure, physiology, genetics, and phylogenetic relationships of the Bacteria and Archaea. Examples of medically and environmentally important organisms are presented.
Prerequisite(s): Biology 1222 or 1223; Chemistry 1050 or the former Chemistry 1020 or 023
Corequisite(s): Biochemistry 2280A
2 lecture hours, 3 laboratory hours, 0.5 course

2. Microbiology and Immunology 2500B – Biology of Infection and Immunity
The biology of selected pathogens and the diseases they cause. An examination of host/parasite relationships and strategies used by microbes to survive in their hosts. Aspects of clinical disease will be studied including diagnosis and treatment based on modern molecular techniques and the nature of host immune responses.
Antirequisite(s): Microbiology and Immunology 4100A, 4200B and 4300A
Prerequisite(s): Biology 1222 or Biology 1223, or permission of the instructor.
3 lecture hours, 0.5 course.

3. Microbiology and Immunology 3300A – Immunology
Elementary concepts of immunity, structure and function of the immune system, antigens and antibodies, complement, genetic basis of the immune response, humoral and cellular immunity, immunological tolerance, organ and tissue transplantation, allergy and autoimmunity.
Prerequisite(s): Biochemistry 2280A and Biology 2581B
2 lecture hours, 0.5 course.

4. Microbiology and Immunology 3400B – Diversity of Prokaryotes and Viruses
A study of selected groups of Bacteria and Archaea that exhibit metabolic and physiological diversity (heterotrophs, phototrophs, autotrophs, chemolithotrophs, extremophiles). Molecular systematics and identification of prokaryotes. Introduction to the structure and replication of bacterial and animal viruses (including HIV and SARS). Viral responses to host cell defenses.
Antirequisite(s): The former Microbiology and Immunology 450b.
Prerequisite(s): Biochemistry 2280A; Biology 2581B; Microbiology and Immunology 2100A. Biochemistry 3381A is recommended.
2 lecture hours, 1 tutorial hour, 0.5 course.

5. Microbiology and Immunology 3600G – Laboratory Techniques in Microbiology and Immunology
This course consists of a series of laboratory exercises designed to familiarize students with techniques in immunology, bacterial genetics, virology and molecular biology.
Prerequisite(s): Biology 2581B; Microbiology and Immunology 2100A; Microbiology and Immunology 3300A; Biochemistry 3381A
1 lecture hour, 3 laboratory hours, 0.5 course
Enrolment limited: priority will be given to students who have achieved at least 70% in both Microbiology and Immunology 3300A and Biochemistry 3381A.

6. Microbiology and Immunology 4100A – Bacterial Pathogenesis
A course offering an integrated view of the genetics and biochemistry of bacteria and their role in pathogenesis. Lectures and student presentations cover topics in bacterial pathogenesis focusing on medically important organisms.
Prerequisite(s): Biochemistry 2280A; Biology 2581B; Microbiology and Immunology 2100A; Microbiology and Immunology 3400B with a mark of at least 70%.
3 lecture hours, 0.5 course.

7. Microbiology and Immunology 4200B – Molecular Virology
Cellular and molecular mechanisms of virus reproduction including approaches to the analysis of virus structure, virus-cell interaction, virus infection, oncogenes and viral transformation of cells to cancer cells. Various examples will be used from bacterial, plant and animal viruses.
Prerequisite(s): Biochemistry 2280A; Biology 2581B; Microbiology and Immunology 3400B with a mark of at least 70%.
2 lecture hours, 2 tutorial hours, 0.5 course.

8. Microbiology and Immunology 4300A – Advanced Immunology
This course covers advanced concepts in organization and regulation of the immune system. Includes structure and function of immunoglobulins and other immune cell receptors, B and T lymphocyte interactions and signal transduction, cellular regulation by cytokines, immunological effector mechanisms, and diseases of the immune system.
Prerequisite(s): Biochemistry 2280A; Biology 2581B; Microbiology and Immunology 3300A with a mark of at least 70%.
2 lecture hours, 0.5 course.

9. Microbiology and Immunology 4700B – Molecular Genetics of Gene Expression
An advanced course examining the application of classical genetics and modern molecular biological approaches to the analysis of gene expression in both prokaryotes and eukaryotes. Topics will include transcriptional control mechanisms, regulation of simple developmental
systems, and gene mutation, mapping, and manipulation.

**Prerequisite(s):** Biochemistry 3381A; Biology 2581B.

2 lecture hours, 0.5 course.

10. **Microbiology and Immunology 4970E – Research Project and Seminar**

The major laboratory course for students in Honors Microbiology and Immunology. The course consists of lectures on laboratory safety, biosafety, use of animals in research, scientific integrity; an independent research project (topic and advisor chosen by consultation between student and faculty); scientific communication (two seminars and a written report).

**Antirequisite(s):** Biochemistry 4483E, the former Biochemistry 484E, the former Microbiology and Immunology 484.

**Prerequisite(s):** Microbiology and Immunology 3600G with a mark of at least 70%. Enrolment is limited, and is available only to students in Year 4 of the Honors Specializations in Microbiology and Immunology and Biochemistry of Infection and Immunity. Students in the Honors Specialization in Biochemistry of Infection and Immunity may substitute Biochemistry 3380G with a mark of at least 70% in place of Microbiology and Immunology 3600G as a prerequisite.

15 hours per week, 1.5 course.

Courses for students in other programs

1. **Microbiology and Immunology 3800 -- Microbiology and Immunology**

A survey course for Nursing Program students dealing with properties of pathogenic bacteria, viruses, fungi, and protozoa, and aspects of diagnosis, treatment, and prevention of infections caused by these agents.

3 lecture hours, 1.0 course.

Note: Restricted to students in the Nursing programs.
2.1.4. Course Enrolment

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2.1.6. University Course Evaluations

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2.2 MEETING THE NEEDS OF THE STUDENT

The Microbiology and Immunology program provides an excellent background for students considering professional programs (e.g. medicine, dentistry, pharmacy, optometry). Also, students are prepared for graduate studies, a teaching career, or work in government or industry. Some students take Microbiology and Immunology 2100A (Biology of Prokaryotes) as a specific prerequisite for application to Pharmacy, Optometry and some dental schools. Note that this course does not satisfy the microbiology prerequisite for the Compressed Time Frame program in the School of Nursing at the University of Western Ontario.

The structure of the degree program at The University of Western Ontario allows students to combine their interests in different subjects and receive credit for each discipline. Thus, students can select an Honors Specialization or Major in another discipline and also register in a Minor or Major in Microbiology and Immunology (we have had students in French or Music do this). It is very important that our department offers a Major in Microbiology and Immunology, as this allows students in a BSc program to study our disciplines in more depth than a Minor module provides. Only students in the BMSc program are eligible to register in our Honors Specializations.
3. PROGRAM ENHANCEMENT AND REJUVENATION

3.1 INTAKE INITIATIVES

The department participates in information sessions for the BMSc program, and provides an information session at the beginning of the Intent to Register period in February. We also attend the ‘Getting Ready for Intent to Register’ information session in the Great Hall on campus in the spring. For these information sessions, we provide copies of our newly-designed brochure about our undergraduate program. We have recently redesigned the Undergraduate section of our departmental website to include all course syllabi. Thus students may read about our courses at any time at their convenience. An email for counseling advice is provided on our website. Graduate student teaching assistants are encouraged to discuss the Microbiology and Immunology program with their students.

3.2 RECENT CHANGES AND ADDITIONS TO THE UNDERGRADUATE PROGRAM

The Honors Specialization in Biochemistry of Infection and Immunity was introduced in 2006, as was the Major in Microbiology and Immunology.

3.3 COURSE CHANGES/REVISIONS

The changes we have made to our courses have been for academic reasons, not to enhance enrollment. Enrollment has been steady the past few years, and sufficient to enable instructors to teach and evaluate students according to the best methods for the number of students registered. All courses are now on WebCT to facilitate transfer of information.

The most significant change in our courses was to implement a minimum mark requirement for some prerequisites for three of the 4000-level courses. This proposal took some discussion at the BMSc Advisory Committee and Educational Policy Committee levels, but was approved. Thus students need to have a minimum mark of 70% in prerequisite courses as follows:
- Microbiology and Immunology 3300A for Microbiology and Immunology 4300A
- Microbiology and Immunology 3400B for Microbiology and Immunology 4100A and 4200B
- Microbiology and Immunology 3600G for Microbiology and Immunology 4970E

The Undergraduate Education Committee in our department felt strongly that this requirement was essential to maintain the academic standards in the advanced courses. It is difficult to teach at an advanced level when some students are not of that academic calibre. So we sacrificed increased enrollment for academic standards.

Three years ago the course coordinators in Microbiology and Immunology 2100A and 3600G met and discussed guidelines for writing lab reports in the disciplines, such that students in both courses receive similar information. Thus a student in Microbiology and Immunology 2100A learns to write a lab report in stages, and with the same guidelines that will
subsequently be used in take Microbiology and Immunology 3600G, where the reports are much more detailed.

It is worth noting that funds from the undergraduate student levy (Science Students Donations) have been used over the past four to five years to purchase new light microscopes (at approximately $5,000 each) for the labs in Microbiology and Immunology 2100A.

Microbiology and Immunology 4300A has undergone several improvements based on student feedback. There are now fewer instructors and tests and exams include a few short answer questions, rather than just multiple choice questions.

The course curriculum in Microbiology and Immunology 3400B (formerly 360b) was revised effective January 2005 to include a tutorial period on Friday. This period is used for student presentations, which are well received by students who appreciate the opportunity to learn oral presentation skills before Year 4.

Supervisors available to students in Microbiology and Immunology 4970E now include researchers in the Department of Anatomy and Cell Biology. This change occurred because the Department of Biochemistry now offers an Honors Specialization in Biochemistry and Cell Biology. The Department of Microbiology and Immunology has for years shared a pool of supervisors with the Department of Biochemistry, and thus the pool was expanded to include those in Anatomy and Cell Biology.

3.4 COURSE ADDITIONS

We have not introduced any new Microbiology and Immunology courses since 2005.

3.5 IMPROVEMENTS TO ENHANCE PROGRAM QUALITY

The department has received approval from the Dean of Medicine to advertise a Faculty Position in Undergraduate Education at the Assistant Professor level, who will play a major role in curriculum development for all courses in the Microbiology and Immunology undergraduate program. Responsibilities will also include lecturing in selected courses and coordination of an undergraduate laboratory course. This will be a five-year, limited-term position. Applications will be accepted until March 31, 2010. We have ideas for new courses and revision of current courses, but no changes to our program will be made until this Educator position has been filled, and our program reviewed.
4. RESOURCES

4.1 FACULTY TEACHING

All of the Microbiology and Immunology courses are taught by regular full-time professors, or professors emeriti (post-retirement appointments). We do not have part-time faculty members as instructors. Microbiology and Immunology as an integrated discipline requires a sound understanding of basic fundamentals in both disciplines. Thus, instructors in upper year courses rely on knowledge that is taught in earlier years, via prerequisite courses. Instructors should understand the program as a whole, so they can set up their curricula to best serve the students in their education.

The number and rank of faculty members involved in teaching the undergraduate Microbiology and Immunology courses is summarized below.

Faculty members involved in undergraduate teaching

<table>
<thead>
<tr>
<th>RANK</th>
<th>2005/06</th>
<th>2006/07</th>
<th>2007/08</th>
<th>2008/09</th>
<th>2009/10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professor</td>
<td>16</td>
<td>16</td>
<td>15</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>8</td>
<td>8</td>
<td>9</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Assistant Professor</td>
<td>6</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Instructor</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

The number of teaching hours in each undergraduate course by faculty members for 2009/10 is available in Appendix B5. For a full listing of the department’s faculty complement, see Appendix B6. The CVs of the following three faculty members are included on Disk 2:

- Dr. Mansour Haeryfar, Assistant Professor:
  - Teaches in Year 3
- Dr. Susan Koval, Associate Professor:
  - Co-Chair of the Undergraduate Education Committee: 1986-1990, 2003-2004
  - Chair of the Undergraduate Education Committee: 1990-1994, 2004-2009
  - Teaches Year 2 and 3 courses
- Dr. John McCormick, Associate Professor
  - Current Chair of the Undergraduate Education Committee
  - Teaches in Years 2 and 4
- Dr. Vince Morris, Professor
  - Teaches in Years 3 and 4

4.2 STAFF

The number of staff members involved in teaching the undergraduate Microbiology and Immunology courses is summarized below. For a full listing of the department’s staff complement, see Appendix B7.
Staff members involved in undergraduate teaching

<table>
<thead>
<tr>
<th>ROLES</th>
<th>2005/06</th>
<th>2006/07</th>
<th>2007/08</th>
<th>2008/09</th>
<th>2009/10</th>
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<tbody>
<tr>
<td>Administrative</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Technical/Laboratory*</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

* supported by the departmental budget

The Administrative staff member is the Teaching and Research Coordinator in the department, as well as the Undergraduate Administrative Assistant. Technical staff, employed through research grants, play a significant role in the supervision of student research projects.

Graduate Teaching Assistantships - Full-time Equivalent (FTE) Appointments

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9.36</td>
<td>9.15</td>
<td>8.72</td>
<td>8.73</td>
<td>10.15</td>
</tr>
</tbody>
</table>

1.0 FTE = 10 hours/week/8 months
* includes participation in Medical Sciences 400E
^ proposed allocation

4.3 FACILITIES AND EQUIPMENT

All classrooms are provided with computers and data projectors. This equipment is maintained either by the Classroom Management Group (UWO) or Teaching & Technology Services (SSMD). New, multi use, teaching laboratories were constructed in the Medical Sciences Building (the Drimmer Family Teaching Facility) and operational in September 2006. Each department has its own equipment, but some common equipment is shared. Older equipment in use by our department is being gradually replaced as the budget allows. Both of our undergraduate courses with laboratory sessions (Microbiology and Immunology 2100A and 3600G) use this facility. The fourth year research projects are done in the laboratory of a faculty member. These students have access to core facilities in the Schulich School of Medicine and Dentistry, should their project require such equipment or analyses. Our department also maintains the Transmission Electron Microscopy facility, which is available for fourth year research projects.

Wireless high-speed access is available throughout campus. Computer labs are available to students on a drop-in basis, or by reservation to the faculty for teaching. Our department does not have a computer facility available to undergraduate students. Microphones are available in all large capacity classrooms. Newer rooms may have two data projectors. Teaching assistants may be assigned to large class sizes. Their duties vary among courses.

4.4 SPEAKERS, CONFERENCES, ETC.

Undergraduate students are invited to participate in all departmental sponsored seminars. Typically there are 35 invited speakers each year. Fourth year students are invited to attend and participate in the annual Infection and Immunity Research Forum, organized by the graduate students in the department and held in November. For the first time last year,
undergraduate students could submit an abstract for a poster presentation, to be judged in a category specifically for undergraduate students.

4.5 LIBRARY RESOURCES

The library supports this department through various activities. Collections activities in this subject area are informed by the presence of an up to date collections management policy. The library strives to acquire materials that will support the department’s instructional activities. Instructors in Microbiology and Immunology continue to make use of the library’s course reserves service to facilitate access for students to course readings.

4.6 PROVIDING GUIDANCE FOR UNDERGRADUATE STUDENTS

Several faculty members of the Department of Microbiology and Immunology who are heavily involved in undergraduate teaching and serve on our Undergraduate Education Committee provide counseling to students. An e-mail account (mni-counsel@uwo.ca) has been created for this purpose and is available on the department website as well as through the Faculty of Science and on the BMSc homepage. The Chair of the Undergraduate Education Committee responds to emails during the term. In the summer, a schedule is set up and three to four counselors rotate to answer queries. When a one-on-one meeting with a student is deemed necessary, such a meeting is arranged. When students’ questions can be better addressed by the academic counselors in the Office of the Dean, Faculty of Science, students are quickly provided with the contact information and referred to the counselors for further assistance.

Students have full and convenient access to course outlines/syllabi through the departmental website (http://www.uwo.ca/mni/undergraduate/index.html). In addition, course descriptions, prerequisites and anti-requisites for each course are clearly stated in the online academic calendar.

Every effort is made to familiarize faculty members with efficient and recently available evaluation techniques that are useful to further improve the quality of our undergraduate education program. To this end, a teaching retreat is held where faculty members and course coordinators discuss such methods, their course content, evaluations and changes in an open forum format to enable constructive discussions. Importantly, such discussions help create harmony among faculty members and their courses and prevent course material overlap when deemed unnecessary. In addition, these retreats usually involve at least one guest speaker who share his/her experience with regard to teaching undergraduate courses (e.g., how best to manage large size classes) or using recently available state-of-the-art technologies for evaluations (e.g., the efficient use of clicker technology). In addition to a teaching retreat, our Undergraduate Education Committee Chair provides a comprehensive update on our courses and the issues pertaining to our undergraduate program in our monthly faculty meetings and sends useful information via e-mail to all faculty and administrative members of the Department when needed.
4.7 COMMUNITY SUPPORT AND OUTREACH: SPECIAL PROGRAMS

The Department has an Outreach Committee which participates in two annual events for high school students: Fall Preview Day in November and March Break Open House in March. Various faculty members accept high school cooperative education students into their laboratories or serve as judges in the London and District Science and Technology Fair. Dr. Susan Koval has been the Divisional Chief for the Life Sciences exhibits in the Fair since 2003. Individual faculty members and graduate students take part in the mini-medical school and Café Scientifique offered through the Schulich School of Medicine & Dentistry.

4.8 AWARDS AND FUNDING

In-Course Scholarships:

**Dr. G.E. Hall Scholarship:** Awarded to a student with the highest average in third year who is entering fourth year of an Honors Specialization or a Major module (in an Honors degree) offered by the Department of Microbiology and Immunology. These scholarships were established through Foundation Western. Value: $400
5. PARTICIPATION IN MEDICAL SCIENCES MODULES

“Medical Sciences” is the name for the multi-disciplinary modules designed for students who want to study more than one basic medical science. The basic medical sciences include:

- Anatomy and Cell Biology
- Biochemistry
- Epidemiology and Biostatistics
- Medical Biophysics
- Microbiology and Immunology
- Pathology
- Pharmacology
- Physiology

5.1 MEDICAL SCIENCES MODULES

Honors Specialization in Medical Sciences:
With capacity for 120 students, the Honors Specialization in Medical Sciences is the module of choice for one third of the students enrolled in the BMSc program. The flexibility to study at least two basic medical science disciplines is a major attraction of this module. During Years 3 and 4, students take several basic medical science courses, some of which are at the advanced (fourth-year) level. In Year 4, students undertake two multi-disciplinary courses -- Medical Sciences 4900F/G and Medical Sciences 4930F/G -- rather than a discipline-specific research project course.

Specialization in Medical Sciences:
This course-based module can only be completed in a non-honors BMSc degree and is not, therefore, as popular as the Honors Specialization or Major modules.

Major in Medical Sciences:
A popular option for students wishing to take introductory courses from at least two basic medical sciences, the Major may be:

- combined with another Major from the basic medical sciences (BMSc degree), or
- taken alone or combined with a Major from another faculty

Minor in Medical Sciences:
This four-course module allows for a limited introduction to one or more of the basic medical science disciplines.

Combined HBA/BMSc program
Students with an 80% average at the end of Year 2 and are accepted into the HBA program may complete the combined degree program -- HBA (Business Administration) and BMSc (Honors Specialization in Medical Sciences). A full year of studies in Ivey (HBA1) is followed by two years of combined studies in Ivey and the BMSc program.
5.1.1. Modular Enrolment

Enrolment numbers in the Medical Sciences modules over the last 5 years are displayed in the chart below. The years of limited enrolment for modules that can only be completed within the BMSc Program are high-lighted.

<table>
<thead>
<tr>
<th>Honors Specialization (HSP) in Medical Sciences</th>
<th>2005/06</th>
<th>2006/07</th>
<th>2007/08</th>
<th>2008/09</th>
<th>2009/10*</th>
</tr>
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<tbody>
<tr>
<td>Year 2</td>
<td>206</td>
<td>74</td>
<td>119</td>
<td>123</td>
<td>126</td>
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<tr>
<td>Year 3</td>
<td>136</td>
<td>136</td>
<td>92</td>
<td>104</td>
<td>130</td>
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<tr>
<td>Year 4</td>
<td>65</td>
<td>109</td>
<td>98</td>
<td>102</td>
<td>99</td>
</tr>
<tr>
<td><strong>total enrolment in HSP in Medical Sciences</strong></td>
<td><strong>407</strong></td>
<td><strong>319</strong></td>
<td><strong>309</strong></td>
<td><strong>329</strong></td>
<td><strong>355</strong></td>
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<tr>
<td><strong>Number graduating with HSP in Medical Sciences</strong></td>
<td><strong>62</strong></td>
<td><strong>109</strong></td>
<td><strong>95</strong></td>
<td><strong>87</strong></td>
<td></td>
</tr>
<tr>
<td>HSP Medical Sciences/ HBA (Business Administration)</td>
<td>2005/06</td>
<td>2006/07</td>
<td>2007/08</td>
<td>2008/09</td>
<td>2009/10*</td>
</tr>
<tr>
<td>Year 4</td>
<td>5</td>
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<td>5</td>
<td>8</td>
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<td>Year 5</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td><strong>total enrolment in Specialization in Medical Sciences</strong></td>
<td><strong>7</strong></td>
<td><strong>2</strong></td>
<td><strong>1</strong></td>
<td><strong>5</strong></td>
<td><strong>15</strong></td>
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<tr>
<td><strong>Number graduating with HSP Medical Sciences/HBA</strong></td>
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<td><strong>5</strong></td>
<td><strong>1</strong></td>
<td><strong>1</strong></td>
<td></td>
</tr>
<tr>
<td>Specialization (SPZ) in Medical Sciences</td>
<td>2005/06</td>
<td>2006/07</td>
<td>2007/08</td>
<td>2008/09</td>
<td>2009/10*</td>
</tr>
<tr>
<td>Year 2</td>
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<td>0</td>
<td>4</td>
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</tr>
<tr>
<td>Year 3</td>
<td>83</td>
<td>76</td>
<td>19</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Year 4</td>
<td>53</td>
<td>61</td>
<td>91</td>
<td>27</td>
<td>6</td>
</tr>
<tr>
<td><strong>total enrolment in SPZ in Medical Sciences</strong></td>
<td><strong>191</strong></td>
<td><strong>140</strong></td>
<td><strong>110</strong></td>
<td><strong>34</strong></td>
<td><strong>11</strong></td>
</tr>
<tr>
<td><strong>Number graduating with SPZ in Medical Sciences</strong></td>
<td><strong>32</strong></td>
<td><strong>27</strong></td>
<td><strong>47</strong></td>
<td><strong>11</strong></td>
<td></td>
</tr>
<tr>
<td>Major in Medical Sciences</td>
<td>2005/06</td>
<td>2006/07</td>
<td>2007/08</td>
<td>2008/09</td>
<td>2009/10*</td>
</tr>
<tr>
<td>Year 2</td>
<td>13</td>
<td>109</td>
<td>87</td>
<td>92</td>
<td>65</td>
</tr>
<tr>
<td>Year 3</td>
<td>6</td>
<td>52</td>
<td>111</td>
<td>140</td>
<td>97</td>
</tr>
<tr>
<td>Year 4</td>
<td>7</td>
<td>106</td>
<td>134</td>
<td>129</td>
<td>151</td>
</tr>
<tr>
<td><strong>total enrolment in Major in Medical Sciences</strong></td>
<td><strong>26</strong></td>
<td><strong>267</strong></td>
<td><strong>332</strong></td>
<td><strong>361</strong></td>
<td><strong>313</strong></td>
</tr>
<tr>
<td><strong>Number graduating with a Major in Medical Sciences</strong></td>
<td><strong>10</strong></td>
<td><strong>75</strong></td>
<td><strong>137</strong></td>
<td><strong>115</strong></td>
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</tr>
<tr>
<td>Minor in Medical Sciences</td>
<td>2005/06</td>
<td>2006/07</td>
<td>2007/08</td>
<td>2008/09</td>
<td>2009/10*</td>
</tr>
<tr>
<td>Year 2</td>
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<td>18</td>
<td>13</td>
<td>14</td>
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</tr>
<tr>
<td>Year 3</td>
<td>8</td>
<td>20</td>
<td>12</td>
<td>11</td>
<td>18</td>
</tr>
<tr>
<td>Year 4</td>
<td>2</td>
<td>19</td>
<td>17</td>
<td>16</td>
<td>26</td>
</tr>
<tr>
<td><strong>total enrolment in Minor in Medical Sciences</strong></td>
<td><strong>26</strong></td>
<td><strong>57</strong></td>
<td><strong>42</strong></td>
<td><strong>41</strong></td>
<td><strong>53</strong></td>
</tr>
<tr>
<td><strong>Number graduating with a Minor in Medical Sciences</strong></td>
<td><strong>4</strong></td>
<td><strong>10</strong></td>
<td><strong>9</strong></td>
<td><strong>21</strong></td>
<td></td>
</tr>
</tbody>
</table>

*as of 10/20/09

5.2 MEDICAL SCIENCES COURSES

Medical Sciences 4900F/G:
In this hands-on laboratory course, students perform a group experiment on a clinical disease (e.g., atherosclerosis). A variety of techniques and current technologies used in medical research are introduced, including: animal models of disease, real time PCR, biochemical assays, histology, and medical imaging.
Medical Sciences 4930F/G:
In this lecture series, research scientists and clinicians provide students with background knowledge in the clinical disease examined in Medical Sciences 4900F/G. Topics include disease, metabolism, medical imaging techniques, drug intervention and signaling pathways.

5.2.1. Medical Sciences Course Enrolment

<table>
<thead>
<tr>
<th>COURSE NUMBER</th>
<th>2005/06</th>
<th>2006/07</th>
<th>2007/08</th>
<th>2008/09</th>
<th>2009/10*</th>
</tr>
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<tbody>
<tr>
<td>400E - Section 001</td>
<td>30</td>
<td>28</td>
<td>31</td>
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<td>--</td>
</tr>
<tr>
<td>400E - Section 002</td>
<td>33</td>
<td>31</td>
<td>30</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>4100F</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>17</td>
</tr>
<tr>
<td>4900F - Section 001</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>21</td>
<td>20</td>
</tr>
<tr>
<td>4900F - Section 002</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>26</td>
<td>21</td>
</tr>
<tr>
<td>4900G - Section 001</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>25</td>
<td>23</td>
</tr>
<tr>
<td>4900G - Section 002</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>28</td>
<td>30</td>
</tr>
<tr>
<td>4930F</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>62</td>
<td>62</td>
</tr>
<tr>
<td>4930G</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>38</td>
<td>32</td>
</tr>
<tr>
<td>Total registrants for year</td>
<td>63</td>
<td>59</td>
<td>61</td>
<td>200</td>
<td>205</td>
</tr>
</tbody>
</table>

*as of 10/20/09

5.2.2 Medical Sciences Course Averages

<table>
<thead>
<tr>
<th>COURSE NUMBER</th>
<th>2005/06</th>
<th>2006/07</th>
<th>2007/08</th>
<th>2008/09</th>
</tr>
</thead>
<tbody>
<tr>
<td>400E - Section 001</td>
<td>85</td>
<td>90</td>
<td>87</td>
<td>--</td>
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<tr>
<td>400E - Section 002</td>
<td>86</td>
<td>90</td>
<td>88</td>
<td>--</td>
</tr>
<tr>
<td>4900F - Section 001</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>88</td>
</tr>
<tr>
<td>4900F - Section 002</td>
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<td>--</td>
<td>--</td>
<td>88</td>
</tr>
<tr>
<td>4900G - Section 001</td>
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<td>4930F</td>
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<td>--</td>
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<td>86</td>
</tr>
<tr>
<td>4930G</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>83</td>
</tr>
</tbody>
</table>

* as of 10/20/09

5.3 MICROBIOLOGY AND IMMUNOLOGY: PARTICIPATION IN MEDICAL SCIENCES MODULES

Students enrolled in Medical Sciences modules must satisfy certain “discipline requirements” such that their module provides them with an interdisciplinary academic experience. This requirement, as well as the department’s participation in the modules, is highlighted below. The popularity of disciplines and the enrolment trend over the past 5 years are depicted in chart form following the modular outline for the Honors Specialization in Medical Sciences.
HONORS SPECIALIZATION IN MEDICAL SCIENCES

Enrolment in this module requires registration in the BMSc program and is limited. Meeting the minimum requirements does not guarantee that students wishing to enter or progress in this module will be offered enrolment. See BMSc PROGRAM.

Admission Requirements

Completion of first-year requirements with no failures. Students must have an average of at least 70% on the following 3.0 principal courses, with no mark in these principal courses below 65%.

1.0 course from: Biology 1222, 1223.
1.0 course: Chemistry 1050, or the former Chemistry 1020 or 023.

1.0 course from: Physics 1020, 1024, 1028A/B and 1029A/B, or the former Physics 022 or 025, must be completed by the end of second year, with a minimum mark of 65%.

Module: 9.5 courses:
0.5 course: Biochemistry 2280A.
0.5 course from: Chemistry 2213A/B or 2273A.
0.5 course from: Chemistry 2223B or a Chemistry half course at the 2000- or 3000-level.
0.5 course from: Biology 2244A/B, Statistical Sciences 2122A/B.
1.5 courses: Biology 2290F/G, 2382B, 2581B.
1.0 course: Medical Sciences 4900F/G and 4930F/G, or the former Medical Sciences 400E.

*With these 5.0 courses, the following 'discipline requirement' must be satisfied: 2.0 courses must be chosen from one of the Basic Medical Science disciplines (see below); 2.0 courses must be chosen from either a second Basic Medical Science discipline or a combination of Basic Medical Science disciplines other than the first discipline chosen; and the remaining 1.0 course may be chosen from any of the Basic Medical Science disciplines, including disciplines already selected.
Basic Medical Science Disciplines:
Anatomy and Cell Biology, Biochemistry, Epidemiology and Biostatistics, Medical Biophysics, Microbiology and Immunology, Pathology, Pharmacology, and Physiology

Notes:
1. In addition to Biology 2290F/G and Chemistry 2213A/B, one half course with a laboratory component chosen from those courses available in the module must be completed prior to entering the final year of the module.
2. History of Science courses may not be included in the Honors Specialization module. These courses may be taken as optional courses, only.

Students are advised to consult with the Medical Sciences counsellor prior to selecting 3000- and 4000-level courses to ensure that appropriate prerequisite courses have been selected.

5.3.1 Discipline Enrolment Trend in the Honors Specialization in Medical Sciences
Registration in courses within each discipline is displayed as a percentage of all basic medical science courses taken by students in Years 2-4 over the past five years.
SPECIALIZATION IN MEDICAL SCIENCES

This module may only be completed within a BMSc degree. See BMSc PROGRAM.

Admission Requirements

Completion of first-year requirements, including the following 3.0 courses with a minimum mark of 60% in each:

1.0 course from: Biology 1222, 1223.
1.0 course: Chemistry 1050, or the former Chemistry 1020 or 023.
1.0 course from: Physics 1020, 1024, 1028A/B and 1029A/B, or the former Physics 022 or 025, must be completed by the end of second year, with a minimum mark of 60%.

Module: 9.0 courses

0.5 course: Biochemistry 2280A.
1.0 course from: Chemistry 2213A/B and either Chemistry 2223B or a 0.5 course in Chemistry at the 2000- or 3000-level, or Chemistry 2273A and 2283G.
0.5 course from: Biology 2244A/B, Statistical Sciences 2122A/B.
1.5 courses: Biology 2290F/G, 2382B, 2581B.

*With these 5.5 courses, the following 'discipline requirement' must be satisfied: 2.0 courses must be chosen from one of the Basic Medical Science disciplines (see below); 2.0 courses must be chosen from either a second Basic Medical Science discipline or a combination of Basic Medical Science disciplines other than the first discipline chosen; and the remaining 1.5 courses may be chosen from any of the Basic Medical Science disciplines, including disciplines already selected.

In addition to Biology 2290F/G and Chemistry 2213A/B, one half course with a laboratory component chosen from those courses available in the module must be completed prior to entering the final year of the module.

Students are advised to consult with the Medical Sciences counsellor prior to selecting 3000- and 4000-level courses to ensure that appropriate prerequisite courses have been selected.

Basic Medical Science Disciplines

Anatomy and Cell Biology, Biochemistry, Epidemiology and Biostatistics, Medical Biophysics, Microbiology and Immunology, Pathology, Pharmacology, and Physiology.
MAJOR IN MEDICAL SCIENCES

Admission Requirements
Completion of first-year requirements, including the following 3.0 courses with a minimum mark of 60% in each:

1.0 course from: Biology 1222, 1223.
1.0 course: Chemistry 1050, or the former Chemistry 1020 or 023.

1.0 course from: Physics 1020, 1024, 1028A/B and 1029A/B, or the former Physics 022 or 025, must be completed by the end of second year, with a minimum mark of 60%.

Module: 6.0 courses
0.5 course: Biochemistry 2280A.
1.0 course from: Chemistry 2213A/B and either Chemistry 2223B or a 0.5 course in Chemistry at the 2000- or 3000- level, or Chemistry 2273A and 2283G.
0.5 course from: Biology 2244A/B, Statistical Sciences 2122A/B.
1.0 course from: Biology 2290F/G, 2382B, 2581B.

*With these 3.0 courses, the following 'discipline requirement' must be satisfied: 1.0 course must be selected from one of the Basic Medical Science Disciplines (see below); 1.0 course must be selected from a different Basic Medical Science Discipline; and the remaining 1.0 course may be selected from any of the Basic Medical Science Disciplines, including one or both of the disciplines already selected.

Note: Basic Medical Science courses at the 4000-level may be included in the Major only with permission of the Medical Sciences counselor.

Basic Medical Science Disciplines
Anatomy and Cell Biology, Biochemistry, Epidemiology and Biostatistics, Medical Biophysics, Microbiology and Immunology, Pathology, Pharmacology, and Physiology.
MINOR IN MEDICAL SCIENCES

Admission Requirements
Completion of first-year requirements, including Biology 1222 or 1223 and Chemistry 1050 or the former Chemistry 1020 or 023, each with a mark of at least 60%.

Module: 4.0 courses
0.5 course: Biochemistry 2280A.
0.5 course: Chemistry 2213A/B.
1.0 course from: Biology 2290F/G, 2382B, 2581B.
1.5 courses from the Basic Medical Science disciplines (see definition below) at the 2000- or 3000-level (with the exception of Physiology 2130, Medical Biophysics 2128A/B and 2129A/B).
0.5 course from either one of the Basic Medical Science disciplines (see definition below) or Biology at the 2000- or 3000-level, or one of Chemistry 2210A/B, 2211A/B, 2214A/B, 2223B or 3393A/B.

Basic Medical Science Disciplines
Anatomy and Cell Biology, Biochemistry, Epidemiology and Biostatistics, Medical Biophysics, Microbiology and Immunology, Pathology, Pharmacology, and Physiology.
6. **SWOT ANALYSIS (Strengths, Weaknesses, Opportunities, Threats)**

**Strengths:**
- all 2000 and 3000 level courses are at greater than 75% capacity
- laboratory courses (Microbiology and Immunology 2100A and 3600G) provide excellent exercises for students
- provide an introductory course (Microbiology and Immunology 2500B, Biology of Infection and Immunity) to students outside our modules (except for the Minor in Microbiology and Immunology)
- a number of courses include current infectious diseases/outbreaks
- research project and seminar course is well-organized and provides students with practical research experience

**Weaknesses:**
- students need more opportunities to develop laboratory skills before Year 4
- no optional courses in Year 4
- different work attitudes and expectations from different supervisors of Microbiology and Immunology 4970E projects
- poor writing skills of undergraduate students

**Opportunities:**
- Educator position
- improve integration of courses
- redesign our Year 3 laboratory course offerings: take the content of MicroImm 3600G and place it in two separate courses: one for immunology, and one for molecular genetics; or base it on research themes
- ask for a one week block of teaching in first year Biology course; to attract students to our disciplines and programs

**Threats:**
- reliance on post-retirement or sessional appointments for teaching commitments
- balance of teaching and research commitments
APPENDICES A1 – A5:

A1. Admission Requirements and Criteria
A2. Summary of Focus Group Sessions
A3. BMSUE Program – Terms of Reference
A4. Western Library Support Services
A5. Core Research Facilities
APPENDIX A1: Admission Requirements and Criteria

ADMISSION TO YEAR 2 OF A BMSc DEGREE

Normally the route into Year 2 of a BMSc degree is through the Biological and Medical Sciences first entry program. Students may, however, apply for entry into Year 2 of a BMSc degree from a different first-year program provided they satisfy the admission requirements and admission criteria.

Admission Requirements:

Successful completion of 5.0 courses in first year, including the following 3.0 principal courses: (exception: modules in Medical Biophysics).

- Biology 1222 or 1223
- Chemistry 1050 or the former Chemistry 020 or 023

NOTE: 1.0 course from Physics 1020, 1024, or 1028A/B and 1029A/B must be completed by the end of Year 2. The combination of Physics 1028A and 1029B is recommended for all Basic Medical Science modules with the exception of modules in Medical Biophysics.

Minimum marks required for entry into Honors Specializations in a BMSc degree:

- 65% in each of the 3.0 first-year principal courses (marks in half courses in mathematics are not averaged – a minimum mark of 65% must be achieved in each half course)
- 65% in the first-year physics course (marks in half courses in physics are not averaged – a minimum mark of 65% must be achieved in each half course)

Minimum marks required for entry into either Double Majors or a Specialization in a BMSc degree:

- 60% in each of the 3.0 first-year principal courses (marks in half courses in mathematics are not averaged – a minimum mark of 60% must be achieved in each half course)
- 60% in the first-year physics course (marks in half courses in physics are not averaged – a minimum mark of 65% must be achieved in each half course)

Admission Criteria:

Preference will be given, based on the following criteria:

- completion of a full load of 5.0 courses in Year 1 (September to April)
- completion of the 3.0 first-year principal courses by the end of Year 1 (April 30th)
- achievement of an average (cutoff average) of 78.0% or higher in the 3.0 first-year principal courses
- achievement of a passing grade in each option

NOTES:

1. Students satisfying the admission requirements and ALL the admission criteria will be admitted to BMSc degrees in Year 2.
2. Additional students, who did not meet all the admission criteria, may be considered for entry if the initial pool of applicants does not fill 370 spaces.
3. Students with averages less than 75.0% in the 3.0 first-year principal courses will not be considered for BMSc degrees.

ADMISSION TO YEAR 3 OF A BMSc DEGREE
Students may apply for admission to Year 3 of a BMSc degree from any second-year module/degree provided they satisfy the admission requirements and criteria. Students who are registered in Year 2 of a BMSc degree are not guaranteed progression into a BMSc degree in Year 3 as they too must meet the minimum marks requirements and the admission criteria.

Minimum marks are required in the following courses:
- the first-year Biology, Chemistry, Mathematics and Physics courses (either a minimum mark of 65% in each course for an Honors Specialization or 60% in each course for a Double Major or Specialization), and
- the modular courses listed in the Honors Specialization, Major or Specialization
The following are considered "foundation" courses for the BMSc degree (except Medical Biophysics):
- Biochemistry 2280A
- Biology 2581b
- Biology 2382b
- Biology 2290F/G
- Chemistry 2213A/B
- Chemistry 2223A/B
- Biology 2244A/B or Statistical Sciences 2122A/B
*or approved alternatives* in the module

Admission Criteria:
Preference will be given, based on the following criteria:
- completion of a full load of 5.0 courses in Year 2 (September to April)
- completion of the 4.0 first-year Biology, Chemistry, Math and Physics courses by the end of Year 2 (April 30th)
- completion of a minimum of 3.0 foundation courses by the end of Year 2 (April 30th), with a minimum of 2.5 foundation courses completed at Western during Fall/Winter session of Year 2
- achievement of a minimum mark of 60% in each foundation course taken
- achievement of an average (cutoff average) of 78.0% or higher in 3.0 foundation courses (if all 3.5 foundation courses are completed by April 30th, the marks from the best 3.0 foundation courses, regardless of the module requested, will be used in the calculation of the cutoff average)
- achievement of a passing grade in each option
- preference for foundation courses attempted only once
• if a foundation course is repeated at Western, the average of the two marks will be used in the calculation of the average

NOTES:
1. Students satisfying the admission requirements (minimum marks in the first-year courses) and ALL the admission criteria will be admitted to BMSc degrees in Year 3.
2. Additional students, who did not meet all the admission criteria, may be considered for entry if the initial pool of applicants does not fill 370 spaces.
3. Students with averages less than 75.0% in their best 3.0 foundation courses will not be considered for BMSc degrees.
4. Students considering courses at Athabasca University should first consult with the departmental or Dean’s Office academic counselors.

ADMISSION TO YEAR 4 OF A BMSc DEGREE
Only those students who have been admitted to Year 3 of the BMSc Program may progress to Year 4 of the BMSc Program.

Spaces are not limited in either the Specializations (with the exception of Pathology and Toxicology) or Double Majors in Year 4. However, each Honors Specialization module offered within BMSc degrees has a limited number of spaces in Year 4 and preference will be given, based on the following criteria:
• completion of the first-year principal courses with a minimum mark of 65% in each (full or half) course
• completion of a full load of courses (5.0) in Year 3
• completion of the “Foundation Courses” and the “Additional Modular Courses” as outlined in the “Weighted Averages Chart” for the Honors Specialization requested, with a mark of at least 60% in each of these courses (NOTE: some Honors Specializations require marks higher than 60% in some of these courses)
• achievement of a weighted average of at least 75%, as calculated for the Honors Specialization requested
• achievement of a passing grade in each option
• preference for foundation courses and additional modular courses completed only once

NOTE: When the number of students applying for a particular Honors Specialization is greater than the number of available spaces in Year 4, departments rank students based on a weighted average during the adjudication period (May). Departments work their way down the rankings, starting at the highest weighted average, until the spaces in the Honors Specialization are filled. The weighted average of the last student admitted to the Honors Specialization will be considered to be the cutoff average for entry into that Honors Specialization.
Weighted Averages Chart – used to determine the ranking of students requesting Year 4 Honors Specialization modules

<table>
<thead>
<tr>
<th>Honors Specialization Module</th>
<th>Foundation Courses</th>
<th>Additional Modular Courses (primarily from the Basic Medical Sciences)</th>
<th>Weighted Average*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biochemistry</td>
<td>Biochemistry 2280A; Biology 2581B; Biology 2244A/B or Stats 2122A/B; 1.0 course from Chemistry 2213A/B plus 2223B, or Chemistry 2273A plus 2283G; 1.0 course from Biology 2382B, Biology 2290F/G, Chemistry 2211A/B, 2214A/B, 2274A, 2284B.</td>
<td>Biochemistry 3380G; Biochemistry 3381A; Biochemistry 3382B</td>
<td>33% (average in Foundation courses) + 67% (average in Additional Modular courses)</td>
</tr>
<tr>
<td>Biochemistry and Cell Biology</td>
<td>Biochemistry 2280A; Biology 2581B; Biology 2382B; Biology 2290F/G; 1.0 course from Chemistry 2213A/B and 2223B, or Chemistry 2273A and 2283G; Biology 2244A/B or Stats 2122A/B</td>
<td>Biochemistry 3380G; Biochemistry 3381A; Biochemistry 3382B; Biology 3316A; Biology 3326F/G; Anatomy &amp; Cell Biology 3309</td>
<td>33% (average in Foundation courses) + 67% (average in Additional Modular courses)</td>
</tr>
<tr>
<td>Biochemistry of Infection and Immunity</td>
<td>Biochemistry 2280A; Biology 2581B; Biology 2382B; Biology 2290F/G; 1.0 course from Chemistry 2213A/B and 2223B, or Chemistry 2273A and 2283G; Biology 2244A/B or Stats 2122A/B</td>
<td>Biochemistry 3380G or Microbiology &amp; Immunology 3600G; Biochemistry 3381A; Biochemistry 3382B; Microbiology &amp; Immunology 2100A; Microbiology &amp; Immunology 3300A; Microbiology &amp; Immunology 3400B</td>
<td>33% (average in Foundation courses) + 67% (average in Additional Modular courses)</td>
</tr>
<tr>
<td>Clinical Biochemistry</td>
<td>Biochemistry 2280A; Biology 2581B; 1.0 course from Chemistry 2213A/B plus 2223B, or Chemistry 2273A plus 2283G; 1.0 course from Biology 2382B, 2290F/G, Chemistry 2214A/B, 2211A/B or Chemistry 2274A plus 2284B; Biology 2244A/B or Stats 2122A/B</td>
<td>Biochemistry 3381A; Biochemistry 3382B; Biochemistry 3385A; Biochemistry 3386B; Biochemistry 3387G</td>
<td>33% (average in Foundation courses) + 67% (average in Additional Modular courses)</td>
</tr>
<tr>
<td>Medical Biophysics</td>
<td>Biochemistry 2280A; Chemistry 2213A/B; Physics 2101A/B; Physics 2102A/B; Calculus 2502A/B or 2302A/B; Calculus 2503A/B or 2303A/B; 0.5 course from Chemistry 2214A/B, Biology 2581B or Biology 2382B; Stats 2122A/B or Biology 2244A/B</td>
<td>Medical Biophysics 3302E; Medical Biophysics 3303E; Medical Biophysics 3330F or Medical Biophysics 3336G</td>
<td>33% (average in Foundation courses) + 67% (average in Additional Modular courses)</td>
</tr>
</tbody>
</table>
**Weighted Averages Chart – used to determine the ranking of students requesting Year 4 Honors Specialization modules**

<table>
<thead>
<tr>
<th>Honors Specialization Module</th>
<th>Foundation Courses</th>
<th>Additional Modular Courses (primarily from the Basic Medical Sciences)</th>
<th>Weighted Average*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical Cell Biology</td>
<td>Biochemistry 2280A; Biology 2581B; Biology 2382B; Biology 2290F/G; 1.0 course from Chemistry 2213A/B and 2223B, or Chemistry 2273A and 2283G; Bio 2244A/B or Stats 2122A/B</td>
<td>Biochemistry 3381A; Biochemistry 3382B; Anatomy &amp; Cell Biology 3309; Biology 3316A; Biochemistry 3380G or Biology 3326F/G</td>
<td>33% (average in Foundation courses) + 67% (average in Additional Modular courses)</td>
</tr>
<tr>
<td>Medical Sciences</td>
<td>Biochemistry 2280A; Biology 2581B; Biology 2382B; Biology 2290F/G; Chemistry 2213A/B or 2273A; Chemistry 2223B or a 0.5 course in Chemistry at the 2000- or 3000-level; Biology 2244A/B or Stats 2122A/B.</td>
<td>3.0, 2000 or 3000-level courses from the Basic Medical Sciences. If more than 3.0 Basic Medical Science courses are taken, the 3.0 with the highest marks will be considered.</td>
<td>33% (average in Foundation courses) + 67% (average in Additional Modular courses)</td>
</tr>
<tr>
<td>Microbiology and Immunology</td>
<td>Biochemistry 2280A; Biology 2581B; Biology 2382B; Biology 2290F/G; Chemistry 2213A/B or 2273A; Biol 2244A/B or Stats 2122A/B</td>
<td>Microbiology &amp; Immunology 2100A; Biochemistry 3381A; Microbiology &amp; Immunology 3300A; 3400B; 3600G</td>
<td>33% (average in Foundation courses) + 67% (average in Additional Modular courses)</td>
</tr>
<tr>
<td>Pathology and Toxicology</td>
<td>Biochemistry 2280A; 1.0 course from Biology 2581B, 2382B, 2290F/G; Chemistry 2213A/B; 0.5 course from Chemistry 2211A/B, 2214A/B or 2223B; Biology 2244A/B or Stats 2122A/B</td>
<td>Pathology 3240A; Pathology 3245B; Pharmacology 3550B; Pharmacology 3560A; Anatomy &amp; Cell Biology 3309 or 3319; Physiology 3120; Physiology 3140A</td>
<td>33% (cumulative average after Year 3**) + 33% (Foundation courses plus any Additional Modular course taken) + 34% (average in Pathology 3240A, 3245B; Pharmacology 3560A; 3550B)</td>
</tr>
<tr>
<td>Pharmacology</td>
<td>Biochemistry 2280A; Biology 2581B; Biology 2382B; Biology 2290F/G; Chemistry 2213A/B; Biology 2244A/B or Stats 2122A/B</td>
<td>Pharmacology 3550B; Pharmacology 3560A; Pharmacology 3580Y; Physiology 3120; Physiology 3140A</td>
<td>33% (average in Foundation courses) + 67% (average in Additional Modular courses)</td>
</tr>
<tr>
<td>Physiology</td>
<td>Biochemistry 2280A; Biology 2581B; Biology 2382B; Biology 2290F/G; Chemistry 2213A/B; Biology 2244A/B or Stats 2122A/B</td>
<td>Physiology 3120; Physiology 3140A; Physiology 3130Y</td>
<td>33% (average in Foundation courses) + 67% (average in Additional Modular courses)</td>
</tr>
<tr>
<td>Physiology and Pharmacology</td>
<td>Biochemistry 2280A; Biology 2581B; Biology 2382B; Biology 2290F/G; Chemistry 2213A/B; Biology 2244A/B or Stats 2122A/B</td>
<td>Physiology 3120; Physiology 3140A; Physiology 3130Y; Pharmacology 3550B; Pharmacology 3560A; Pharmacology 3580Y;</td>
<td>33% (average in Foundation courses) + 67% (average in Additional Modular courses)</td>
</tr>
</tbody>
</table>

*When calculating averages, marks in full-year courses are counted twice and the total is divided by the number of 0.5 course equivalents.

** Cumulative average is the average of all courses taken at Western to date
APPENDIX A2: Summary of Focus Group Sessions

Students in Year 4 of the various Honors Specialization modules were invited to participate in focus group sessions at the end of the academic year. Five focus group sessions were held, four of which were comprised of 4-7 students in the Honors Specialization module(s) offered by a particular department and one of which was comprised of 4-7 students in the Honors Specialization in Medical Sciences. The questions below were posed to each group and the responses, along with comments elicited during discussion, were recorded. Not all of the points below were common to all five groups but were common to most of the groups.

Q. What led you to choose this program and how are you hoping to use it in your career?
   • program offered laboratory experience
   • provided a good background for medical school
   • offered a solid foundation for graduate studies

Q. What’s working well for you, in this program?
   • the choice to undertake either a discipline-specific Honors Specialization that contained a thesis or a multidisciplinary Honors Specialization that did not contain a thesis (Medical Sciences)
   • undergraduate thesis provided the opportunity to participate in research, thus improving laboratory and critical thinking skills
   • smaller class sizes in many of the third and fourth year courses allowed for greater interaction with instructors who were passionate about the students and their subject areas
   • smaller size of some of the programs created a cohesive unit (students, faculty and staff)
   • a diverse range of courses was offered, even in discipline-specific Honors Specialization modules

Q. What’s not working well for you, in this program?
   • evaluation methods in some courses:
     o heavily-weighted exams cause too much stress – students would like to see other methods of evaluation throughout the term, such as assignments, quizzes
     o multiple choice tests – students do not feel they are given the opportunity to demonstrate what they have learned
     o transition from multiple choice style of tests in Years 1-3 to long-answer questions in Year 4 – students are not well-prepared
   • some skills were missing as students progressed from Year 3 to Year 4:
     o writing skills – students in most of the Honors Specialization modules had written a few lab reports prior to Year 4 but hadn’t necessarily received much instruction in scientific writing
     o limited experience with using primary literature as opposed to textbooks prior to Year 4
     o statistical skills were not as honed as they should have been (knowledge about which statistical analysis to perform for a particular situation was weak)
- experimental design skills were not developed prior to Year 4
- the experience in some team-taught courses was not optimal:
  - too many instructors and/or a lack of communication between instructors in a course sometimes adversely affected the fluidity of a course. Unfamiliarity of the topics covered by another instructor led to redundancy in lecture material and/or a disconnect between components within a course
- striking a balance between two disciplines in an Honors Specializations taught jointly by two departments was not accomplished

**Q. What’s missing in the program that you would have liked to see?**

- information about career opportunities related to the discipline being studied and general career opportunities
- skills such as scientific writing and critical appraisal of primary literature
- general and detailed laboratory techniques
- more introductory basic medical science courses in Year 2 to provide a foundation and an introduction to the various disciplines
- many of the topics covered in Year 4 lecture courses reflect the instructors’ areas of expertise while other generally relevant topics are either not covered or insufficiently emphasized

**Q. To what degree did your 2nd and 3rd year courses prepare you to handle the content of your 4th year courses?**

- Year 2 courses provided a good foundation for Year 3 courses in many circumstances but these Year 2 courses sometimes seemed irrelevant by Year 4
- the content of the Year 3 courses provided a strong foundation for Year 4 courses but the style of teaching and evaluation in Year 3 (textbook and multiple choice tests) did not prepare for the teaching style and methods of evaluation in Year 4.

**Q. What guidance did you receive in selecting and progressing through this program, and who provided it?**

- academic calendar
- professors
- departmental counselors
- academic (faculty-level) counselors
- BMSUE Office – information sessions
- fellow students
- senior students
  - students would like to receive more guidance from senior students in their program
APPENDIX A3: Basic Medical Sciences Undergraduate Education (BMSUE)
Program Committee Terms of Reference

Purpose: To provide high quality broad-based programs in the basic medical sciences that address the changing needs of students and the workplace.

Program Committee Composition

- Associate Dean, BMSAA (Chair)
- Associate Dean (Academic), Faculty of Science
- BMSUE Coordinator, ex officio
- BMSUE Administrative Assistant, ex officio
- Academic Manager, Academic Counseling Services, ex officio
- Undergraduate Chair, Department of Anatomy and Cell Biology
- Undergraduate Chair, Department of Biochemistry
- Undergraduate Chair, Department of Medical Biophysics
- Undergraduate Chair, Department of Microbiology and Immunology
- Undergraduate Chair, Department of Pathology
- Undergraduate Chair, Department of Physiology and Pharmacology
- Undergraduate Chair, Department of Epidemiology and Biostatistics
- BMSc Representative, Science Students’ Council

In its deliberations and actions the Program Committee shall strive to:

- Foster interactions and effective communication between the basic medical science departments and the BMSUE office
- Make use of the expertise and knowledge of the faculty in the basic medical science departments to deliver specific courses and modules within the BMSUE program
- Recognize the contributions of all members/departments
- Encourage full participation of all members/departments

Committee Responsibilities: The committee shall meet on a monthly basis to review and discuss affairs related to the BMSUE and the BMSc program including policies and regulations, curriculum content, student performance, student enrolment, student counseling and student outreach activities.

- Policies and Regulations
  - Advise on policies and regulations about eligibility for BMSc program
  - Develop and recommend best practices for academic performance
  - Continuing Program review

- Curriculum/Course Review
  - Review proposals for new courses/modules
  - Review proposals for changes in existing courses/modules
Review existing courses/modules
Suggest revisions to Medical Sciences courses and modules

Compare curricula from the Basic Medical Science departments
- Develop cross-disciplinary modules (review courses with common themes, e.g. biology of cancer; neurosciences)
- Ensure consistency in course content across departments
- Ensure consistency in evaluation of student performance across departments

Recommend and review proposals for articulation agreements with Colleges of Applied Arts and Technology, e.g. Fanshawe College

• BMSc operations
  - Modular enrolment (consider and review under-subscribed as well as over-subscribed modules)
    - Number of spaces in research projects
  - Course enrolment
    - Reviewing constraints (priorities and restrictions)
  - Intent to Register
  - Adjudication
  - Convocation

• Student Recruitment, Retention and Advancement
  - Discuss outreach activities for Basic Medical Science departments/BMSc program:
    - Fall Preview Day
    - March Break Open House
    - Ontario Universities’ Fair
  - Discuss and review promotional materials (e.g. brochures, web sites)
  - Advise and assist in development of student exit surveys, including use of the data
  - Advise and assist in career development and career opportunities for BMSc students

Protocol
- Associate Dean, BMSUE, chairs the meetings
- Voting:
  - Seven Undergraduate Chairs/Chair (designate) of Epidemiology-Biostatistics
  - Associate Dean (Academic), Faculty of Science
  - BMSc student representative
  - Associate Dean BMSAA casts a vote in case of a tie
  - 50% of voting membership must be present for quorum
- Committee to meet monthly; composition of committee and proceedings may vary depending on agenda items and topics of discussion/information
- Additional stakeholders in topics of discussion (e.g. department EPC members) may be invited to meetings as required.
APPENDIX A4: Report on Western Libraries Support for the Bachelor of Medical Sciences Program

Date: December, 2009

John Costella

Introduction:
Western Libraries, the fourth largest research library in Canada, comprises nine service locations distributed across the University campus and is a member of the Ontario Council of University Libraries, the Canadian Association of Research Libraries and the Association of Research Libraries. Students in the Bachelor of Medical Sciences program, hereinafter referred to as BMSc, have access to collections of over nine million items in print, microform, and various other formats. In addition, a strategic priority is to acquire and provide access to information in digital formats, essentially making Western Libraries available anywhere, anytime. Recognized for the quality of its staff, the access and services provided, and its outstanding collections, Western Libraries supports the University’s mission of providing the best student experience among Canada’s leading research-intensive universities.

This report reviews Western Libraries’ activities in support of undergraduate students enrolled in the BMSc program. Each of the major sections explains how Western Libraries supports the undergraduate review process and demonstrates alignment with the Ontario Council of Academic Vice Presidents (OCAV) Guidelines for University Undergraduate Degree Level Expectations (UDLE).

Undergraduates in the BMSc program not only have access to all the resources of Western Libraries, but are specifically supported by the Allyn & Betty Taylor Library. The Taylor Library supports the Faculties of Engineering, Health Sciences, Schulich School of Medicine & Dentistry, and Science. It is recognized that students within the Program have the choice of obtaining the BMSc degree not just in Medical Sciences but can also choose to study in one or more of Basic Medical Science (BMS) disciplines. The report will consider library support keeping in mind these multi and cross disciplinary options for students in the Program. Included in the section “Department Specific Library Support” below is more detailed information on library services and resources aimed at specific BMS areas.

Teaching and Learning:
Managing information in the most effective way is an integral component of teaching and learning at Western. The information literate student is able to access information efficiently, assess it critically, effectively assimilate and apply the information responsibly. To this end Information Literacy (IL) instruction offered to students in BMSc is aligned with the Association of College and Research Libraries (ACRL) Information Literacy Competency Standards for Higher Education. Released in 2000, these international standards enumerate five competencies and related performance indicators supplemented with outcome measures for each indicator. The standards articulate and assess the skills undergraduates require to succeed academically and to set the foundation for lifelong learning.

Instruction occurs at a variety of levels for BMSc students. The Taylor Library facilitates formal instruction integrated into the regular classroom schedule. Depending upon their course of
studies many of the BMSc students will have received information literacy instruction in a number of core Biology courses at both the first and second year levels (eg Biology 1222 – General Biology, Biology 2290G - Scientific Method in Biology). Some students will also have received more advanced instruction as part of upper level courses in many of the BMS departments. Taylor librarians have for several years also been involved with information literacy sessions to students enrolled in Medical Sciences 4900 - Medical Sciences Laboratory.

Library instruction takes place in a variety of formats including in class, computer lab, or online. Online instruction supported by tutorials, guides and interactive assignments function to extend classroom instruction and provide resources for BMSc students whenever and wherever they need it. For areas where no formal library instruction is in place, students can arrange one on one or small group sessions with the liaison librarian.

**Collections:**
The purpose of the library collection is to provide resources that support both the research and instructional initiatives within a particular discipline or department. Librarians work with faculty to create and periodically revise the collection management policy for specific subject disciplines. More information on this ongoing activity is included in the department specific section.

The scope and depth of the collection at the Taylor Library provides students in BMSc with a diverse selection of materials covering all aspects of BMS and in a variety of formats. Students in the Program have access to all of these resources thus providing the opportunity to expand both the breadth and depth of their knowledge.

As a result of collection development activities, students have electronic access to the full journal packages from commercial publishers like Elsevier (Science Direct), Springer (Springerlink), Wiley (Interscience), and many more. The journal offerings are further enhanced by providing access to titles from Open Access sites such as Biomed Central, the Directory of Open Access journals, the Public Library of Science (PLoS), and PubMed Central. Our journal subscriptions rank favourably when compared to Journal Citation Reports (JCR) subject lists. After reviewing the journal lists from 15 of the JCR subjects representing the BMS disciplines, it was determined that on average Western Libraries subscribes to 83% of the titles listed in those areas. There has also been increasing attention given to the acquisition of journal backfile packages that have enriched the depth of journal coverage BMSc students have access to electronically. An example of content adding to this increased depth is the Wiley InterScience's Biotechnology, Biochemistry, and Biophysics Backfile Collection which the library acquired several years ago.

Recent collection development examples that have enhanced the information available to students in the BMSc program include the Biomedical and Life Sciences collection of the Henry Stewart Talks, the Thieme Electronic Book Library, and the Springer Protocols including the archive.

Students in the program also have available a variety of databases which aid in the location of information at all levels from primary through to tertiary. Some notable examples include
BIOSIS, Ei Compendex, EMBASE, Inspec, Pubmed, Scopus, and Web of Science. BMSc students also have access to RefWorks, which aids in the management and formatting of citation information.

Collaboration and Communication:
Communication and collaboration within The Taylor Library is vital for providing excellent quality service for students and faculty members affiliated with the BMSc program. To facilitate this communication the Library has assigned a liaison librarian who supports both the BMSc program and BMS departments.

We facilitate patrons' learning and utilization of library resources. The Taylor Library has a series of Browse by Program pages including specific pages for many of the BMS subject areas in order to simplify user access to selected resources. These materials are available both in print and online. We encourage patron-librarian communication and collaboration and facilitate this process by offering reference services in person, via email, telephone, or instant messaging.

Finally, we support professional communication amongst library staff to help ensure professional development and increase awareness of current trends. Within the Taylor library the creation of the Life Sciences and Physical Sciences teams has ensured a forum for the exchange of information between all librarians. From here there are communication routes established to ensure information exchange between and among all Taylor Library staff, as well as across the broader Western Libraries community.

Services:
Western Libraries offers a full range of in-person and online library services to our undergraduate community. Throughout our nine physical locations, more than 400 public workstations provide access to library resources, office productivity software and wireless access to the Internet. All locations offer printing and photocopying facilities. The Taylor Library has technologies for viewing videos and DVDs. Computers with adaptive technology and other facilities for students with disabilities are also available.

Throughout the academic year, the Taylor Library is open over 75 hours during the week and another 22 hours on weekends giving students a safe, comfortable environment in which to meet, study and pursue research. During exam periods Taylor Library expands its opening hours. Library staff work with faculty members to ensure that students in BMSc have convenient access to required readings for their courses.

Through the Western Libraries web site, students can make use of many self-serve options. For example, students can renew loans and request delivery of items from one location to another. The request delivery service is further enhanced by an electronic document delivery option for items located in our Archives and Research Collections Centre and the Research Depository Library. Students may also submit Interlibrary Loan requests via RACER, and access electronic course reserves from the Library site. A new frequently asked questions service, Ask Western Libraries, is available to answer basic questions about library services and facilities. Western Libraries regularly participates in the Association of Research Libraries' LibQual survey in order to gauge service quality and responds to customer feedback in a timely manner.
Summary and Future Trends:
Western Libraries strives to contribute to the best undergraduate experience for students in BMSc by:
   1. Providing the highest possible level of teaching, learning and research assistance
   2. Acquiring and maintaining excellent research collections in a variety of formats
   3. Supporting communication and collaboration with the user community
   4. Offering meaningful and relevant library resources and services

The Taylor Library continuously assesses needs that inform the development of our collections and services. The liaison librarian maintains communication lines, either through the Chairs, specific faculty, or administrative staff, for the purpose of providing information or eliciting feedback. By collaborating with the faculty, the Library is well positioned to fully contribute, now and in the years to come, to student and faculty success in the BMSc program.
APPENDIX A5: Core Research Facilities in the Schulich School of Medicine & Dentistry

Regional centres and core research facilities available to researchers within the Schulich School of Medicine & Dentistry include:

**Regional Centres**
- London Regional Cell and *In Vitro* Molecular Imaging Facility
- London Regional Cell and *In Vivo* Molecular Imaging Facility
- Centre for Functional and Metabolic Mapping
- London Regional Genomics Centre
  - DNA Sequencing Facility
  - Microarray Facility
- London Regional Transgenic and Gene Targeting Facility
- London Regional Proteomics Centre
  - Biological Mass Spectrometry Laboratory
  - Biomolecular Interactions and Conformations Facility
  - Biomolecular NMR Facility
  - Functional Genomics and Proteomics Facility
  - Macromolecular Crystallography Facility
  - MALDI-TOF Mass Spectrometry Facility

**Other Core Facilities**
- 2D and 3D Micro-ultrasound Imaging Facility
- 2D and 3D Ultrasound Imaging Facility
- Bioelectromagnetics Research Laboratories
- Biostatistical Support Unit
- Brain Tumour Tissue Bank
- Cryo-sectioning Laboratory
- Experimental Transplant Pathology Laboratory
- Film Processor Equipment
- Fluorescent Deconvolutional Microscope
- Imaging Research Laboratories (Robarts Research Institute)
- Lawson Cyclotron and Radiochemistry Facility
- LHRI Clinical Research Services
- LHSC Sleep Laboratory and Sleep Clinic
- London Regional Flow Cytometry Facility
- Microscopic Image Analysis Facility
- Multi-slice CT scanner
- Near Infra-red Spectroscopy
- Peptide Synthesis Facility
- Poster Preparation/Multi Media Facility
- Real Time PCR Facility
- Robarts Clinical Trials
- Robarts HeliSpin™ Core Facility
- Schulich School of Medicine & Dentistry Imaging Facility
- Screening Lab for Immune Disorders
- Skeletal Biology Laboratories Core Facilities
- Transmission Electron Microscopy Facility
- Victoria Research Laboratory Confocal Microscope Core Facility
- Virtual Augmentation and Simulation for Surgery and Therapy (VASST lab)
APPENDICES B1 –B7:

B1. Modular Requirements
B2. Course Outlines (Samples)
B3. Assignments (Samples)
B4. Midterm Tests and Final Examinations (Samples)
B5. Teaching in Undergraduate Courses in 2008-2009
B6. Faculty Complement
B7. Staff Complement
APPENDIX B1 – Modules Offered

HONORS SPECIALIZATION IN MICROBIOLOGY AND IMMUNOLOGY

Enrolment in this module requires registration in the BMSc Program and is limited. Meeting the minimum requirements does not guarantee that students wishing to enter or progress in this module will be offered enrolment. See BMSc Program.

ADMISSION REQUIREMENTS

Completion of first-year requirements with no failures. Students must have an average of at least 70% on the following 3.0 principal courses, with no mark in these principal courses below 65%.

1.0 course from: Biology 1222 (General Biology), Biology 1223 (Introductory Biology)
1.0 course: Chemistry 1050 (Discovering Chemistry) or the former Chemistry 020 or 023.
1.0 course from: Calculus 1000A/B (Calculus I), Calculus 1100A/B (Calculus with Fundamentals), Calculus 1201A/B (Mathematical Applications for Biological Sciences), Calculus 1301A/B (Calculus II), Calculus 1501A/B (Calculus II for Mathematical and Physical Sciences), Linear Algebra 1600A/B (Linear Algebra I), Mathematics 1225A/B (Methods of Calculus), Mathematics 1228A/B (Methods of Finite Mathematics), Mathematics 1229A/B (Methods of Matrix Algebra), Statistical Sciences 1024A/B (Introduction to Statistics), Applied Mathematics 1413 (Applied Mathematics for Engineers I), or the former Mathematics 030.

1.0 course from: Physics 1020 (Physics I), Physics 1024 (Introductory Physics), Physics 1028A/B and 1029A/B, (Physics for Biological Sciences I and II), must be completed by the end of second year, with a minimum mark of 65%.

MODULE = 9.5 courses

0.5 course: Biochemistry 2280A (Biochemistry and Molecular Biology)
1.0 course: Chemistry 2213A/B (Organic Chemistry for Life Sciences), Chemistry 2223B (Organic Chemistry of Biological Modules)
1.5 courses: Biology 2581B (Genetics), Biology 2290F/G (Scientific Method in Biology), Biology 2382B (Cell Biology)
0.5 course: Microbiology and Immunology 2100A (Biology of Prokaryotes)
0.5 course from: Biology 2244A/B (Analysis & Interpretation of Biological Data) OR Statistical Sciences 2122A/B (Statistics for Science)
0.5 course: Biochemistry 3381A (Biological Macromolecules)
1.5 courses: Microbiology and Immunology 3300A (Immunology), 3400B (Diversity of Prokaryotes and Viruses), 3600G (Laboratory Techniques in Microbiology and Immunology)
1.5 course: Microbiology and Immunology 4970E (Research Project and Seminar)
2.0 courses: Microbiology and Immunology 4100A (Bacterial Pathogenesis), 4200B (Molecular Virology), 4300A (Advanced Immunology), 4700B (Molecular Genetics of Gene Expression)

Notes:
1. This module requires a minimum mark of 70% in each of Microbiology and Immunology 2100A, 3300A, 3400B, 3600G and Biochemistry 3381A.
2. Enrolment in Biochemistry 3381A requires a minimum mark of 65% in Biochemistry 2280A; and a minimum average of 65% in Chemistry 2213A/B and 2223B.
HONORS SPECIALIZATION IN BIOCHEMISTRY OF INFECTION AND IMMUNITY
(Offered jointly with the Department of Biochemistry)
Enrolment in this module requires registration in the BMSc Program and is limited. Meeting the minimum requirements does not guarantee that students wishing to enter or progress in this module will be offered enrolment. See BMSc Program.

ADMISSION REQUIREMENTS
Completion of first-year requirements with no failures. Students must have an average of at least 70% on the following 3.0 principal courses, with no mark in these principal courses below 65%.

1.0 course from: Biology 1222 (General Biology), Biology 1223 (Introductory Biology)
1.0 course: Chemistry 1050 (Discovering Chemistry) or the former Chemistry 020 or 023.
1.0 course from: Calculus 1000A/B (Calculus I), Calculus 1100A/B (Calculus with Fundamentals), Calculus 1201A/B (Mathematical Applications for Biological Sciences), Calculus 1301A/B (Calculus II), Calculus 1501A/B (Calculus II for Mathematical and Physical Sciences), Linear Algebra 1600A/B (Linear Algebra I), Mathematics 1225A/B (Methods of Calculus), Mathematics 1228A/B (Methods of Finite Mathematics), Mathematics 1229A/B (Methods of Matrix Algebra), Statistical Sciences 1024A/B (Introduction to Statistics), Applied Mathematics 1413 (Applied Mathematics for Engineers I), or the former Mathematics 030.

1.0 course from: Physics 1020 (Physics I), Physics 1024 (Introductory Physics), Physics 1028A/B and 1029A/B, (Physics for Biological Sciences I and II), must be completed by the end of second year, with a minimum mark of 65%.

MODULE = 10.0 courses
1.0 course from: Chemistry 2213A/B (Organic Chemistry for Life Sciences) and 2223B (Organic Chemistry of Biological Modules), OR Chemistry 2273A (Organic Chemistry I: Structure and Spectroscopy) and 2283G (Organic Chemistry II: Mechanisms and Reactivity)
0.5 course: Biochemistry 2280A (Biochemistry and Molecular Biology)
1.5 courses: Biology 2581B (Genetics), Biology 2290F/G (Scientific Method in Biology), Biology 2382B (Cell Biology)
0.5 course from: Biology 2244A/B (Analysis & Interpretation of Biological Data) OR Statistical Sciences 2122A/B (Statistics for Science)
1.5 courses: Microbiology and Immunology 2100A (Biology of Prokaryotes), 3300A (Immunology), 3400B (Diversity of Prokaryotes and Viruses)
1.0 course: Biochemistry 3381A (Biological Macromolecules) and 3382B (Biochemical Regulation)
0.5 course from: Biochemistry 3380G (Biochemistry Laboratory), Microbiology and Immunology 3600G (Laboratory Techniques in Microbiology and Immunology)
1.0 course: Microbiology and Immunology 4100A (Bacterial Pathogenesis), 4200B (Molecular Virology), 4300A (Advanced Immunology), 4700B (Molecular Genetics of Gene Expression)
1.0 course: Biochemistry 4410A (Molecular Biology of DNA and RNA), 4420B (Molecular Biology of Proteins)
1.5 courses from: Biochemistry 4483E (Research Project and Seminar), Microbiology and Immunology 4970E (Research Project and Seminar)

Notes:
1. Enrolment in Biochemistry 3381A requires a minimum mark of 65% in Biochemistry 2280A; and a minimum average of 65% in Chemistry 2213A/B and 2223B, or a minimum mark of 60% in each of Chemistry 2273A and 2283G.
2. A minimum mark of 70% is required in each of Microbiology and Immunology 2100A, 3300A and 3400B.
3. Enrolment in Biochemistry 4483E is limited and requires a minimum mark of 70% in each of Biochemistry 3381A, 3382B, and either Biochemistry 3380G or Microbiology and Immunology 3600G.
4. Enrolment in Microbiology and Immunology 4970E is limited and requires a minimum mark of 70% in Microbiology and Immunology 3600G.
MAJOR IN MICROBIOLOGY AND IMMUNOLOGY

A degree containing this module normally requires 4 years for completion.

ADMISSION REQUIREMENTS

Completion of first-year requirements, including the following 3.0 courses with a minimum mark of 60% in each:

1.0 course from: Biology 1222 (General Biology), 1223 (Introductory Biology)
1.0 course: Chemistry 1050 (Discovering Chemistry)
1.0 course from: Calculus 1000A/B (Calculus I), Calculus 1100A/B (Calculus with Fundamentals), Calculus 1201A/B (Mathematical Applications for Biological Sciences), Calculus 1301A/B (Calculus II), Calculus 1501A/B (Calculus II for Mathematical and Physical Sciences), Linear Algebra 1600A/B (Linear Algebra I), Mathematics 1225A/B (Methods of Calculus), Mathematics 1228A/B (Methods of Finite Mathematics), Mathematics 1229A/B (Methods of Matrix Algebra), Statistical Sciences 1024A/B (Introduction to Statistics), Applied Mathematics 1413 (Applied Mathematics for Engineers I), or the former Mathematics 030.

1.0 course from: Physics 1020 (Physics I), Physics 1024 (Introductory Physics), Physics 1028A/B and 1029A/B, (Physics for Biological Sciences I and II), must be completed by the end of second year, with a minimum mark of 60%.

MODULE = 6.0 courses

0.5 course: Biochemistry 2280A (Biochemistry and Molecular Biology)
1.0 course: Chemistry 2213A/B (Organic Chemistry for Life Sciences), Chemistry 2223B (Organic Chemistry of Biological Modules)
1.0 course: Biology 2382B (Cell Biology), Biology 2581B (Genetics)
0.5 course: Microbiology and Immunology 2100A (Biology of Prokaryotes)
0.5 course: Biochemistry 3381A (Biological Macromolecules)
1.5 courses: Microbiology and Immunology 3300A (Immunology), 3400B (Diversity of Prokaryotes and Viruses), 3600G (Laboratory Techniques in Microbiology and Immunology)
1.0 course from: Microbiology and Immunology 4100A (Bacterial Pathogenesis), 4200B (Molecular Virology), 4300A (Advanced Immunology), 4700B (Molecular Genetics of Gene Expression)

Notes:
1. Enrolment in Biochemistry 3381A requires a minimum mark of 65% in Biochemistry 2280A; and a minimum average of 65% in Chemistry 2213A/B and 2223B.
2. Biology 2290F/G (Scientific Method in Biology) and either Biology 2244A/B (Analysis & Interpretation of Biological Data) or Statistical Sciences 2122A/B (Statistics for Science) are recommended option courses.
3. Enrolment in either Microbiology and Immunology 4100A or 4200B requires a minimum mark of 70% in Microbiology and Immunology 3400B
4. Enrolment in Microbiology and Immunology 4300A requires a minimum mark of 70% in Microbiology and Immunology 3300A.
SPECIALIZATION IN MICROBIOLOGY AND IMMUNOLOGY
This Specialization may only be completed in a BMSc degree.

ADMISSION REQUIREMENTS

Completion of first-year requirements, including the following 3.0 courses with a minimum mark of 60% in each:
1.0 course from: Biology 1222 (General Biology), 1223 (Introductory Biology)
1.0 course: Chemistry 1050 (Discovering Chemistry)
1.0 course from:
1.0 course: Calculus 1000A/B (Calculus I), Calculus 1100A/B (Calculus with Fundamentals), Calculus 1201A/B (Mathematical Applications for Biological Sciences), Calculus 1301A/B (Calculus II), Calculus 1501A/B (Calculus II for Mathematical and Physical Sciences), Linear Algebra 1600A/B (Linear Algebra I), Mathematics 1225A/B (Methods of Calculus), Mathematics 1228A/B (Methods of Finite Mathematics), Mathematics 1229A/B (Methods of Matrix Algebra), Statistical Sciences 1024A/B (Introduction to Statistics), Applied Mathematics 1413 (Applied Mathematics for Engineers I), or the former Mathematics 030.

1.0 course from: Physics 1020 (Physics I), Physics 1024 (Introductory Physics), Physics 1028A/B and 1029A/B, (Physics for Biological Sciences I and II), must be completed by the end of second year, with a minimum mark of 60%.

MODULE = 9.0 courses
0.5 course: Biochemistry 2280A (Biochemistry and Molecular Biology)
1.0 course: Chemistry 2213A/B (Organic Chemistry for Life Sciences), Chemistry 2223B (Organic Chemistry of Biological Modules)
1.5 courses: Biology 2290F/G (Scientific Method in Biology), 2382B (Cell Biology), 2581B (Genetics)
0.5 course: Microbiology and Immunology 2100A (Biology of Prokaryotes)
0.5 course from: Biology 2244A/B (Analysis & Interpretation of Biological Data) OR Statistical Sciences 2122A/B (Statistics for Science)
0.5 course: Biochemistry 3381A (Biological Macromolecules)
1.5 courses: Microbiology and Immunology 3300A (Immunology), 3400B (Diversity of Prokaryotes and Viruses), 3600G (Laboratory Techniques in Microbiology and Immunology)
2.0 courses: Microbiology and Immunology 4100A (Bacterial Pathogenesis), 4200B (Molecular Virology), 4300A (Advanced Immunology), 4700B (Molecular Genetics of Gene Expression)
1.0 course from: Biology or the Basic Medical Science Disciplines* at the 2000- or 3000-level.

Notes:
1. Enrolment in Biochemistry 3381A requires a minimum mark of 65% in Biochemistry 2280A; and a minimum average of 65% in Chemistry 2213A/B and 2223B, or a minimum mark of 60% in each of Chemistry 2273A and 2283G.
2. This module requires a minimum mark of 70% in each of Microbiology and Immunology 3300A and 3400B.

*Basic Medical Science Disciplines: Anatomy and Cell Biology, Biochemistry, Epidemiology and Biostatistics, Medical Biophysics, Microbiology and Immunology, Pathology, Pharmacology, Physiology
MINOR IN MICROBIOLOGY AND IMMUNOLOGY

ADMISSION REQUIREMENTS

Completion of first-year requirements, including Biology 1222 or 1223, and Chemistry 1050 or the former Chemistry 1020 or 023, each with a mark of at least 60%.

MODULE = 4.0 courses

0.5 course: Chemistry 2213A/B (Organic Chemistry for Life Sciences)
0.5 course: Biochemistry 2280A (Biochemistry and Molecular Biology)
1.0 course: Biology 2382B (Cell Biology), Biology 2581B (Genetics)
2.0 courses: Microbiology and Immunology 2100A (Biology of Prokaryotes), 2500B (Biology of Infection and Immunity), 3300A (Immunology), 3400B (Diversity of Prokaryotes and Viruses).
Course Outlines from 2008/09 for the following courses are provided:

- Microbiology and Immunology 2100A
- Microbiology and Immunology 3300A
- Microbiology and Immunology 4200B
Microbiology and Immunology 2100A: Biology of Prokaryotes
Fall Term  2008

Course Information

This course will cover the fundamental aspects of the structure, physiology and genetics of prokaryotic microorganisms in the phylogenetic domains Bacteria and Archaea. It will begin with a consideration of the ‘pathways of discovery’ in microbiology, followed by microbial nutrition and growth, prokaryotic structure and function, microbial metabolism and genetics, control of growth of bacteria by antibiotics and environmental conditions, and a discussion on food and waterborne bacterial diseases. An introduction to taxonomy in the microbial world will also be presented. The laboratory exercises complement the lectures and introduce the student to basic microbiological techniques and applications.

Prerequisites: Biology 1222 or 1223; Chemistry 1050 or the former Chemistry 020 or 023.
Corequisite: Biochemistry 2280A

Senate Regulations regarding prerequisites are as follows:
“Unless you have either the prerequisites for this course or written special permission from your Dean to enroll in it, you will be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.”

Lectures:
Monday and Wednesday, 11:30-12:30 pm  Natural Sciences (NS) 7

Laboratories:
Tuesday, Wednesday or Thursday,  2:30 to 5:30 pm Medical Sciences Building (MSB) 120

Instructors: from the Department of Microbiology and Immunology
   Dr. Susan Koval
   Dr. Peter Cadieux
   Dr. Carole Creuzenet

Instructors are available through WebCT mail or by appointment.

Course Coordinator:  Dr. Susan Koval
   Dental Science Building  3013A
   Tel: 519-661-3439
Who should take this course?
Biology of Prokaryotes is an entry-level course. For prospective Honors Microbiology and Immunology students it will provide a good foundation for advanced work. As such, it will include details as well as concepts. For other students, it will provide a useful background for other disciplines of biology, such as biochemistry, cell biology, genetics, environmental sciences and the health-related professions. Instructors will assume a fundamental working knowledge of biology and a developing knowledge of the concepts introduced in Biochemistry 2280A as taken concurrently or previously.

Information flow:

WebCT site: access at http://webct.uwo.ca

For assistance with WebCT, please contact the ITS Computer Support Centre [helpdesk@uwo.ca, 519-661-3800]. Troubleshooting information is also available online. A list of common problems and solutions are available at http://webct.uwo.ca/commonProblems.html. Students should also ensure their computer is properly prepared by visiting http://webct.uwo.ca/checkMyBrowser.html.


Two copies of the 12th edition will be available on 2 h reserve in the Taylor Library. Specific readings will be assigned from the textbook by each instructor. The readings expand the concepts discussed in lectures.

N.B. Students may use the previous 11th edition of the textbook [probably available at the Used Book Store]. Most of the basic information will be the same in both editions, with updates in the new 12th edition. Instructors will try their best in lectures to reference figures and text in both editions. Use of the 11th edition of the textbook cannot be used as the basis for appeal of a grade in this course.

Additional microbiology textbooks, for use in writing lab reports, are on 2 h reserve for this course in the Taylor library.


One copy of the lab manual will be available on 2 h reserve in the Taylor library.
Evaluation:

<table>
<thead>
<tr>
<th>Component</th>
<th>% of Final Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midterm Exam</td>
<td>30</td>
</tr>
<tr>
<td>Laboratory Exercises</td>
<td>25</td>
</tr>
<tr>
<td>Final Exam</td>
<td>45</td>
</tr>
</tbody>
</table>

**Midterm Exam:** Thursday October 30, 7 to 9 pm WSC 55 and 240

The midterm and final exams will consist of multiple choice questions from lectures, assigned textbook readings and laboratory material. The questions will be a combination of single best answer and multiple-multiple choice. There will be a few practise exam questions provided for the midterm exam. The final exam (3 h) will be cumulative, with emphasis on the second half of the course.

Software may be used to check multiple choice exams, as per the following Senate Regulations: “Computer-marked multiple-choice exams may be subject to submission for similarity review by software that will check for unusual coincidences in answer patterns that may indicate cheating”.

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**Deadlines and ethical issues**

**Exams**

We do **not** offer a makeup for the midterm exam. If you have a conflict (a previously scheduled test in another course) on October 30, we will make arrangements for you to write **early**.

If you are forced to miss the midterm exam and meet the requirements outlined below, you will be ‘exempted’ from the midterm and may **write** a ‘comprehensive’ version of the final exam. It will count for 75% of your course mark. It will be a written exam, in short answer format, not multiple choice format.

If you are absent from the final exam, and meet the requirements outlined below, you may write a Special Exam in early January (date to be determined). According to Senate Regulations, if a student fails to write a scheduled Special Examination, permission to write another Special Examination will be granted only with the permission of the Dean in exceptional circumstances and with appropriate documents. **In such a case, the date of this Special Examination normally will be the scheduled date for the final exam the next time the course is offered.**
Illness and Emergencies

If a serious illness or other emergency prevents you from taking an exam, attending a lab or from meeting other course requirements, you must do three things:

1. Seek appropriate and timely help for your situation.

2. Obtain a Western Student Medical Certificate (SMC) and submit this to the Faculty of Science Counselling Service in the Dean’s Office in the Western Science Centre. If the academic counsellors believe the circumstances warrant academic consideration, they will make a recommendation to Dr. Koval. Information on the SMC is provided below.

3. Inform Dr. Koval of the situation immediately, preferably before the deadline or laboratory session, but in no case more than 24 hours afterward. Email (via WebCT) or telephone messages [519-661-3439] are acceptable.

Western Medical Accommodation Policy (Medical Notes)

Documentation from Family Physicians and Walk-In Clinics
A Western Student Medical Certificate (SMC) is required where a student is seeking academic accommodation. This documentation should be obtained at the time of the initial consultation with the physician or walk-in clinic. An SMC can be downloaded under the Medical Documentation heading of the following website: https://studentservices.uwo.ca/secure/index.cfm. Hard copies are available from the student’s home Faculty Academic Counselling Service.

Documentation from Student Health Services
Students obtaining documentation from Student Health Services should sign a “release of information.” This form authorizes Student Health Services to provide information to the student’s home Faculty. Release of information forms are available from, and can be arranged through, the student’s home Faculty Academic Counselling Service.

Documentation from Hospital Urgent Care Centres or Emergency Departments
Students should request that an SMC be filled out. Students may bring this form with them, or request alternative Emergency Department documentation. Documentation should be secured at the time of the initial visit to the Emergency Department. Where it is not possible for a student to have an SMC completed by the attending physician, the student must request documentation sufficient to demonstrate that his/her ability to meet his/her academic responsibilities was seriously affected.
Laboratories

The laboratory component will contribute 25% to the course mark as follows:

(a) laboratory reports 20
(b) subjective mark 5

(a) Laboratory reports:
Quality lab results are expected from every student. The length of the report will vary according to the exercise. Two formal lab reports will be assigned. For other reports, a summary or outline of experiments will be requested. The summary should demonstrate a thorough understanding of the procedures and correct interpretation of data presented in the summary. All steps to any calculations should be given. Data sheets from the lab manual will be used for some exercises, and this will be indicated in the information for individual laboratory sessions. A summary of lab reports and their due dates is provided in a separate document.

(b) Subjective mark:
Your subjective mark will be assigned by your teaching assistant (TA). This will be assessed on the basis of your performance in the laboratory and your degree of skill in microbiological techniques. Attendance will also form a portion of the subjective mark.

Absence from laboratory periods
If you have to miss a lab period due to temporary illness or a conflict, you MUST contact Dr. Koval within 24 hours and make arrangements to attend another lab section that week. To be entirely excused from a lab period, you MUST present a medical certificate (SMC) to Dr. Koval. There will not be an opportunity to make up any missed laboratory work in later weeks.

Lab reports are due at the beginning of the lab the week after completion of the exercise, or for some exercises on the day of the lab. Late assignments will be accepted up until Friday at 4 PM in the student lab (MSB 120) or in Lydia Dafoe’s prep room (MSB 123) the week they are due, but FIFTY PERCENT of the value of the lab report will be deducted as a late penalty. No credit will be given to lab reports turned in after that time. Extensions of deadlines will be considered only with documentation.

If a student misses a lab period, with valid documentation, the mark for that lab will be pro-rated over the other labs. If a student misses a lab period, and does not provide appropriate documentation, a mark of ‘0’ will be assigned. The student may write up the lab report (for the academic knowledge) but this will not be given a mark. If a student does a lab exercise, but misses the follow-up required for that experiment, two outcomes are possible. If the follow-up is the following week, during the next lab period, and that lab period is missed, the student can still hand in a lab report, but will lose some marks, depending upon the exercise. If the follow-up is 24 to 48 hours later, the student will get ‘0’ for the lab report. The bottom line is that follow-up observations and further tests are an integral and important part of experiments.
We encourage students to discuss ideas with each other and with other experts, and to consult with reference material when preparing lab reports. If you wish to use ideas or passages from a reference, you must cite the source in your list of references. However, the organization and composition of your lab report must be your own entirely. Expressing another person’s data or words as your own is plagiarism, and will be dealt with severely.

Senate Regulations regarding plagiarism are as follows:
“Plagiarism: Students must write their essays and assignments in their own words. Whenever students take an idea, or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence (see Scholastic Offence Policy in the Western Academic Calendar).”
### Microbiology and Immunology 2100A: Biology of Prokaryotes

**Lecture Schedule**  
**Fall 2008**

**Room: Natural Sciences 7**

<table>
<thead>
<tr>
<th>Date</th>
<th>Lecture Topic</th>
<th>Professor</th>
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<tbody>
<tr>
<td>September 8</td>
<td>Introduction</td>
<td>Koval</td>
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<tr>
<td>September 10</td>
<td>Microbiology: Past, present and future</td>
<td>Koval</td>
</tr>
<tr>
<td>September 15</td>
<td>Nutrition and cultivation</td>
<td>Cadieux</td>
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<tr>
<td>September 17, 22, 24,29; October 1</td>
<td>Cell structure and function</td>
<td>Koval</td>
</tr>
<tr>
<td>October 6</td>
<td>Systematics</td>
<td>Koval</td>
</tr>
<tr>
<td>October 8</td>
<td>Metabolism</td>
<td>Koval</td>
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<tr>
<td>October 13</td>
<td><em>Thanksgiving</em></td>
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<tr>
<td>October 15</td>
<td>Systematics</td>
<td>Koval</td>
</tr>
<tr>
<td>October 20, 22</td>
<td>Cell division and peptidoglycan synthesis</td>
<td>Cadieux</td>
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<tr>
<td>October 27, 29; November 3, 5</td>
<td>Bacterial genetics</td>
<td>Creuzenet</td>
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<tr>
<td>November 10, 12</td>
<td>Antimicrobial growth control</td>
<td>Cadieux</td>
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<tr>
<td>November 17, 19</td>
<td>Environmental effects on microbial growth</td>
<td>Koval</td>
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<tr>
<td>November 24, 26; December 1</td>
<td>Food and waterborne bacterial diseases</td>
<td>Creuzenet</td>
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<tr>
<td>December 3</td>
<td>In Class Review: question and answer session</td>
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</tbody>
</table>

**Mid Term Exam:**  
Thursday October 30; 7 to 9 pm  
WSC 55 and WSC 240

Questions will be based on lectures to the end of the ‘Cell division and peptidoglycan synthesis’ section. No questions on Bacterial genetics. There will also be questions from Laboratories 1 to 5.
<table>
<thead>
<tr>
<th>LAB</th>
<th>WEEK OF</th>
<th>TOPIC</th>
<th>Exercises in Lab Manual</th>
<th>Relevant Readings in Text Book</th>
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<tbody>
<tr>
<td></td>
<td>September 8</td>
<td>Biosafety; Writing lab reports</td>
<td>Introduction</td>
<td>32.4</td>
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<tr>
<td>1</td>
<td>September 15</td>
<td>Media preparation; aseptic transfers</td>
<td>1-2, 1-3, 1-4 2-1</td>
<td>5.2, 5.3</td>
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<tr>
<td>2</td>
<td>September 22</td>
<td>Microscopy</td>
<td>3-1, 3-2, 3-3, 3-4 use 2-2</td>
<td>2.1, 2.2</td>
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<tr>
<td></td>
<td>September 29</td>
<td>Bacterial staining</td>
<td>3-4, 3-6, 3-8 pp. 145-148</td>
<td>2.2</td>
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<tr>
<td>3</td>
<td>September 22</td>
<td>Section on bacterial structure and simple stains</td>
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<td>4</td>
<td>October 6</td>
<td>Selective and differential media</td>
<td>4-1, 4-4, 4-6 2-8, 2-10</td>
<td>32.2 6.12, 6.16</td>
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<td></td>
<td>October 6</td>
<td>Effect of temperature and osmotic pressure on growth</td>
<td></td>
<td></td>
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<td>5</td>
<td>October 13</td>
<td>Bacterial identification (follow-up in 24 h)</td>
<td>5-1, 5-3, 5-4, 5-6, 5-7, 5-14, 5-17 9-1, 9-4</td>
<td>32.2</td>
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<td></td>
<td>October 13</td>
<td>NB. Attendance at follow-up is mandatory; no lab mark if absent</td>
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<td></td>
<td>October 20</td>
<td>Follow-up of Lab 5</td>
<td></td>
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<td>6</td>
<td>October 27</td>
<td>Standard plate count</td>
<td>6-1 6-2</td>
<td>6.10</td>
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<td></td>
<td>October 27</td>
<td>Semi-quantitative method for numbers (urine culture)</td>
<td>6-5 7-1 7-2</td>
<td>32.3, part of 27.4</td>
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<td></td>
<td>October 27</td>
<td>Environmental sampling: RODAC™ plate Snyder test</td>
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<td></td>
<td>October 27</td>
<td>Antimicrobial susceptibility test</td>
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<td>7</td>
<td>November 3</td>
<td>Water analysis: Membrane filter technique and Most Probable Number (MPN)</td>
<td>7-5 7-6</td>
<td>part of 22.2 26.1, 27.3</td>
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<tr>
<td></td>
<td>November 3</td>
<td>Follow-up of Lab 6</td>
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<tr>
<td>Date</td>
<td>November 10</td>
<td>Event Description</td>
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<td></td>
<td>Plasmid lab (protocol on WebCT site)</td>
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<td></td>
<td>Continuation of MPN Lab 7</td>
<td>part of 27.12</td>
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<td>9</td>
<td>November 17</td>
<td>Lactic acid bacteria: yogurt and probiotics (protocol on WebCT site)</td>
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<td></td>
<td>Follow-up of plasmid Lab 8</td>
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<tr>
<td></td>
<td>Follow-up of MPN Lab 7</td>
<td>part of 16.1</td>
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<tr>
<td>10</td>
<td>November 24</td>
<td>Follow-up of Lab 9 (Lactic acid bacteria)</td>
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<td></td>
<td>Milk quality demonstrations:</td>
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<td></td>
<td>Casein hydrolysis test</td>
<td>5-13</td>
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<td></td>
<td>Methylene blue reductase test</td>
<td>7-7</td>
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<td></td>
<td>Pasteurization pp. 781-782</td>
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MICROIMM 3300A – Immunology  
(2008-2009)

Course Coordinator: Dr. Mansour Haeryfar  
Mansour.Haeryfar@schulich.uwo.ca  
Tel: (519) 850-2488 office (Dental Sciences Building room 5012)  
Website: http://publish.uwo.ca/~mhaeryfa/

Instructors:  
1) Dr. Alexander Timoshenko (e-mail: atimoshe@uwo.ca); office location: Medical Sciences Building room M386; office hours: every Tuesday (3:00-4:30 pm) starting on September the 9th and ending on October 21st  
2) Dr. Mansour Haeryfar (office hours: every Tuesday between 3:00 and 4:30 pm for the entire duration of the course)  
3) Dr. Gill Strejan (e-mail: gstrejan@uwo.ca); office location: Dental Sciences Building room 5013 (appointments made by e-mail only)

Teaching Coordinator: Mr. Fred Williams (e-mail: fred.williams@schulich.uwo.ca); Tel: (519) 661-3457; Office location: Dental Sciences Building room 3014

Teaching Assistant: Ms. Karly Lycett-Lambert (e-mail: klycettl@uwo.ca)

Lecture Room Location: NS-145 (Natural Sciences Bldg. room 145)  
Time: Tuesdays (Tue.) and Thursdays (Thu.) between 1:30 and 2:20 pm

Course Description: 2 lecture hours per week, 0.5 course  
This course covers elementary concepts of immunity, structure and function of the immune system, antigens and antibodies, complement, genetic basis of the immune response, humoral and cellular immunity, immunological tolerance, organ and tissue transplantation, allergy and autoimmunity.

Prerequisites: Biochemistry 2280A and Biology 2581B  
Senate regulations regarding prerequisites are as follows:  
“Unless you have either the prerequisites for this course or written special permission from your Dean to enroll in it, you will be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites”.

Teaching Materials:  
Five copies of this textbook have been made available for short-term loan (three copies on 2-hour loan, and two copies on 24-hour loan) from Allyn & Betty Taylor Library (Call No. QW504.J33i 2008). Please note that although specific textbook sections and materials covered during lectures are the core learning resources for this course, additional readings may be assigned by each instructor and tested in your exams. Lecture materials (e.g., powerpoint slides and/or notes) will be posted on WebCT prior to lectures. Students will need to log into WebCT frequently to check for messages and announcements from the instructors and/or the teaching assistant.
Information Flow:
WebCT Owl Site: https://owl.uwo.ca
For assistance with WebCT Owl, please contact the ITS Computer Support Centre [helpdesk@uwo.ca, (519) 661-3800]. Troubleshooting information is also available online. A list of commonly encountered problems and solutions can be found at http://webct.uwo.ca/commonProblems.html
Students should also ensure that their computer and browser are properly prepared by visiting http://webct.uwo.ca/checkMyBrowser.html

Exam Time & Locations: Please see below (Lecture Schedule).
Exam format: “Multiple Multiple Choice”
Mark Distribution:
Midterm 1 exam covering lectures 1-10 (25 questions worth 25% of the final grade)
Midterm 2 exam covering lectures 11-19 (25 questions worth 25% of the final grade)
Final exam covering all lectures (50 questions worth 50% of the final grade)

Exam Procedure:
1. You will enter the exam room(s) 5 minutes before the exam.
2. You will leave your backpacks, briefcases, laptops, etc. in the front section of the room. Please make sure that your cell phones and other electronic devices are turned off and not with you when you write the exam.
3. Return to your seats. The exam books will already be on your desk.
4. You will place your student ID card, face up, on your desk.
5. You will not touch the exam book until you are instructed to do so.
6. Make sure that you have only one question book. Also remember to provide your name and ID number on your question book and on your scantron card. You will be required to hand in both the question book and the scantron card at the end of the exam.
7. Do not ask proctors to provide their interpretation of the questions.
8. Due to the large size of the class, no questions will be answered during the exam. However, rest assured that every effort will be made to address your concerns. If you believe that a question is ambiguous, use blank pages at the back of your question book. Write down the question number, your reasoning as to why you think the question(s) is/are ambiguous and your answer(s) based on your interpretation. Also make sure to write down the question numbers on the front cover of your exam book. Illegible writing should be avoided in order to enable the instructors to re-evaluate your answer(s) fairly and efficiently.
9. You will stop writing at the end of the exam time. Students who continue to write past the allotted time could have their exam cancelled at the discretion of the proctors. Remain seated and calm until the proctors approach you to collect the exam materials.
10. If you finish the exam earlier than 10 minutes prior the exam end, raise your hand so one of the proctors can collect your exam materials. Please make sure to pick up the items you have left at the front section of the exam room and leave quietly.
11. If you finish writing within the final 10 minutes of the exam, out of respect for your peers and to avoid their distraction, you are requested to remain seated until the exam end.

Exam review:
Students are welcome to review their answers and exam evaluations for up to three weeks after the marks are announced. To do so, the arrangements need to be made by contacting our teaching assistant, Karly Lycett-Lambert, who will make sure to have the exam books ready for your review.
Ethical and Special Considerations

Exams:

1) There will be no makeup exams for the midterms. In the event of a timing conflict, special arrangements will be made so that the student(s) can write the exam earlier than others.
2) Petitions for permission to waive a midterm exam will be entertained only if they are submitted on compassionate grounds (e.g., sickness or inadvertent physical discomfort during the test) with supporting documentation (please consult the current academic calendar at http://www.westerncalendar.uwo.ca/2008/index.html). In order to have the zero mark pertaining to the missed midterm exam removed, the student will be required to:
   i) Provide formal documentation to one of the student counsellors at the Office of the Dean of Science, not to the course coordinator, within 24 hours after the exam. The student Medical Certificate you may have to use can be found at https://studentservices.uwo.ca/secure/medical_document.pdf
   ii) Ask the student counsellor to contact our teaching coordinator (Mr. Fred Williams) directly and notify him of the receipt and approval of your document by the Office of the Dean. This has to be done before the midterm marks are posted.

Students whose petition to waive the midterm exam requirements for the completion of this course is approved will be allowed to write the final exam, in which case the final exam will count towards 75% or 100% of the student’s final grade depending on whether one or both midterm exams were missed, respectively.

2) One makeup for the final exam will be allowed under circumstances described above. The information regarding the date, time and location of the makeup exam will be emailed to the students by the Teaching Coordinator (Mr. Fred Williams) in due course.

3) Computer-marked multiple choice exams may be subject to submission for similarity review by software that will check for unusual coincidences in answer patterns. All the students in this course are subjected to regulations outlined under “Scholastic Discipline for Undergraduate Students” in the UWO Academic Calendar (http://www.westerncalendar.uwo.ca/2008/).

LECTURE SCHEDULE

1. September 4 (Thu): Immunity & Immunology: A General Overview (Dr. Haeryfar)
2. September 9 (Tue): Specificity of the Immune Responses (Dr. Timoshenko)
3. September 11 (Thu): Cells of the Immune System (Dr. Timoshenko)
4. September 16th (Tue): The Anatomy of the Immune System: I. Central Lymphoid Organs (Dr. Timoshenko)
5. September 18 (Thu): The Anatomy of the Immune System: II. Peripheral Lymphoid Organs/Tissues (Dr. Timoshenko)
6. September 23 (Tue): Pattern Recognition Receptors (Dr. Timoshenko)
7. **September 25 (Thu):** The Complement System (Dr. Timoshenko)

8. **September 30 (Tue):** Immunoglobulins: I. Basic Structure (Dr. Timoshenko)

9. **October 2 (Thu):** Immunoglobulins: II. Generation of Diversity, Somatic Hypermutation and Allelic Exclusion (Dr. Timoshenko)

10. **October 7 (Tue):** Immunoglobulins: III. Isotype Switching, Classes & Subclasses (Dr. Timoshenko)

11. **October 9 (Thu):** The Major Histocompatibility Complex (MHC) System (Dr. Timoshenko)

**Midterm Exam 1**
*When:* Friday, October 10, 7:00 pm
*Where:* NS-145 (Natural Sciences Bldg. room 145)
*Format:* A one-hour “multiple-multiple choice” exam consisting of 25 questions from lectures 1-10 (inclusive) (2 questions from lecture 1, and 23 questions from Dr. Timoshenko’s lectures
Please note that the materials covered in lecture 11 will **not** be tested in this midterm exam.

12. **October 14 (Tue):** The Endogenous Pathway of Antigen Processing and Presentation (Dr. Timoshenko)

13. **October 16 (Thu):** The Exogenous Pathway of Antigen Processing and Presentation (Dr. Timoshenko)

14. **October 21 (Tue):** Antigen Recognition by B Cells (Dr. Haeryfar)

15. **October 23 (Thu):** B Cell Development (Dr. Haeryfar)

16. **October 28 (Tue):** Manifestations of humoral (B Cell-mediated) Immune Responses (Dr. Haeryfar)

17. **October 30 (Thu):** Antigen Recognition by T Cells (Dr. Haeryfar)

18. **November 4 (Tue):** T Cell Development (Dr. Haeryfar)

19. **November 6 (Thu):** Manifestations of T Cell-mediated Immune Responses (Dr. Haeryfar)

**Midterm Exam 2**
*When:* Saturday, November 8, 10:00 am
*Where:* NS-145 (Natural Sciences Bldg. room 145)
*Format:* A one-hour “multiple-multiple choice” exam consisting of 25 questions from lectures 11-19 (inclusive) (8 questions from Dr. Timoshenko’s lectures and 17 questions from Dr. Haeryfar’s lectures

20. **November 11 (Tue):** Immunological Tolerance (Dr. Haeryfar)

21. **November 13 (Thu):** A nice treat before your final lecture bloc!!!

22. **November 18 (Tue):** Immunity to Infectious Diseases (Dr. Strejan)
23. **November 20 (Thu):** Hypersensitivity & Allergy (Dr. Strejan)

24. **November 25 (Tue):** Autoimmunity (Dr. Strejan)

25. **November 27 (Thu):** Transplantation Immunology (Dr. Strejan)

26. **December 2 (Tue):** Principles of Tumor Immunology (Dr. Strejan)

**Final Exam**

**Location & time:** to be announced by The Office of Registrar

**Format:** A two-hour exam consisting of 50 questions proportionally distributed among ALL lectures (19 questions from Dr. Timoshenko, 14 questions from Dr. Haeryfar and 17 questions from Dr. Strejan).

**GOOD LUCK!**
1. Faculty

Dr. Vincent L. Morris (course coordinator), Tel. 661-3452, E-mail: vmorris@uwo.ca.
Dr. Laura Hertel, Tel. 661-4009, Email: Laura.Hertel@schulich.uwo.ca
Dr. J.S. Mymryk, London Regional Cancer Centre, Tel. 685-8300 ext. 53012, E-mail: jmymryk@uwo.ca.
Dr. G. Dekaban, Robarts Research Institute, Tel. 663-5777 Ext. 34241 or Ext. 34239, E-mail dekaban@rri.on.ca.

2. Course Description

A. This course is primarily designed to provide a basic understanding of animal virology. In addition, recent topics related to animal virology from the current literature or reputable sources for the internet will be covered where appropriate. Relevant reference to bacterial, and plant virology may be made if applicable.

B. This course consists of 2 hour lectures given on Tuesdays (Rm. 3008 DSB; 10:30AM-12:30PM) and a 2 hour tutorial on Thursday (RM. MSB-M282; 8:30AM-10:30 AM). The tutorials will consist of student presentations (see attached schedule) or a midterm examination.

C. Student Presentations will consist of participation in a group oral presentation on a current topic of interest to and/or related to animal virology. The presentations will be 40 minutes with 20 minutes for questions from the audience. Students will prepare a 1 page (on both sides) handout to be given out at the beginning of the presentation. Extra page(s) for references should also be provided. The presentation is expected to include molecular aspects of your topic. Presentations will be evaluated based on the handout, content, presentation, and the ability to answer questions by fellow students and the attending faculty.

D. Student Presentations – Students are encouraged to begin early. For references, students can begin by looking for pertinent recent review articles to gain an overview of the topic and select which aspects of the topic they wish to choose for a more detailed discussion. Thus the entire scope of the topic chosen does not have to be covered. The portion to be covered and a rationale for choosing this portion should be presented at the beginning of the presentation. However, it should be noted that students are expected to not just use review articles but to present data from current research papers (2004 or later). Presentations should be limited in scope to the extent that the topic can be covered in depth. The review articles can be used to find references to specific current papers. In addition, current papers on virology in journals such as Science, Nature, Cell, J. Virology, and Virology can also be used. As noted above students are expected to include molecular aspects of their topic. Topics can include viral life cycle, clinical presentation, pathogenesis and diagnosis, epidemiology, molecular biology and genetics, treatment and prevention. The papers used in the presentation and handout should be referenced at the end of the handout (not included in the page limitation).
3. **Student Evaluation:**

A. **Midterm examination**
   25 marks

   **Student Presentation**
   20 marks

   **Student Participation**
   5 marks + (1 bonus mark possible)

   **Final Examination**
   50 marks

B. The Midterm Exam will be 2 hour and will be given during a scheduled tutorial.

C. Student presentations will be evaluated as follows: 5 marks—handout (including references), 5 marks—content (including molecular component), 5 marks—presentation; 5 marks—ability to answer questions.

D. Student participation: **Attendance is mandatory for the student presentations, and the presence of students will be recorded; in addition, instructors will keep track of student participation in the form of questions.**

E. Final Examination will be 3 hours long and will be given during the regularly scheduled final examination period. **A section on the final examination will be based on the handouts from the student presentations.**

4. **Texts:** There is no text for the course. Reference will be made to notes, book chapters, and/or review journal articles by the instructors. The instructors may also hand out notes or make them available on Web CT where appropriate.

   A major source for notes is:
   *Fields Virology, 4th or 5th Edition, Ed. B.N. Fields and D.M. Knipe, Raven Press, 2001 (4th edition) or 2002 (5th edition).* This is the current bible of animal virology. There is also a single volume edition called *Fundamental Virology* by Fields and Knipe containing chapters from the above volume.

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LIST OF POTENTIAL STUDENT PRESENTATION TOPICS

1. Filovirus (e.g. Ebola, Marburg)

2. Fowl plague virus (H5N1) and human influenza

3. Foot and Mouth Disease – Pros and Cons of Vaccination

4. Debate about destruction of stocks of infectious human smallpox virus and bringing back vaccinations against smallpox. (Effect of potential bioterrorism and potential mutations of closely related viruses such as Monkey Pox can also be included in this debate).

5. Herpes B Virus

6. Rabies and recombinant vaccines used in the environment to vaccinate viral reservoirs

7. Hepatitis D virus

8. BSE and “Mad Cow Disease”.

9. Hanta virus

10. Norwalk Virus

11. Haemorrhagic fever virus

12. West Nile Virus

13. SARS

14. Hepatitis E virus

15. Use of animal viruses in cloning genes

16. Any other relevant topic (must be approved by instructor)
DEPARTMENT OF MICROBIOLOGY AND IMMUNOLOGY 4200B
MOLECULAR VIROLOGY—2009
SCHEDULE

For Student Presentations:
(A) Presentation 8:30-9:20
(B) Presentation 9:30-10:30

Jan. 6 Morris Introduction—History, Virology, Virus structure, Taxonomy, Virus-cell interaction. Student Talk Schedule

Jan. 8 Morris Planning for student presentations

Jan. 13 Morris Plus stranded viruses: Polio and others

Jan. 15 Student Presentations

Jan 20 Morris Negative Stranded Viruses

Jan 22 Student Presentations

Jan 27 Morris Hepatitis Viruses

Jan 29 Student Presentations

Feb 3 Morris RNA Tumor Viruses (nonhuman)

Feb 5 Student Presentations

Feb 10 Mymryk DNA Tumor Viruses- SV40 and Polyoma Viruses

Feb 12 Midterm Examination (On V. Morris Lectures only-- covering up to and including RNA tumor viruses)

Feb 16 – 20 Study Week

Feb 24 Mymryk Adenoviruses

Feb 26 Student Presentations

March 3 Hertel Pox Viruses and Herpes Viruses

March 5 Student Presentations

March 10 Hertel Pox Viruses and Herpes Viruses

March 12 Student Presentations
March 17  Hertel  Pox Viruses and Herpes Viruses
March 19  Student Presentations
March 24  Hertel  Pox Viruses and Herpes Viruses
March 26  Student Presentations
March 31  Dekaban  Human Retroviruses I
April 2    Student Presentations
April 7    Dekaban  Human Retroviruses II

Final Examination
APPENDIX B3 – Assignments

Laboratory Report Assignments from 2008/09 for Microbiology and Immunology 2100A are provided
Microbiology and Immunology 2100A - 2008

Guidelines for writing a complete lab report

Prepared in consultation with Dr. K. Summers, Coordinator, MicroImm 3600G and Dr. T. Stavraky, Physiology and Pharmacology.

The goal of a lab report is to:
✓ provide a complete and accurate account of work done in the lab session(s)
✓ effective communication of the work
  • subtitles (e.g. Methods/Results)
  • a paragraph defines a single, clear point
  • spelling, grammar and punctuation must be correct

Organization
All biological science journals that report original data use the following standard set of subsections:
● Abstract
● Introduction
● Materials and Methods
● Results
● Discussion
● References

Do not use creative writing. Be concise and scientific.

Format
All lab reports must be typed. Use Times New Roman 12 point font, double spacing, and margins of 1 inch. All pages should be numbered consecutively.

Each report should have a title page with the name of the exercise(s), course name and number, student name, teaching assistant name and day of the lab session. Plus the date of submission.
Lab 1 Report: Media Preparation and Aseptic Transfers

DUE DATE: the week of September 29 during your lab period

Marks are indicated in bold in brackets. Total = 17

Exercise 1-2 Nutrient Broth and Nutrient Agar Preparation [10]
There are no Results to report from this exercise, nor data sheets to use from the lab manual.

Practice: Introduction
Your assignment will be to write an Introduction on media and their preparation, as would be found in the first part of a complete lab report. This will give you practice, and feedback from your TA, before you write the first complete lab report (for lab 5).

Information on growth media may be obtained from your textbook (Brock Biology of Microorganisms) and your lab manual, as well as three other microbiology textbooks that have been put on 2 h reserve in the Taylor Library for this course. Do not reference lecture notes or prelab talk. No peer-reviewed journal research articles are required for this writing assignment, as few articles are published these days just on media for prokaryotes. The principles of sterilization would be a good topic to include in your Introduction. Please include a list of your references, as per the format in the file ‘Guidelines for writing a complete lab report’.

The Introduction (1 page maximum) should be typed, double-spaced and in 12 point Font. It should include a clear statement of the purpose of the exercise. It should be written in complete sentences, in paragraphs. Remember, the Introduction will be assessed on neatness, organization, grammar and spelling.

Exercise 1-3 Aseptic Transfers
Results: Describe your observations for each aseptic transfer. [2]

Question: What does the presence or absence of turbidity mean with respect to bacterial numbers? [1]

Exercise 2-1 Ubiquity of Microorganisms
Procedure: State the area you sampled [0.5].
Results: List the colony numbers and types on your nutrient agar plate. Are there any distinguishing features of the growth on this medium? [2]

Question: Why did you choose that area to sample for microorganisms? [1.5]
Abstract
No abstract is required for lab reports in MicroImm 2100A

Introduction (1-2 pages)
The introduction contains background information to prepare the reader for the experiment(s) to be discussed. This information should include a review of pertinent literature (which will be listed in the References section). Only include information relevant to your experiment. You should include a general statement on why the particular methods used were selected.

The introduction should also include a clear statement of the purpose or goals of the experiments. What will/did the experiment accomplish?

Materials and Methods (1-2 pages)
This section should contain a brief description of the materials and procedures used in your experiment. For MicroImm 220a, do not repeat in detail the materials and methods provided in the lab manual or on information sheets provided by Dr. Koval. You may reference this source of information. Note any changes provided by your TA or any variation you have devised.

Results (no page limit)  DO NOT repeat the Methods!
What data did you obtain? Present the data in an understandable framework, in tables or figures. Describe the results obtained clearly. Do not include interpretations or discussion. All numeric data must have units.

Discussion (1-2 pages)
This section should interpret the results and explain their relevance by pointing out and discussing the relationships among your data relevant to data from other researchers. i.e. do your results concur with previous experiments? Point out the assumptions that were made and the factors that limit the interpretation of your study. State conclusions and applications to bacteriology.

References
This section should describe all sources of information used for background information (in the Introduction) and the interpretation of your results (in the Discussion). Be sure to refer to these references at the appropriate places in your report (but do not put a reference at the end of every sentence!). You should use books or peer-reviewed articles in journals. Your TA will discuss with you how to find journal articles on line. The article (not just the Abstract) must be read by you. Do not reference lecture notes or prelab talks. Do not reference Web pages. The one exception is the online edition of the treatise ‘The Prokaryotes’.
There are peer-reviewed research articles and peer-reviewed review articles. Know the difference.
You may be asked to provide a copy of the first page of each peer-reviewed article you use.

Reference format: Note the use of italics and bold face.
Each reference in the reference list must be cited in the text.

In the text, references should be inserted in parentheses in date order, as follows: (Pugsley, 1996; Matsunaga et al., 1997). The reference list should be in alphabetical order according to the first-named author. Papers with two authors should follow those of the first-named author, arranged in alphabetical order according to the name of the second author. Articles with more than two authors should follow those of the first named author in chronological order; with multiple references from the same first author in a given year, please list the references in cited order. The title of the article must be included. For papers with up to seven authors, the names of all authors should be listed. For papers with eight or more authors, the first six names should be listed, followed by 'et al.' The following provide examples of formats for articles, books and book chapters:

Journal Article


Book

Book Chapter


E (electronic) book (e.g. The Prokaryotes)
Microbiology and Immunology 2100A - 2008

Lab 4 Report

Selective and Differential Media; Environmental Effects on Growth

DUE DATE: the week of October 20 during your lab period

Marks are indicated in bold in brackets. Total = 33

This lab report will be written in two parts.


No Introduction or Materials and Methods sections are required.

Results [5]
Please fill in the data sheets for each of the following exercises: [1 mark per sheet]
Do NOT fill in the column titled 'Interpretation'. That should be written in the Discussion.

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Medium</th>
<th>Page Number of Data Sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-1</td>
<td>Mannitol Salt</td>
<td>201</td>
</tr>
<tr>
<td>4-4</td>
<td>Eosin Methylene Blue</td>
<td>215</td>
</tr>
<tr>
<td>4-6</td>
<td>MacConkey</td>
<td>223</td>
</tr>
</tbody>
</table>

Chromocult agar
Describe results for each organism tested. [2]

Practice Discussion [10]
The next stage in learning to write a lab report will be to write a discussion about your results of growth of bacteria on various selective and differential media. The Guidelines for writing a Discussion that are pertinent to this set of experiments are as follows:
This section should interpret the results. Point out the assumptions that were made and the factors that limit the interpretation of your study. State conclusions and applications to bacteriology.

Use three appropriate references. Some of the questions in the lab manual may provide ideas for your Discussion.

Length: 1 to 2 pages
Questions from the lab manual  [10]
Answer the following questions from the lab manual for each medium [marks for each question are in **bold**].

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Questions, marks and page number in lab manual</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-1</td>
<td>4 <strong>[1]</strong> and 5 <strong>[2]</strong> page 202</td>
</tr>
<tr>
<td>4-4</td>
<td>2 <strong>[1]</strong>, 5 <strong>[1]</strong>, 6 <strong>[1]</strong> page 216</td>
</tr>
<tr>
<td>4-6</td>
<td>2 <strong>[2]</strong> page 223</td>
</tr>
</tbody>
</table>

Define the scientific term “positive control”. How were these used in this laboratory and why is it always important to include these in your experimental design? **[2]**

Part 2. **Environmental Effects on Growth**  [8]

**Exercise 2-8**
Fill in data sheet on page 87.
Section 1 will be plate data. Insert the temperatures you used. Record the presence or absence of growth. **[3]** We did not use an uninoculated control.

For Section 2, insert the temperatures you used to incubate your plates. What have you learned about pigment production by *Serratia marcescens*? **[1]**

**Exercise 2-10**
Fill in data sheet on page 99 **[2]**
Answer question 2 **[2]** on page 99.
Lab 5 Report: Bacterial Identification

DUE DATE: the week of November 3 during your lab period
Total marks: 67

Before writing this report, please read the ‘Guidelines for writing a complete lab report’ file.
FOCUS your Introduction and Discussion sections. State your information and logic clearly and concisely.

The data sheets and questions in the lab manual for the individual exercises will NOT be used for this lab report. The lab report should NOT exceed 6 pages double spaced (not including title page, tables and references).

Introduction [10] 1-2 pages
This section of the lab report should be used to introduce methods for identification of bacteria. You could write out steps in the identification of an organism. You could discuss the kinds of tests used.

Materials & Methods [5] 0.5 to 1.0 page
Rather than write out the procedures for every test you performed, reference the lab manual. Should any of the procedures have changed from those given in the lab manual, be sure to mention them here.

Results [20] no page limit
This is one of the most important sections of your lab report, as your discussion will be based on it.

- fill in the Table provided at the end of this document with results for your unknown bacterium; for the tests, describe the results observed. A simple statement of ‘positive’ or ‘negative’ is not sufficient. This Table may be hand-written.
- record any mistakes and unexpected or equivocal results
- Write out the IMViC results [+ or -] for your unknown
  I = indole (from the SIM tube)
  M = methyl red (from the MR-VP tube)
  Vi = Voges-Proskauer (from the MR-VP tube)
  C = citrate (from the Citrate test)
- match your IMViC results with ones shown in Figure 9-2 and indicate which identification chart you proceeded to
- give the name of the organism identified by the IMViC results
- Fix a copy of your API 20E result sheet to your lab report. Write the identification of your unknown bacterium based on these results ON the sheet.

Be sure to be clear and concise. Here you will note the results of all of the tests performed. Make sure that you ONLY mention the results. This section should NOT include interpretations of your results.
With the results of the reactions from the IMViC and API 20E tests, you should be able to complete the identification of your unknown bacterium.

**Discussion [20] 1-2 pages**

You will use this section to interpret your results and lead the reader through your reasoning. You may discuss the IMViC tests, but do not discuss ALL the tests on the API 20E multiple test system.

Take your test results and explain what they mean. If a test on the API 20E test was repeated in another exercise (e.g. citrate utilization or the VP test), were the results the same?

Then provide information on your bacterium. You should discuss information that is relevant to your organism such as its natural reservoir, optimal growth conditions, pathogenicity, virulence … etc. Use this section to give the reader the important aspects of your organism.

**Conclusion [2]**

**References [5]**

Find literature to support the identification of your bacterium.

Be sure to reference ALL information that you did not provide yourself. This becomes particularly important in your Introduction and Discussion. You may use and are encouraged to use several sources to get your information:

- the lab manual
- text books
- *The Prokaryotes* (available online via the UWO Library website)

  * on 2h reserve for this course at the circulation desk in the Taylor Library

You must use at least three of the above sources of information

- You **must** also use at least **ONE** recent research journal article as a reference for your organism. A maximum of five journal articles is allowed
- **read** the journal article
- attach to your lab report the **first page** of each journal article used


Your TA will discuss what a good reference is. If you are uncertain as to your choice of journal article(s), consult your TA.
Should you fail to reference any information, your writing will be considered plagiarism: a major academic offence for which you will be severely penalized. Any information that did not come from your own knowledge MUST be referenced.

You may wish to reproduce figures or tables from publications. In that case, the citation must appear at the bottom of the illustration.

**Format** [5]
This includes spelling, punctuation and grammar.

Provide a title for tables.
Cite references where you use them in the lab report.

In writing, when you first use the name of an organism, it is written in full: genus and species. In subsequent use, the genus is abbreviated to the first letter.
E.g. *Pseudomonas aeruginosa* and *P. aeruginosa*
Student Name:
TA Name:

Identification Sheet for Unknown Bacterium Number: _____

<table>
<thead>
<tr>
<th>TEST</th>
<th>RESULTS FOR YOUR BACTERIUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colony morphology:</td>
<td></td>
</tr>
<tr>
<td>Nutrient agar</td>
<td></td>
</tr>
<tr>
<td>MacConkey agar</td>
<td></td>
</tr>
<tr>
<td>Microscopy</td>
<td></td>
</tr>
<tr>
<td>a. Gram reaction</td>
<td></td>
</tr>
<tr>
<td>b. Cell shape, arrangement</td>
<td></td>
</tr>
<tr>
<td>Catalase test</td>
<td></td>
</tr>
<tr>
<td>Oxidase test</td>
<td></td>
</tr>
<tr>
<td>Utilization of glucose (O or F)</td>
<td></td>
</tr>
<tr>
<td>Methyl red test</td>
<td></td>
</tr>
<tr>
<td>Voges Proskauer test</td>
<td></td>
</tr>
<tr>
<td>H₂S formation</td>
<td></td>
</tr>
<tr>
<td>Indole production</td>
<td></td>
</tr>
<tr>
<td>Citrate test</td>
<td></td>
</tr>
<tr>
<td>Gelatinase test</td>
<td></td>
</tr>
<tr>
<td>Motility (in SIM)</td>
<td></td>
</tr>
<tr>
<td>Nitrate reduction</td>
<td></td>
</tr>
</tbody>
</table>
Microbiology and Immunology 2100A - 2008

Lab 6 Report

Environmental Sampling; Standard Plate Count; Urine Culture; Snyder Test; Antibiotic Sensitivity and Resistance

DUE DATE: the week of November 10 during your lab period

Answer questions ON the data sheets. Marks are indicated in bold in brackets. Total = 16

Exercise 6-5  Environmental Sampling: the RODAC™ Plate
No report required

Exercise 6-1  Standard Plate Count (Viable Count)
Do not use the table on the Data Sheet on page 341, as we did not plate samples in duplicate. Create your own table with your data. Follow the instructions on page 341 for entering the data. [2]

Calculate the density of the original sample in CFU/ml using the formula provided. [1]

Answer questions 7, 18, 20, and 26 on pages 342 to 344. [1 mark each]

Exercise 6-2  Urine Culture
Calculate the original cell density (OCD) in CFU/ml of the ‘simulated’ urine sample. [1]

Exercise 7-1  Snyder Test
No report required

Exercise 7-2  Antimicrobial Susceptibility Test (Kirby-Bauer Method)
Draw a new Data Sheet, like the one on page 375. Include a column for carbenicillin and a row for Pseudomonas aeruginosa.
Record your observations for the three bacteria. [6]

Answer question 5 on page 376. [2]

Question for thought: Why is the agar medium green in the plate inoculated with Pseudomonas aeruginosa?
Microbiology and Immunology 2100A - 2008

Lab 7 Report: Water Analysis

DUE DATE: the week of November 24 at the beginning of the lab period

Report:
Marks are indicated in brackets; total is 19

Exercise 7-5 Membrane Filter Technique [9]
• First, write down the results from the water sample you filtered [1]
• Next, submit the summary tables 1 (total colony counts) and 2 (total coliform counts) from your aisle with the collated results for each water sample. These tables are on page 2 in this file. [2]
• which water sample has the highest number of bacteria as detected by this technique? [1]
• will all bacteria present in the water samples grow on this medium? Explain your answer. [2]
• why can we use EMB agar for this technique, rather than the Endo LES agar that the exercise in the lab manual uses? [1]

Answer question 3 on page 392. [2]

Exercise 7-6 Multiple Tube Fermentation Method for Total Coliform Determination [4]
• for the water sample you tested (as a pair), enter your data in Section 1 in the Tables on the data sheets on pages 399 and 400. Adjust the dilution factor in the Tables if necessary. [2]
• complete the calculations in Section 2 on page 400 [2]

Readycult® Coliform 100 Test [2]
• give the results for all three environmental water samples tested in your lab session
• was the presence of E. coli confirmed in any water samples? In which ones?

Summary Questions [4]
1. For the water sample you tested by the MPN method, how do the results of the membrane filter technique and the MPN method compare? [2]
2. Which water samples tested are potable? [1]
3. What is the microbiological status of the wastewater treatment plant effluent? Does it need to be disinfected by UV or chlorination? [1]
### Table 1. Total number of colonies

<table>
<thead>
<tr>
<th>Sample</th>
<th>100</th>
<th>10</th>
<th>1.0</th>
<th>0.1</th>
<th>0.01</th>
</tr>
</thead>
<tbody>
<tr>
<td>drinking water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coves pond water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thames River water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>wastewater treatment plant effluent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 2. Total number of coliforms

<table>
<thead>
<tr>
<th>Sample</th>
<th>100</th>
<th>10</th>
<th>1.0</th>
<th>0.1</th>
<th>0.01</th>
</tr>
</thead>
<tbody>
<tr>
<td>drinking water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coves pond water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thames River water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>wastewater treatment plant effluent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Lab 8 Report: Plasmids

DUE DATE: on or before Wednesday December 3 at 4 pm in the office of the Department of Microbiology and Immunology (DSB 3014). Please use the drop-off box just inside to the right of the door to the office.

Mark are indicated in bold in brackets. Total = 57

Before writing this report, please read (again) the ‘Guidelines for writing a complete lab report’ file.

The lab report should NOT exceed 5 to 6 pages double spaced (not including title page, tables and references).

Introduction [10] 1-2 pages
This section of your lab report should be used to generally introduce any theory relevant to understanding the content of the lab report. You may want to briefly talk about plasmids, transposons, antibiotic resistant bacteria, etc. You may use books and journal article(s) here to provide background information.

Materials and Methods [2]
Rather than writing out the procedures in detail, reference to the lab handout provided to you on the WebCT Vista course site. Should any procedure have changed from that stated in this handout, you MUST mention it in this section.
Be sure to state clearly that you set up a bacterial mating mixture.

Results [20] no page limit
This is the most important section of your lab report as any discussion and conclusions will be based on it.

Part A [10]
Prepare a table that lists all of the different plates used and the corresponding counts. Be sure to list the counts for ALL dilutions plated.
Write out your results in paragraph form and refer to the table.

Part B [10]
Calculate
a) the number of donors in the mating mixture
b) the number of Met+ exconjugates
c) from A and B, calculate the % donor cells that transferred the F’ plasmid
d) the number of Met+, tet resistant exconjugates
e) the frequency of transposition of Tn10 from the chromosome onto the F’ plasmid

N.B. Show your calculations
**Discussion** [15]  1-2 pages

You will use this section to interpret your results and lead the reader through your reasoning. Take the results stated above and explain what they mean. Discuss the validity of your plate counts as well as the quality of your serial dilutions (i.e. does every serial dilution give you the same number of cells in the original sample?). Also discuss which bacteria you would expect to grow on the different types of plates (i.e. what would the bacteria have “picked up” to grow on the different plates).

**References** [5]  On a separate page

Be sure to reference ALL information that you did not provide yourself. This becomes particularly important in your Introduction and Discussion.

You may use and are encouraged to use several sources to get your information (i.e. books, journal articles). You must use at least ONE journal article as a reference. A maximum of five journal articles is allowed. Attach to your lab report the first page of each journal article used.

You may wish to reproduce figures or tables from publications. In that case, the citation must appear at the bottom of the illustration.

**Should you fail to reference any information, your writing will be considered plagiarism: a major academic offence for which you will be severely penalized. Any information that did not come from your own knowledge MUST be referenced.**

**Format** [5]

This includes spelling, punctuation and grammar. Please include a title for each table, and legends for each figure.
Microbiology and Immunology 2100A - 2008

Lab 9 Report: Lactic Acid Bacteria

A mini report and your last one!

DUE DATE: on or before Wednesday December 3 at 4 pm in the office of the Department of Microbiology and Immunology (DSB 3014). Please use the drop-off box just inside to the right of the door to the office.

Mark are indicated in bold in brackets. Total = 8

A. Observations of bacteria in yogurt [4]

• what yogurts did you stain?
• what did you see in your Gram stains?
• based on the description of the bacterial contents on the product label of your chosen yogurts:
  ▶ what organism(s) could the Gram-positive cocci be?
  ▶ what organism(s) could the Gram-positive rods be?
• did the probiotic yogurt have more total bacteria (just based on your observations) than the other yogurt?

B. Proof of a manufacturer’s claim [4]

• in a Table, provide the CFU/dilution of the probiotic capsule contents tested
• calculate the CFU/capsule
• how do your results compare with the manufacturer’s claim?
• provide one reason for a discrepancy between your results and the manufacturer’s claim
Midterm tests and Final examinations for the following courses are provided:

- Microbiology and Immunology 2100A
- Microbiology and Immunology 3300A
- Microbiology and Immunology 4200B
Multiple Choice Questions (60)
Pages (11)

You have exactly two hours to complete the exam

Section I: combination of answers  [1-43]
Please use the answering scheme at the top of each page
Part marks will be given for the combination questions as follows:

<table>
<thead>
<tr>
<th>Correct Answer</th>
<th>Student Answer</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>All of the above</td>
<td>1, 2 and 3</td>
<td>0.5</td>
</tr>
<tr>
<td>1, 2 and 3</td>
<td>1 and 3</td>
<td>0.5</td>
</tr>
<tr>
<td>2 and 4</td>
<td>4</td>
<td>0.5</td>
</tr>
</tbody>
</table>

All other possibilities receive no credit

Section II: single best answer  [44-60]
(A) 1, 2 and 3 are correct
(B) 1 and 3 are correct
(C) 2 and 4 are correct
(D) 4 only is correct
(E) all or none are correct

1. Robert Koch is known for his work on the following pathogens:
   1) Bacillus anthracis
   2) Penicillium notatum
   3) Mycobacterium tuberculosis
   4) Legionella pneumophila

2. Not all of the known bacterial pathogens have been proved by Koch’s postulates. This is because:
   1) some cannot be stained by Gram’s method
   2) some cannot be cultivated in artificial media
   3) some cannot be grown in any animal other than the human
   4) some are too dangerous to be cultured in the laboratory

3. Spores
   1) Are always smaller in diameter than the vegetative cell
   2) Can be seen in unstained preparations by light microscopy
   3) Are always found at the end of vegetative cells
   4) Are resistant to dessication

4. Carrier mediated transport is necessary when
   1) Diffusion will not allow adequate amounts of a substance to enter the cell.
   2) Movement of solutes into the cell is against a concentration gradient
   3) Hydrophilic molecules need to be transported across a membrane
   4) The level of nutrients in nature is very low

5. The following molecules are unique to the prokaryotic cell wall:
   1) N-acetylmuramic acid
   2) lipopolysaccharide
   3) teichoic acid
   4) N-acetylglucosamine

6. Which of the following structures are not found in Archaea?
   1) Lipopolysaccharides
   2) Endospores
   3) Teichoic acids
   4) S-layers

7. Prokaryotic flagella
   1) Are anchored in the cytoplasmic membrane
   2) Flex back and forth to provide movement
   3) Move by energy generated by the proton motive force
   4) Are randomly arranged on bacterial cells

8. Porins in the outer membrane of Gram-negative Bacteria function to allow
   1) Non-specific diffusion of ions into the cell
   2) Specific transport of some solutes into the cell
   3) Exit of low molecular weight substances
   4) Entry of DNA
9. The cytoplasmic membrane
   1) Is the only membrane system found in Bacteria
   2) Allows free penetration of water molecules
   3) Has specific transport systems, some of which require energy
   4) Allows passage of small, non-polar substances

10. Which of the following statements accurately describes the functions of the Bacterial cell wall?
    1) Provides rigidity to the cell
    2) Contributes to the shape of the cell
    3) Is important for cell growth and division
    4) Provides energy for flagellar rotation

11. Which of the following statements about cytoplasmic membranes are true?
    1) Bacteria and Eukarya have ester-linked fatty acids
    2) Archaea have ether-linked fatty acids
    3) All prokaryotic cells have phospholipids in the cytoplasmic membrane
    4) Only Bacterial cells have a bilayer membrane structure

12. With regard to transport in bacterial cells, which of the following statements are true?
    1) Porins in the cytoplasmic membrane allow non-specific diffusion of ions into the cell
    2) Transport proteins in the cytoplasmic membrane convey sugars and other essential nutrients into the cytoplasm
    3) Secretion of proteins into the periplasm occurs via antiporter transport proteins
    4) The outer membrane of Gram-negative bacteria serves as a permeability barrier.

13. Unique molecules in peptidoglycan that are not found in Archaea or Eukarya cells include
    1) Diaminopimelic acid
    2) N-acetyl glucosamine
    3) N-acetyl muramic acid
    4) L-alanine

14. The following statements about teichoic acids are true:
    1) They are acidic polysaccharides found in the cell wall of Gram-negative Bacteria
    2) They are always polymers containing ribitol phosphate esters
    3) Some teichoic acids are also bound to membrane lipids of Gram-negative Bacteria
    4) They are acidic polymers found in the cell wall of Gram-positive Bacteria

15. The cell walls of Archaea species may contain
    1) S-layers
    2) N-acetylglucosamine
    3) Pseudopeptidoglycan
    4) Peptidoglycan
16. The following statements about Bacteria are true
   1) Most Bacteria are Gram-negative
   2) Many Gram-negative Bacteria produce endospores
   3) Lipopolysaccharide is a signature molecule of Gram-negative Bacteria
   4) Most Gram-negative Bacteria are pathogenic

17. The following statements about Archaea are true
   1) Various cell wall types exist, but none contain peptidoglycan
   2) Some species are motile by means of flagella
   3) Diglycerol tetraether lipid monolayers are very common in hyperthermophilic species
   4) Contain a 70S ribosome

18. The following statements about capsules IS/ARE true:
    Capsules
   1) Are highly hydrated polysaccharides
   2) Can be homo- or hetero-polysaccharides
   3) Protect against phagocytosis by macrophages
   4) Can be stained with India Ink

19. Motility of prokaryotes can be assessed by
   1) Phase contrast light microscopy
   2) Electron microscopy
   3) Use of semi solid agar growth medium
   4) Simple stains for light microscopy

20. How does a symporter protein transport two different solutes?
   1) by group translocation
   2) a concentration gradient of each solute is established
   3) there are two channels in the membrane-spanning transporter
   4) there are specific binding sites on the protein for each solute

21. Which of the following statements IS/ARE correct about bacterial taxonomy?
   1) It is the science that identifies and names organisms and arranges them into categories called taxa
   2) Bacterial taxonomy will always be based only on morphological and physiological characteristics
   3) The reference source of prokaryotic classification guidelines is Bergey's Manual of Systematic Bacteriology
   4) Archaea are not included in Bergey's Manual of Systematic Bacteriology because they are a distinct domain from Bacteria
22. A very large (up to 600 μm in length) motile microorganism, *Epulopiscium*, has been observed by light microscopy in the gut contents of a marine surgeonfish. So far, attempts to maintain this unusual symbiont in pure culture have been unsuccessful. Which of the following statements about the taxonomic position of this microorganism IS/ARE correct?

1) It cannot be taxonomically identified until it can be grown in pure culture
2) It cannot be a prokaryotic cell since the cell size and volume exceed that of some eukaryotic cells
3) Only 16S rRNA sequencing will confirm if the isolate is prokaryotic or eukaryotic
4) Electron microscopy can aid in the identification of the organism as prokaryotic or eukaryotic

23. Which of the following phenotypic characteristic(s) IS/ARE of taxonomic value?

1) Shape
2) Ability to use nitrogen sources
3) Motility
4) Genomic GC ratio

24. Analysis of the fatty acids present in lipids

1) is a useful taxonomic tool for identifying new species of *Bacteria* and *Archaea*
2) requires that the fatty acids be chemically changed to their corresponding methyl esters
3) requires that membranes be isolated
4) is very dependent upon growth conditions and medium

25. Lithos is the Greek word for stone. Trophe is the Greek word for food. Thus, when the microbial biochemist describes a microorganism as a lithotroph, she means:

1) that the microorganism is always found on or in rocks
2) that the microorganism obtains its energy by degrading rocks
3) that the microorganism requires minerals as cofactors for growth
4) that the microorganism obtains its energy by oxidizing inorganic compounds

26. Prokaryotic microorganisms have varying carbon requirements:

1) Many prokaryotes can acquire their carbon from CO₂ and are referred to as autotrophic
2) Many prokaryotes can acquire their carbon from organic compounds and are referred to as heterotrophic
3) Many prokaryotes can acquire their carbon from CO₂ and are photosynthetic
4) Many prokaryotes can acquire their carbon and their energy from organic compounds and are referred to as autotrophic

27. The ‘electron tower’ of redox pairs:

1) Arranges redox pairs in order from strongest reductants at the top to strongest oxidants at the bottom
2) Lists the redox pairs with the reduced form on the left and the oxidized form on the right
3) Lists the electrical potential relative to a standard substance, H₂
4) Lists those redox pairs involved in the transfer of single electrons
28. In a biological oxidation-reduction reaction:
   1) Electrons can be transferred
   2) Co-enzymes can participate as carriers in redox reactions
   3) Hydrogen atoms can be transferred
   4) Molecular oxygen (O₂) must be involved

29. Fermentation products made during glycolysis by prokaryotes are:
   1) Different, depending upon the organism utilizing this pathway
   2) Metabolic waste products, resulting from the reduction of pyruvate
   3) The result of an anaerobic process of energy generation
   4) Natural products, some of which are used in the food and beverage industries

30. Agar
   1) Is used as a solidifying agent in bacteriological media
   2) Is non-toxic
   3) Unlike gelatin, is not digested by most bacteria
   4) Is a gelling agent from marine algae

31. Autoclaving:
   1) can safely be used to sterilize aqueous solutions of all chemicals
   2) can be used to pre-sterilize plastic petri dishes before use
   3) sterilizes objects by dry heat at 170 C for 90 min
   4) sterilizes objects by steam at a temperature of 121 C and a pressure of 15 psi

32. Which of the following bacteria are members of the family *Enterobacteriaceae*?
   1) *Salmonella*
   2) *Proteus*
   3) *Citrobacter*
   4) *Shigella*

33. Lactose fermentation
   1) Occurs in all members of the *Enterobacteriaceae*
   2) Lowers the pH of the medium
   3) Splits lactose into the monosaccharides glucose and fructose
   4) Occurs in the production of yogurt

34. Gram's staining procedure
   1) Is almost essential in the identification of an unknown bacterium
   2) Reflects the biochemical and structural differences in the cell walls of *Bacteria*
   3) Can be used for clinical and environmental isolates
   4) Uses crystal violet as a primary stain
(A) 1, 2 and 3 are correct  (D) 4 only is correct
(B) 1 and 3 are correct  (E) all or none are correct
(C) 2 and 4 are correct

35. In a Biosafety Level 2 facility, which of the following safety equipment and practices are required?
   1) Laboratory coats
   2) Respiratory protection
   3) Class I or II biological safety cabinet
   4) Controlled laboratory access

36. Which of the following statements about light microscopy are TRUE?
   1) The limit of resolution is a function of the numerical aperture of an objective lens
   2) The practical limit to magnification is around 2000X
   3) The light microscope may be modified to improve its ability to produce images with contrast without staining
   4) The best limit of resolution is about 0.02 µm

37. The following statement(s) is/are TRUE regarding bacterial nutrition and cultivation:
   1) Crystal violet and neutral red dye are both used as SELECTIVE agents in MacConkey’s growth media
   2) Hydroxamate and Enterobactin are iron scavengers termed siderophores
   3) It is thought that only about 10% of all bacteria can be cultivated presently
   4) Most micronutrients function as coenzymes

38. Complex growth media:
   1) Typically uses yeast extract, peptone and/or other organic digests
   2) Gives you better control over which particular organisms will grow compared to chemically-defined media
   3) Is chemically undefined
   4) Gives you better reproducibility than chemically-defined media

39. The following statement(s) is/are TRUE regarding prokaryotes and eukaryotes:
   1) Both translate RNA to protein in a similar fashion
   2) Both use proteins as catalysts
   3) Histones are absent in prokaryotes
   4) Only prokaryotes can carry out chromosome replication and transcription simultaneously

40. Peptidoglycan synthesis involves the following molecules:
   1) N-acetyl glucosamine/N-acetyl muramic acid/pentapeptide precursor
   2) FtsI
   3) Bactoprenol
   4) Lipopolysaccharide

41. The following statement(s) regarding bacterial cell morphology is/are TRUE:
   1) Peptidoglycan plays a major role in determining cell shape
   2) Crescentin and crescentin-like proteins are believed to confer the characteristic spherical shape of a coccoid bacterium
   3) The “rod” shape is the default shape for a bacterium
   4) FtsZ,MreB and Mbl resemble eukaryotic tubulin and actin
(A) 1, 2 and 3 are correct  
(B) 1 and 3 are correct  
(C) 2 and 4 are correct  
(D) 4 only is correct  
(E) all or none are correct

42. The following statement(s) is/are true regarding the bacterial growth cycle:
   1) Cells are considered the healthiest during exponential phase
   2) The time spent in lag phase is dependent upon multiple factors including the history of the inoculating culture and the growth conditions
   3) During stationary phase, the total cell number stays relatively stable
   4) During death phase, lysed organisms can supply nutrients to those remaining alive in the culture

43. The following is/are TRUE regarding FtsI:
   1) It is inhibited by beta-lactam antibiotics
   2) It supplies the energy necessary for peptidoglycan cross-linking
   3) It is a transpeptidase
   4) It is also called bactoprenol

Choose the best single answer

44. The first person to ‘see’ bacteria was
   A) Galileo
   B) Ferdinand Cohn
   C) Antoni van Leewenhoek
   D) Robert Koch

45. *Archaea* differ from Gram-negative aerobic rods and cocci because *Archaea*
   A) Are neither rods nor cocci
   B) Are not aerobic
   C) Lack peptidoglycan
   D) Lack nuclei

46. The periplasm is a(n)
   A) Part of the outer cell membrane of Gram-negative bacteria
   B) Part of the inner cell membrane of Gram-negative bacteria
   C) Region between the cytoplasmic membrane and the outer membrane of Gram-negative bacteria
   D) Alternate name for the inner cell membrane of any prokaryotic cell

47. Aquaporins are
   A) Water transport proteins
   B) Molecules that prevent water from crossing a membrane
   C) Enzymes involved in the generation of water within the cells
   D) Cations bound to water molecules
Choose the best single answer

48. Negatively charged molecules that are partially responsible for the negative charge of the Gram-positive bacterial cell surface are
   A) diaminopimelic acids
   B) teichoic acids
   C) phospholipids
   D) peptide interbridges

49. The first classification system for bacteria was proposed by
   A) Beijerinck
   B) Cohn
   C) Koch
   D) Winogradsky

50. The electron carriers in the electron transport chain are arranged in the following order of decreasing reduction potential \([E_0]\) negative to positive:
   A) \(NAD^+/NADH \rightarrow \text{quinones} \rightarrow \text{iron sulfur proteins} \rightarrow \text{flavoproteins} \rightarrow \text{cytochromes}\)
   B) \(NAD^+/NADH \rightarrow \text{iron sulfur proteins} \rightarrow \text{flavoproteins} \rightarrow \text{quinones} \rightarrow \text{cytochromes}\)
   C) \(NAD^+/NADH \rightarrow \text{flavoproteins} \rightarrow \text{iron sulfur proteins} \rightarrow \text{quinones} \rightarrow \text{cytochromes}\)
   D) \(NAD^+/NADH \rightarrow \text{quinones} \rightarrow \text{cytochromes} \rightarrow \text{flavoproteins} \rightarrow \text{iron sulfur proteins}\)

51. Which of the following statements is FALSE?
   A) A variety of fermentation pathways exist in prokaryotes
   B) Proton motive force is only used for aerobic respiration
   C) Chemolithotrophs are exclusively prokaryotic organisms
   D) Prokaryotes can be photoautotrophs or photoheterotrophs

52. The roadblock to the oxidation of glucose is overcome in fermentation by the
   A) oxidation of NADH back to NAD+
   B) reduction of NADH back to NAD+
   C) oxidation of NAD+ back to NADH
   D) reduction of NAD+ back to NADH

53. From the standpoint of the microorganism, in glycolysis the crucial product
   A) is ATP; the fermentation products are waste products
   B) is ethanol or lactate; ATP is a waste product
   C) is \(CO_2\); ATP is a waste product
   D) is not relevant because glycolysis is not a major pathway

54. \textit{Escherichia coli} grows equally well both in the presence (using respiration) and absence (using fermentation) of oxygen.

   Based on its oxygen requirement it is termed a:

   A) Obligate anaerobe
   B) Microaerophilic
   C) Facultative anaerobe
   D) Indifferent anaerobe
   E) Obligate aerobe
Choose the best single answer

55. To complete DNA replication of the lagging strand, the enzymes below function in the following order:

A) Primase, DNA Polymerase III, DNA Polymerase I, DNA Ligase
B) Primase, DNA Polymerase I, DNA Polymerase III, DNA Ligase
C) Primase, DNA Polymerase III, DNA Ligase, DNA Polymerase I
D) Primase, DNA Polymerase I, DNA Ligase, DNA Polymerase III
E) Primase, DNA Ligase, DNA Polymerase III, DNA Polymerase I

56. In Gram negative bacteria, the glycan chains of peptidoglycan are crosslinked:
   A) Only through the glucosamine residues by short peptide chains containing diaminopimelic acid
   B) Only through the muramic acid residues by short peptide chains containing diaminopimelic acid
   C) Only through the glucosamine residues by short peptide chains containing a glycine interbridge
   D) Only through the muramic acid residues by short peptide chains containing a glycine interbridge
   E) Through both the glucosamine and muramic acid residues by short peptide chains containing a glycine interbridge

57. This enzyme separates the DNA into single strands during DNA replication:
   A) DnaB (Helicase)
   B) DnaA (Initiator protein)
   C) DNA Polymerase III
   D) Topoisomerase IV
   E) Single-stranded binding protein

58. The enzyme that provides energy for divisome assembly during cell division is:
   A) FtsI
   B) FtsK
   C) FtsA
   D) FtsZ
   E) ZipA

59. Which of the following statements is false?
   A) MreB and Mbl are the major determinants of bacterial cell shape
   B) FtsZ resembles eukaryotic tubulin
   C) MinE is important in peptidoglycan synthesis
   D) FtsK helps chromosomes separate into their respective daughter cells
   E) FtsZ has enzymatic activity that allows it to get its own energy for polymerization and depolymerization
Choose the best single answer

60. Identify which of the following statements is FALSE:

A) New DNA is always synthesized in the 5’ to 3’ direction
B) The quinolone antibiotics inhibit the activity of DNA gyrase
C) Primase is only needed on the leading strand
D) DNA polymerase I synthesizes DNA while removing the RNA primer put in by primase
E) If you stretched out the chromosomal DNA of a typical Escherichia coli bacterial cell its length would measure approximately 1mm
The University of Western Ontario

Microbiology and Immunology 2100A
Biology of Prokaryotes
Final Exam
December 6, 2008 7:00 - 10:00 PM

EC 2155 A-Drou
EC 2168A/B Du-Z

100 Multiple Choice Questions on 17 pages

You have exactly three hours to complete the exam

Use the answering scheme at the top of each page

Section I: combination of answers  [1-66]
Please use the answering scheme at the top of each page
Part marks will be given for the combination questions as follows:

<table>
<thead>
<tr>
<th>Correct Answer</th>
<th>Student Answer</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>All of the above</td>
<td>1, 2 and 3</td>
<td>0.5</td>
</tr>
<tr>
<td>1, 2 and 3</td>
<td>1 and 3</td>
<td>0.5</td>
</tr>
<tr>
<td>2 and 4</td>
<td>4</td>
<td>0.5</td>
</tr>
</tbody>
</table>

All other possibilities receive no credit

Section II: single best answer  [67-100]

Student ID Number: ________________________________

Student Name (print): ________________________________
1. The absence of coliforms indicates
   1) fecal contamination
   2) the absence of pathogens
   3) the presence of pathogens
   4) that water is safe to drink

2. Water quality improvement was possible because of:
   1) improved coliform counting methods
   2) eradication of *Salmonella typhi*
   3) chlorination procedures
   4) *Vibrio cholera* disappeared

3. Plasmid P can only replicate in bacterium B and not in other bacteria. Which statement(s) is/are true?
   1) Plasmid P needs host proteins to replicate
   2) Plasmid P has a broad host range
   3) Plasmid P will likely act as a suicide plasmid in bacteria different from bacterium B
   4) Addition of an antibiotic cassette within plasmid P will allow replication in bacteria different from bacterium B

4. The common features of the R and F plasmids are:
   1) The presence of *tra* genes
   2) The presence of replication functions
   3) The presence of insertion elements.
   4) The presence of multiple antibiotic resistance genes

5. Which of the following is/are true?
   1) *Legionella pneumophila* causes pneumonia in old soldiers only
   2) *Legionella pneumophila* survives in water
   3) *Legionella pneumophila* is an extracellular parasite
   4) *Legionella pneumophila* can be spread via air conditioning systems.

6. The emetic disease triggered by *Bacillus cereus*
   1) is due to a preformed diarrheagenic toxin
   2) is due to a heat stable peptidic toxin
   3) is a toxin-caused food infection
   4) is caused most often by un-refrigerated fried rice

7. The following bacteria can cause food-borne infections:
   1) *Clostridium botulinum* and *Listeria monocytogenes*
   2) *Clostridium perfringens* and EHEC
   3) *Clostridium botulinum* and *Staphylococcus aureus*
   4) *Listeria monocytogenes* and *Salmonella typhimurium*
Questions 1 - 66
(A) 1, 2, 3       (B) 1 and 3       (C) 2 and 4       (D) 4 only       (E) all or none are correct
Questions 1 - 66
(A) 1, 2, 3  (B) 1 and 3  (C) 2 and 4  (D) 4 only  (E) all or none are correct

8. Germination of endospores
   1) is often associated with food-borne poisoning
   2) is often associated with food-borne infection
   3) can cause *Bacillus cereus* emetic disease
   4) is necessary for food-borne poisoning

9. Which of the following bacteria produce(s) a superantigen toxin?
   1) *Clostridium botulinum*
   2) EHEC
   3) *Campylobacter jejuni*
   4) *Staphylococcus aureus*

10. *Clostridium botulinum* is dangerous because
   1) it exists as toxin-producing endospores
   2) its grows readily in non-refrigerated food
   3) it makes a potent neurotoxin
   4) its toxin is a superantigen

11. *Listeria monocytogenes*
   1) can grow and spread from cell to cell after initial survival in macrophages
   2) gets stuck in macrophages where it survives happily
   3) uses actin as a propeller to move from cell to cell
   4) can only grow in specific salt, temperature and acid conditions

12. Which of the following statement(s) is/are true?
   1) Conjugation can be interrupted by breakage of the conjugating DNA
   2) Conjugation is unidirectional
   3) Conjugation can be interrupted by shaking the culture too hard
   4) Conjugation only requires the *mpf* set of genes

13. Which of the following practices can put our food and water supply at risk in terms of bacteriological safety?
   1) Manure composting
   2) Prophylactic use of antibiotics in animal feed
   3) Poor sewage infrastructure maintenance
   4) Freezing all chicken put on the market

14. The following food-borne pathogens are found in the reservoirs listed below.
   1) Soil for *Clostridium botulinum*
   2) Human nose for *Staphylococcus aureus*
   3) Chicken for *Salmonella typhimurium*
   4) Human skin for *Listeria monocytogenes*

   1) Is commonly found in cattle but does not usually cause symptoms in the animals
   2) Only causes water-borne epidemics
3) Is able to cause disease in humans, especially in the elderly or the very young
4) Produces a potent superantigen

16. Which one(s) of the following are prevalent food-borne pathogens:
   1) Pseudomonas aeruginosa
   2) Campylobacter jejuni
   3) Helicobacter pylori
   4) E. coli O157:H7

17. The best definition for a mutation is:
   1) It is an inherited change in the DNA that always affects a cell’s phenotype
   2) It is an inherited change in the DNA that only affects a cell’s genotype
   3) It is a change in a single base of the DNA with minimal effect on the cell’s phenotype
   4) It is an inherited change in the DNA that alters the cell’s genotype but might or might not alter its phenotype.

18. If a bacterium contains a high-copy number plasmid,
   1) the bacterium will divide more than the same bacterium that would not contain the plasmid
   2) the plasmid is present within the cell in a defined (= always the same) numbers of copies of itself
   3) the plasmid has integrated in several areas of the chromosome
   4) the bacterium can still take up other plasmids

19. Which one of the following is/are true?
   1) Transformation is the most efficient method to transfer plasmids from one cell to another
   2) Transformation works best on linear pieces of DNA
   3) Naturally transformable bacteria do not need to become competent to take up DNA by transformation
   4) Transformation of non-naturally transformable bacteria is possible

20. Transformation involves which of the following steps:
   1) Binding of doubled-stranded DNA
   2) Circularization of in-coming DNA
   3) Degradation of one strand of the DNA during uptake
   4) Degradation of the recipient’s chromosome

21. Which of the following process(es) can be used to map bacterial chromosomal genes:
   1) Transposition
   2) Conjugation
   3) Transformation
   4) Transduction

22. An insertion sequence is:
Questions 1 - 66

(A) 1, 2, 3  (B) 1 and 3  (C) 2 and 4  (D) 4 only  (E) all or none are correct

1) made of a gene encoding a transposase and an antibiotic resistance cassette
2) made of a gene encoding a transposase and short inverted terminal repeats
3) the largest transposable element known
4) never a free-floating piece of DNA in the bacterial cytoplasm.

23. Transposition events involve
   1) insertion of a transposon at a specific site in the bacterial chromosome
   2) random insertion of the insertion sequence in the bacterial chromosome
   3) duplication of the DNA where integration of the insertion sequence occurs
   4) pili-mediated transfer of transposons from 1 cell to another

24. During replicative transposition:
   1) two sequential DNA cutting events occur
   2) there is replication through the transposon
   3) the transposon insertion site is eliminated from the DNA
   4) the donor DNA keeps its transposon

25. Which one of the following is/are correct?
   1) The toxin responsible for diphtheria is plasmid-encoded
   2) The toxin responsible for dysentery is phage-encoded
   3) Treating infections caused by phage-encoded toxins with antibiotics is always recommended
   4) Toxin-encoding genes are often found on pathogenicity islands.

26. What distinguishes an F from an F’ plasmid?
   1) Only the F’ plasmid can replicate.
   2) The F plasmid has tra genes which the F’ plasmid does not have
   3) The F’ plasmid is conjugative when F is not
   4) The F’ plasmid has incorporated host chromosomal DNA

27. What are the minimum elements required to constitute a transposable element?
   1) insertion sequences
   2) a transposase gene
   3) an antibiotic resistance cassette
   4) two short inverted terminal repeats

28. Which of the following would be important for a generalized transducing phage?
   1) A site-specific recombination system
   2) A relatively large DNA genome
   3) Efficient degradation of host cell DNA
   4) Low specificity for DNA packaging/recognition

29. By mixing live rough Streptococcus pneumoniae with heat-killed smooth Streptococcus pneumoniae, one might obtain
   1) live smooth Streptococcus pneumoniae by transformation
   2) non-virulent smooth Streptococcus pneumoniae by conjugation
3) virulent *Streptococcus pneumoniae* that can kill mice
4) a-capsular virulent *Streptococcus pneumoniae*
30. The following is/are true about vancomycin:
   1) It is a glycopeptide antibiotic used sparingly as a last resort
   2) It is produced by the bacterium *Nocardia orientalis*
   3) It functions by binding to the terminal D-alanyl-D-alanine in the peptidoglycan pentapeptide and blocking transpeptidation
   4) Luckily, no bacterial resistance has arisen to it yet

31. The following is/are true about lagging strand DNA synthesis:
   1) DNA ligase isn’t required at all
   2) DNA polymerase III removes RNA primers and replaces them with DNA
   3) DnaA keeps the strand single stranded
   4) Primase generates RNA primers for DNA Polymerase III to use

32. The following are siderophores (iron scavengers):
   1) Hydroxamate
   2) Bactrim
   3) Enterobactin
   4) Trimethoprim

33. Quinolone antimicrobial agents:
   1) Interact with DNA gyrase
   2) Are synthetic antimicrobial agents
   3) Include ciprofloxacin and norfloxacin
   4) Are based upon the prototype sulfanilamide

34. The following statement(s) is/are true regarding antimicrobial chemotherapeutic agents:
   1) Gerhard Domagk discovered the sulfa drugs in the 1930s
   2) The growth factor analogs are no longer used today
   3) Their selective toxicity is measured using the chemotherapeutic index
   4) Semi-synthetic agents never work as good as the original agent they are based upon

35. The following antibiotic(s) target protein synthesis:
   1) Quinolones
   2) Sulfanilamide
   3) Cephalosporins
   4) Aminoglycosides

36. The following antibiotic(s) attack peptidoglycan synthesis:
   1) Vancomycin
   2) Erythromycin
   3) Cephalosporins
   4) Aminoglycosides
Questions 1 - 66
(A) 1, 2, 3  (B) 1 and 3  (C) 2 and 4  (D) 4 only  (E) all or none are correct

37. The following statement(s) is(are) TRUE:
   1) B-lactamase inhibits transpeptidase by inactivating it
   2) Methicillin resistance is via production of an alternative transpeptidase resistant to B-lactam antibiotics
   3) Tetracycline resistance is through alteration of the D-alanyl-D-alanine to D-alanyl-D-lactate on the terminus of the pentapeptide
   4) The major B-lactam antibiotics are the penicillins, cephalosporins and cephamycins

38. Which of the following statements is/are TRUE:
   1) Macronutrients never function as enzyme co-factors
   2) It is thought that less than 1% of bacteria can be cultivated using standard methods
   3) Chemically-defined media often use organic digests like peptone
   4) *Streptococcus pneumoniae* and *Neisseria meningitides* can both cause bacterial meningitis

39. The following is/are TRUE about the transpeptidation reaction:
   1) It requires ATP
   2) FtsI carries it out
   3) Penicillin inhibits it by binding to the terminal D-alanyl-D-alanine
   4) It results in the covalent attachment of D-alanine on one peptide to diaminopimelic acid on the other peptide

40. Which of the following statements is/are TRUE?
   1) The overall structure of the cytoplasmic membrane is stabilized by hydrogen bonds, hydrophobic interactions and divalent cations such as Mg$^{2+}$ and Ca$^{2+}$
   2) The majority of motile prokaryotes move by means of rotating flagella.
   3) Bacterial endospores are ideal structures for dispersal by wind, water or through the animal gut.
   4) In Gram-negative bacteria, cross-linkage of peptidoglycan occurs by way of a peptide interbridge.

41. Microorganisms can survive in what we consider extreme environments. Examples of such environments are:
   1) The hypersaline Great Salt Lake in Utah, USA
   2) The hot springs in Banff, Alberta, which are about 60°C
   3) The hypersaline, alkaline (pH 10) Lake Hamara in Egypt
   4) Fanshawe Lake in London, ON

42. The following statement(s) about cardinal temperatures is/are TRUE:
   1) The maximum growth rate of a bacterium occurs at the maximum growth temperature
   2) The optimum temperature is always nearer the maximum than the minimum
   3) Cardinal temperatures are two temperatures: minimum and maximum
4) The cardinal temperatures can be modified by the composition of the medium

43. All prokaryotes have minimum growth temperatures because:
   1) There are very few habitats on Earth with cold environments (less than 25°C)
   2) Oxygen is poorly soluble in water at lower temperatures
   3) Proteins unfold at low temperatures
   4) Cell division does not occur at low temperatures

44. Which of the following statement(s) about temperature and bacteria is/are TRUE?
   1) *Escherichia coli* is a thermophile
   2) The typical temperature range from minimum to optimum for a given bacterium is about 50°C
   3) Thermophiles are found in warm blooded animals
   4) The most thermophilic of all prokaryotes are certain species of *Archaea*

45. Which of the following statement(s) is/are TRUE about pH and microbial growth?
   1) Most organisms show a growth pH range of 2 to 3 units
   2) Some bacteria are obligate extremophiles and cannot grow at neutral pH
   3) Both bacteria and fungi can grow at low pH
   4) Alkaliphilic bacteria are usually found in highly basic habitats such as seawater

46. In the food industry, the solutes salt and sucrose are commonly used as preservatives to inhibit microbial growth because
   1) No bacteria can grow in NaCl concentrations greater than 3%
   2) These solutes increase the water activity of the food product
   3) When a cell is in an environment of low water activity, water tends to flow into the cell, causing lysis
   4) They are less expensive than antibiotics

47. Unlike humans, prokaryotes vary in their requirements for oxygen. Which of the following statement(s) is/are TRUE about these prokaryotic relationships?
   1) Extensive aeration of broth cultures is often required for obligate aerobes
   2) Facultative anaerobes do not require O₂, and do not grow better when O₂ is present
   3) Among obligate anaerobes, the sensitivity to O₂ varies greatly
   4) Microaerophilic aerobes should be grown in an anoxic jar to reduce the concentration of O₂

48. With regard to pH and microorganisms
   1) As a group, bacteria are more acid-tolerant than fungi
   2) Strongly acidophilic bacteria lyse at neutral pH values because the cytoplasmic membrane is destroyed
   3) Only genera of *Archaea* can grow at low pH
   4) Obligate acidophiles cannot grow at neutral pH
Questions 1 - 66

(A) 1, 2, 3  (B) 1 and 3  (C) 2 and 4  (D) 4 only  (E) all or none are correct
49. The term ‘water activity’ used in microbiology
   1) Is an expression of the amount of water in a substance
   2) Is an expression of the relative availability of water in a substance
   3) Refers to the diffusion of water from a region of high water concentration to
      a region of low water concentration
   4) Is a function of the concentration of solutes such as salts and sugars that are
      dissolved in water

50. Superoxide reductase
   1) Reduces superoxide to H₂O₂ without the concomitant production of O₂
   2) Is produced by members of the Archaea
   3) Is produced in obligate anaerobes
   4) Is produced in eukaryotic phagocytic cells

51. Which of the following statements is/are TRUE?
   1) Permanently frozen land areas are sterile
   2) A psychrophile is an organism that can grow optimally at a low temperature
   3) Cold-adapted microorganisms can be found in continental temperate climates
      because the variable temperature environment favours their survival
   4) Some liquid water is essential for metabolism and growth of psychrophilic
      organisms

52. Which of the following statements about lysozyme is/are TRUE?
   1) It can be used to produce protoplasts of Gram-positive Bacteria
   2) It is a natural antimicrobial agent produced by the human body
   3) It can be produced in a phagolysosome of macrophages, to destroy ingested
      bacteria
   4) It hydrolyses the β-1,3 glycosidic bonds in peptidoglycan

53. In the lab exercise on the effect of temperature on growth, why were bacterial cultures
    incubated at 10°C, rather than at 4°C?
    1) No psychrophiles can grow at 4°C
    2) It takes too long for psychrophiles to grow at 4°C
    3) The refrigerator was full
    4) More psychrophiles have an optimum temperature of approximately 10°C
       than 4°C

54. The current ‘record holders’ for growth at a particular extreme condition include the
    following growth optima:
    1) optimum salt concentration is 25%
    2) optimum lowest pH is 0.7
    3) optimum lowest temperature is 4.8°C
    4) optimum highest pH is 12
55. Which of the following statement(s) are TRUE?
   1) Archaea were named as such (meaning ‘old’) because phylogenetic studies showed that they were more related to Bacteria than Eukarya.
   2) Phylogenetic studies can be done on Archaea by sequence analysis of the 18S rRNA gene
   3) Only Archaea exist in thermophilic environments
   4) DNA-DNA hybridization is a genotypic method that can be used for taxonomic studies of Archaea

56. Which of the following statements is/are TRUE about bacterial phylogeny?
   1) Ribosomal RNA is a useful molecule for determining phylogenetic relationships
   2) DNA:DNA hybridization can be used as a phylogenetic tool
   3) Two phylogenetic domains of prokaryotic cells have been indentified
   4) It is the science that identifies and names organisms and arranges them into categories called taxa

57. Some prokaryotes are facultative anaerobes, which means:
   1) Under the appropriate nutrient and culture conditions they can grow under either oxic or anoxic conditions
   2) Some can produce energy by fermentation
   3) Some can perform aerobic respiration
   4) Some can perform anaerobic respiration

58. The antibiotic disk diffusion test for pathogenic bacteria is routinely done on Mueller-Hinton agar because:
   1) The medium needs to be standardized to ensure reliable results
   2) Antibiotics are ineffective in broth cultures
   3) Most pathogenic bacteria will grow on this medium
   4) Mueller and Hinton were friends of Kirby and Bauer

59. The function of a reducing agent in medium is to:
   1) Remove oxygen from the medium
   2) Allow a technician to use small volumes of liquid medium
   3) Allow cultivation of anaerobes
   4) Provide a source of energy

60. Human pathogens that can be found as contaminants in raw milk include:
   1) Salmonella
   2) Lactobacillus
   3) Campylobacter
   4) Legionella
Questions 1 - 66

(A) 1, 2, 3  (B) 1 and 3  (C) 2 and 4  (D) 4 only  (E) all or none are correct

61. Spoilage of raw milk occurs when:
   1) Milk is not stored at 7°C or below at all times
   2) Mesophilic lactose fermenters produce lactic acid, which causes the milk to sour
   3) Psychrophilic *Pseudomonas* species produce lipases and proteinases which spoil the milk
   4) Only when pathogens are introduced by contamination from the cow’s bedding and manure

62. The process of pasteurization
   1) Was designed to kill endospores
   2) Destroys all pathogens that may be harmful to health
   3) Eliminates the growth of spoilage bacteria in perishable liquids
   4) Is named for Louis Pasteur, who first used heat for controlling the spoilage of wine

63. Brucellosis is a bacterial human infectious disease which may be acquired from the milk of infected animal reservoirs (e.g. cows, goats). Control of the causative agent *Brucella* may be achieved by:
   1) Proper storage of milk
   2) Vaccination of animals
   3) Decontamination of public water sources
   4) Pasteurization of raw milk

64. Domestic wastewater:
   1) Is made up of raw sewage and other used household water (from washing, cooking, food processing)
   2) Must be treated to remove contaminants
   3) The effluent water from a wastewater treatment facility can be discharged into rivers, streams or lakes
   4) The effluent water from a wastewater treatment facility is potable

65. How do the major microbial groups differ in the composition of their cytoplasmic membrane?
   1) *Archaea* have ether-linked lipids
   2) *Bacteria* and *Eukarya* have ester-linked lipids
   3) Cytoplasmic membranes of *Eukarya* contain sterols
   4) *Archaea* have ester-linked lipids and sterols

66. Which of the following statements about simple transport systems is/are TRUE?
   1) A binding protein in the periplasm picks up a specific solute and moves with it through the membrane
   2) There is a conformational change in the membrane-spanning transporter protein which effects the movement of the solute into the cell
   3) Protons combine with the solute and together they move through the membrane transporter
   4) The amino acid sequence of a membrane transporter used for simple
Questions 1 - 66

(A) 1, 2, 3  (B) 1 and 3  (C) 2 and 4  (D) 4 only  (E) all or none are correct

transport is significantly similar to that of a membrane transporter used for group translocation
Questions 67 – 100
Choose the best single answer

67. The following sequence of auxotrophic markers: Trp, Gal, Leu is found upstream of an IS element in the chromosome of bacterium A. Following the formation of an Hfr using this IS element as insertion site and conjugation into bacterium B, in what order will auxotrophic mutants of bacterium B appear?
   A) Trp first, Gal second, Leu third
   B) Leu first, Gal second, Trp third
   C) All at once
   D) The transfer is impossible

68. Which one of the following combinations are spore-forming bacteria?
   A) Bacillus cereus and Clostridium perfringens
   B) Bacillus cereus and Staphylococcus aureus
   C) Staphylococcus aureus and Campylobacter jejuni
   D) Listeria monocytogenes and EHEC

69. The diarrheal disease triggered by Bacillus cereus
   A) resembles a Staphylococcus aureus food-borne disease
   B) resembles a Clostridium perfringens food-borne disease
   C) is due to cereulide
   D) requires antibiotic therapy

70. Food that you can buy in supermarkets:
   A) contains no bacteria
   B) contains no pathogenic bacteria
   C) is generally safe
   D) can cause food poisoning only

71. Which of the following bacteria is/are intracellular pathogens?
   A) Listeria monocytogenes and Legionella pneumophila
   B) Legionella pneumophila and EHEC
   C) Staphylococcus aureus
   D) Clostridium perfringens

72. Which of the following bacteria is/are known to cause long-term effects after acute food poisoning?
   A) EPEC and Campylobacter jejuni
   B) EHEC only
   C) Campylobacter jejuni and EHEC
   D) Clostridium botulinum

73. What does the O157:H7 denomination of Enterohemorragic E. coli stand for?
   A) its capsule and flagellum serotypes
   B) its capsule and pili serotype
   C) its lipopolysaccharide and pili serotypes
   D) its lipopolysaccharide and flagellum serotypes
Questions 67 – 100

Choose the best single answer

74. A reversion mutation:
   A) always happens at the same site as where the original mutation occurred
   B) can occur at a different site than where the original mutation occurred, but has to be within the same gene
   C) can occur in a different gene than the gene where the original mutation had occurred
   D) only restores the genotype but not the original phenotype

75. Which one of the following is/are true?
   A) Two plasmids which belong to the same incompatibility group can not coexist in a cell
   B) Incompatible plasmids look very different from one another
   C) Incompatible plasmids have narrow host-ranges
   D) A narrow-host-range plasmid is incompatible with a broad host-range plasmid

76. Which one of the following is/are true?
   A) Excision of a lysogenic phage from the bacterial chromosome can lead to the production of defective phages
   B) Insertion of a lysogenic phage occur at random sites in the bacterial DNA
   C) A lysogenic phage can drag any part of the bacterial chromosome along with its own DNA upon excision
   D) There is no lysis of the donor bacteria during specialized transduction

77. The F plasmid:
   A) allows for the production of Hfr strains
   B) is the only known conjugative plasmid
   C) is found in all E. coli strains
   D) carries insertion sequences but no tra genes

78. Conservative transposition involves:
   A) Total excision of the transposon from the donor DNA, with a free-floating stage within the cell
   B) Nicking of the DNA at each end of the transposon only
   C) Nicking of the DNA at each end of the transposon and of the target insertion site.
   D) Production of a co-integrate

79. Coupling transposition and conjugation
   A) is not possible
   B) is dependent on homologous recombination
   C) can occur between two plasmid-free bacteria
   D) can result in transfer of resistance markers present in a transposon from one cell to another
Questions 67 – 100
Choose the best single answer

80. If strain A carries a tetR transposon on its chromosome and also carries the F’ plasmid
A) It can not be used to transfer TetR to any other bacterium by conjugation
B) It will lose its F’ plasmid if I use it in a conjugation experiment
C) The transposon can not integrate in to the F’ plasmid
D) The transposon would need to integrate into the F’ plasmid to transfer TetR to another bacterium by conjugation

81. How would one know that a stretch of DNA found in the bacterial chromosome is actually a pathogenicity island?
A) It encodes for virulence factors
B) It G+C % content is different from that of the rest of the chromosome
C) It is flanked by transposable elements
D) All of the above

82. Dr Joshua Lederberg discovered:
A) the genetic code
B) transposition
C) conjugation
D) transformation

83. Salvarsan was discovered by:
A) Alexander Fleming
B) Paul Ehrlich
C) Gerhard Domagk
D) Ernst Chain
E) Howard Florey

84. Semi-synthetic penicillin antibiotics are created by modifying which group:
A) N-acyl group
B) N-acetylmuramic acid group
C) B-lactam ring
D) N-acetyl group
E) N-acetylglucosamine group

85. As discussed in class, Methicillin resistance in *Staphylococcus aureus* mainly occurs through this mechanism:
A) The production of a B-lactamase that destroys the antibiotic
B) The modification of the terminal D-alanine to D-lactate in the N-acetylmuramic acid/N-acetylglucosamine pentapeptide
C) The acquisition of preformed folic acid from the environment
D) The production of an alternative transpeptidase resistant to B-lactams
E) The efflux of Methicillin using siderophores
Questions 67 – 100
Choose the best single answer

86. The Minimum Inhibitory Concentration (MIC) of an antimicrobial agent can be defined as:
   A) Its maximum tolerable dose / minimum effective dose
   B) The highest amount of agent that completely inhibits the growth of a test organism
   C) The highest amount of agent that completely kills all test organisms
   D) The smallest amount of agent that completely inhibits the growth of a test organism
   E) The smallest amount of agent that completely kills all test organisms

87. If a bacterial strain starts to develop resistance to an antibiotic, meaning that you have to use more to get the same killing effect, what happens to the chemotherapeutic index for that antibiotic against that strain?
   A) It increases due to the increase in the minimum effective dose
   B) It decreases due to the increase in the minimum effective dose
   C) It increases due to the decrease in the minimum effective dose
   D) It decreases due to the decrease in the minimum effective dose
   E) None of the above

88. The original Benzyl-Penicillin (PenG) was only active against:
   A) Gram positives because it could not get past LPS and into Gram negatives
   B) Gram negatives because it could not get past LPS and into Gram positives
   C) Gram positives because it could not get past the thicker cell wall in Gram negatives
   D) Gram negatives because it could not get past the thicker cell wall in Gram positives
   E) Both Gram positives and Gram negatives

89. Eosin Methylene Blue agar and MacConkey’s agar are considered differential and selective media because they:
   A) Inhibit the growth of Gram-negative bacteria and differentiate lactose fermenters from non-fermenters
   B) Inhibit the growth of Gram-positive bacteria and differentiate lactose fermenters from non-fermenters
   C) Inhibit the growth of Gram-negative bacteria and differentiate glucose fermenters from non-fermenters
   D) Inhibit the growth of Gram-positive bacteria and differentiate glucose fermenters from non-fermenters
   E) None of the above

90. This type of enzyme links the N-acetylmuramic acid and N-acetylglucosamine units together in the growing peptidoglycan chain:
   A) Glycolase
   B) Autolysin
   C) Bactoprenase
   D) Transpeptidase
   E) Siderophore
91. If I start with 16 bacterial cells in a culture, $t = 6h$ and $g = 1.5h$, I will theoretically end up with how many cells at the end of $t$:
   A) 128
   B) 256
   C) 64
   D) 512
   E) 1028

92. When a bacteriocidal, but not bacteriolytic, agent is added to a culture:
   A) The total cell count and viable cell count both decrease over time
   B) The total cell count and viable cell count both stay stable
   C) The total cell count rises but the viable cell count stays stable
   D) The total cell count stays stable and the viable count decreases over time
   E) The total cell count decreases over time and the viable cell count stays stable

93. This reaction is catalyzed by which enzyme?
   \[ \text{H}_2\text{O}_2 + \text{NADH} + \text{H}^+ \rightarrow 2 \text{H}_2\text{O} + \text{NAD}^+ \]
   A) Catalase
   B) Peroxidase
   C) Superoxide dismutase
   D) Superoxide reductase

94. The National Microbiology Laboratory in Canada is located in:
   A) Ottawa
   B) Montreal
   C) Winnipeg
   D) Vancouver

95. The teaching laboratory that is used for Microbiology and Immunology 2100A is NOT a biosafety level 2 facility because:
   A) The laboratory sessions do not use Biosafety Level 2 microorganisms
   B) There is no biological safety cabinet
   C) There is no autoclave available
   D) There is no self-closing double door for access to the facility

96. All yogurts are not created equal. But all yogurts are made by combining milk with the following live and active bacteria:
   A) *Lactobacillus acidophilus* and *Lactobacillus rhamnosus*
   B) *Lactobacillus rhamnosus* and *Lactobacillus bulgaricus*
   C) *Lactobacillus bulgaricus* and *Streptococcus thermophilus*
   D) *Streptococcus thermophilus* and *Bifidobacterium bifidum*
97. You have spread 100 µl of a sample diluted by a factor of $10^3$ onto the surface of a nutrient agar plate. After incubation, you counted 58 colonies. What was the original bacterial density (CFU/ml) of the sample?
   A) 580
   B) 5800
   C) 58000
   D) 580000

98. For routine testing of recreational water from Lake Huron at the Pinery Provincial Park beach, 200 ml of water from approximately 20 meters offshore from the public beach were collected. Ten ml of this water was filtered, and the filter paper placed on an ENDO agar medium plate. After incubation for 48 hours you counted 24 coliform colonies on the membrane filter. What is the coliform density of the lake water in CFU per 100 ml?
   A) 2.4
   B) 24
   C) 240
   D) 2400

99. Consider the scenario that you are on a wilderness camping trip in Temagami Provincial Park in Northern Ontario. You are canoeing and portaging to a cabin in the interior. This type of travel precludes how much drinking water you can carry with you. So, being the microbiology student that you are, you make a preliminary trip to the river this cabin is on, collect 200 ml of the water, and take it back to your lab for analysis. The water looks very clean, so you are hopeful. You filter three different volumes of the river water: 10 ml, 1 ml and 0.1 ml. The membrane filters are placed on ENDO agar and the plates incubated for 48 hours. On the filter through which you have passed 10 ml there are 270 total colonies and 1 coliform colony. On the filter through which you have passed a 1.0 ml water sample there are 19 total colonies and no coliform colonies. The bacterial cell density in CFU/ml is:
   A) 1.9
   B) $2.7 \times 10^1$
   C) $1.9 \times 10^2$
   D) $2.7 \times 10^3$

100. Aseptic technique refers to
   A) The microbial inoculum placed into test tube or onto a Petri dish
   B) The transfer of bacterial cells without contamination of the original culture, the medium or the surroundings
   C) The autoclave or other sterilizing procedures
   D) Cleanliness in the laboratory
Instruction:
1. You are provided with ONE Question Book.

2. Check that your Question Book contains Questions 1 to 25. Total 7 pages including this cover page. Multiple choice questions are to be answered using the following code:
   (A) 1, 2, 3    (D) 4 only
   (B) 1 and 3    (E) 1, 2, 3, 4, and 5
   (C) 2 and 4

3. Provide answers to questions on SEPARATE Scantron sheet. Fill in the EXAM CODE on the Scantron sheet.

4. Question Book and the corresponding Scantron sheet will be collected at 8:00 p.m.

One blank pages (page 7) is enclosed at the back of each of the Question Books. If you think that a question is ambiguous, you MUST provide: the Question number on this cover page and in the blank page, provide a rationale as to why you think it ambiguous, what is your interpretation, AND your answer(s) based on such interpretation in the blank pages provided. Illegible writings will NOT be evaluated.

IF you have provided answers in the blank page (page7), you must

place the QUESTION NUMBERS here: _______________________

Student ID Number: ______________________________________

Student Name:____________________________________________
1. Innate immune responses …
   1) are highly antigen specific.
   2) increase with repeated exposure to the same antigen.
   3) lead to the development of immunological memory.
   4) are present in all individuals at all times.
   5) result from clonal selection of antigen-specific lymphocytes.

2. Secondary (recall) adaptive responses …
   1) have a shorter lag phase in comparison with primary responses.
   2) are weaker but more sustained than primary responses.
   3) reflect the responses elicited by memory cells.
   4) are less antigen-specific than primary responses.
   5) always provide temporary protection against infection.

3. Which of the following statements about antigens and immunogens is (are) TRUE?
   1) Adjuvants differ from protein carriers in that they form stable linkages with the immunogen.
   2) Basically any organic molecule can be immunogenic when conjugated to a protein carrier.
   3) Large and particulate antigens are less immunogenic than small and soluble ones.
   4) Typically T cells recognize linear epitopes whereas B cells recognize conformational epitopes.
   5) Antigens are disease-causing organisms such as bacteria, fungi, viruses, and parasites.

4. Which parts of the V-type immunoglobulin domain contribute to its complementarity determining regions (CDRs)?
   1) Those which form discrete loops of the folded structure of the V domain.
   2) Framework regions such as FR1, FR2, FR3, and FR4.
   3) Hypervariable regions such as HV1, HV2, and HV3.
   4) There are no CDRs within V domains.
   5) Those which form Fc fragment of an immunoglobulin molecule.

5. How do macrophages contribute to the immune response?
   1) Uptake and kill invading pathogens.
   2) Present antigens to lymphocytes.
   3) Induce inflammation at the site of infection by releasing cytokines and lipid mediators.
   4) Produce antibodies.
   5) Inactivate the complement system.
6. Gradient centrifugation through Ficoll-Hypaque (density 1.077 g/mL) is often used to separate cells of immune system from the blood. Where do you expect to see different subpopulations of white blood cells in the tube after centrifugation?
   1) Lymphocytes are in the pellet.
   2) Lymphocytes are within the interface band.
   3) Neutrophils are within the interface band.
   4) Neutrophils are in the pellet.
   5) Lymphocytes and neutrophils form a pellet while red blood cells stay at the interface.

7. Which of the following statements about T and B lymphocytes is/are correct?
   1) Naive B cells cannot differentiate into effector cells without cooperation with T cells.
   2) Naive T and B cells have different morphological features.
   3) B and T cells mature in the same central lymphoid organ.
   4) A given T or B cell carries antigen receptor of only one specificity.
   5) T and B cells are the major population of white blood cells.

8. Removal of the bursa of Fabricius from young chicks results in:
   1) Markedly decreased numbers of circulating T lymphocytes.
   2) Red blood cell deficiency.
   3) Delayed rejection of skin grafts.
   4) Low serum level of antibodies.
   5) Deficient innate immunity.

9. Which of the following statements apply to the bone marrow?
   1) Active bone marrow is located throughout the skeletal system in children.
   2) Maturing myeloid cells are the most common cell type in normal bone marrow.
   3) The best source of active bone marrow from adults would be iliac crest (hip).
   4) The best source of active bone marrow from adults would be tibia (shin).
   5) Antigen-dependent responses occur mainly in bone marrow.

10. Common essential steps of maturation of both T and B cells are associated with:
    1) Migration of precursor cells from bone marrow to the thymus.
    2) Rearrangement of antigen-receptor genes.
    3) Differentiation into plasma cells.
    4) Interaction with stromal cells.
    5) MHC restriction.
11. The structural organization of ALL peripheral lymphoid organs is based on the following common principle(s):
   1) All peripheral lymphoid organs have similar size.
   2) Germinal centers are parts of lymphoid follicles and represent sites of intense B-cell proliferation, differentiation, and somatic hypermutation.
   3) A capsule of dense connective tissue surrounds the aggregates of lymphoid cells.
   4) The majority of T and B cells are localized in clearly separated areas of the lymphoid tissue.
   5) Antigens reach all peripheral lymphoid organs via lymphatics.

12. Which of the following molecules can be recognized by pattern recognition receptors?
   1) LPS.
   2) Unmethylated CpG repeats.
   3) Lipoteichoic acid.
   4) \( \gamma \)-glutamyl diaminopimelic acid.
   5) Muramyl dipeptide.

13. Which of the following statements about pathogen-associated molecular patterns (PAMPs) and Toll-like receptors are correct?
   1) LPS is a PAMP found in the cell walls of gram-negative bacteria, and is recognized by TLR-4.
   2) Activation of TLRs triggers the production of pro-inflammatory cytokines.
   3) dsRNA signals through TLR-3.
   4) TLRs that are localized to internal membrane-bound compartments recognize lipoproteins.
   5) TLRs and NOD proteins use the same adaptor protein in their signaling cascades.

14. IFN-\( \alpha \) and IFN-\( \beta \) induced by viral infections make the following contributions to host defence:
   1) Interfere with viral replication.
   2) Activate NK cells.
   3) Increase MHC class I molecules expression in most cell types.
   4) Serve as ligands for toll-like receptors (TLRs).
   5) Initiate the alternative pathway of complement activation.

15. You were given a mouse colony and found that these mice failed to undergo both humoral and cellular response upon immunization with antigen X. Which of the following can explain the absence of immune responses to X in these animals?
   1) Mutation in the \( RAG-1 \) and \( RAG-2 \) genes.
   2) X is a hapten.
   3) X lacks immunogenicity.
   4) X is a protein antigen isolated from a mouse of the same colony.
   5) These mice have been given high dose irradiation.
16. Complement …
   1) is secreted by macrophages and hepatocytes in response to antigen binding.
   2) participates in both innate and adaptive immune responses.
   3) is a group of active proteolytic enzymes found in serum.
   4) is involved in opsonization of microorganisms for phagocytosis.
   5) is involved in sensitization of T cells to antigen.

17. C3b component of the complement system…
   1) is the larger cleavage product of the C3 convertase enzymatic activity.
   2) is an anaphylatoxin.
   3) joins C3 convertase to generate C5 convertase.
   4) is a component of the membrane attack complex (MAC).
   5) is an antibody.

18. If a person is born without C2 and C4,
   1) the classical pathway will be changed into the lectin pathway.
   2) complement system will be completely shut down.
   3) C9 will polymerize inappropriately and lyse host cells.
   4) the amount of C3b produced during bacterial infections will be reduced.
   5) C3b will not be able to bind to bacteria.

19. Which of the following compartments of lymphoid organs is/are populated mainly with B cells?
   1) Germinal centers of the spleen.
   2) Paracortical area of draining lymph nodes.
   3) Lymphoid follicles of Payer’s patches.
   4) Periarteriolar lymphoid sheaths (PALS) of the spleen.
   5) Medulla of the thymus.

20. You were told that sample X contained IgA antibodies purified from the serum of a normal subject. Which of the following would be expected?
   1) Antibodies in the sample have a molecular weight of approximately 320 kDa.
   2) Antibodies in the sample have a molecular weight of approximately 160 kDa.
   3) Antibodies in the sample are linked together by J chain.
   4) Hinge regions are present in these antibodies.
   5) Hinge regions do not exist in these antibodies.

21. Which of the following maternal antibodies can be found in the fetus?
   1) IgG1
   2) IgG2
   3) IgG3
   4) IgD
   5) IgM
22. Which of the following describe the sequence of gene rearrangements that occur in B cells?
   1) $D_H$ segment recombines with $J_H$ before the recombination of $V_H$ to $D_HJ_H$.
   2) $V_H$ segment recombines with $D_H$ before the recombination of $V_HD_H$ with $J_H$.
   3) $V_L$ and $J_L$ recombine before transcription of the light chain is to take place.
   4) $V_L$, $J_L$, and $C_L$ recombine before transcription of the light chain is to take place.
   5) $V_H$, $D_H$, $J_H$, and $C_H$ recombine before transcription of the heavy chain is to take place.

23. Which of the following immunoglobulins can activate complement as a single molecule when bound to an antigen?
   1) IgE
   2) IgG
   3) IgA
   4) IgM
   5) IgD

24. Sample A are IgG antibodies that have been digested with papain, and sample B are IgG antibodies digested with pepsin. The labels of these two samples came off. Which of the following are expected outcome regarding these two samples?
   1) Reduction reaction of sample A should yield products of approximately 25 kDa.
   2) Reduction reaction of sample A should yield products of approximately 50 kDa.
   3) Papain digestion of sample B should yield products of approximately 50 kDa and less.
   4) Papain digestion of sample B should yield products of approximately 25 kDa and less.
   5) Digestion of sample A with pepsin should yield products of approximately 110 kDa.

25. Isotype switching...
   1) requires signals from T cells and cytokines.
   2) enables the same assembled $V_H$ exon to be associated with different $C_H$ genes.
   3) requires enzymes breaking up DNA.
   4) requires RAG-1 and RAG-2 enzymes.
   5) does not require antigen stimulation.
Instruction:
1. You are provided with ONE Question Book.

2. Check that your Question Book contains Questions 1 to 25. Total 8 pages including this cover page. Multiple choice questions are to be answered using the following code:
   (A) 1, 2, 3  (D) 4 only
   (B) 1 and 3  (E) 1, 2, 3, 4, and 5
   (C) 2 and 4

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place the QUESTION NUMBERS here: ____________________

Student ID Number: ________________________________

Student Name:____________________________________
1. In cells with mutations in either \( TAP1 \) or \( TAP2 \) genes,
   1) antigenic peptides generated by proteasomal proteolysis would not be delivered to the endoplasmic reticulum.
   2) there would be a problem with antigen presentation to CD4 T cells.
   3) there would be no expression of MHC class I molecules on the cell surface.
   4) invariant chain (Ii) would fail to bind MHC molecules.
   5) immunoproteasomes would not be assembled.

2. Major histocompatibility complex (MHC) class I and class II molecules...
   1) present sugars to T cells.
   2) present peptides to T cells.
   3) create holes in the membranes of bacteria.
   4) are expressed on the surface membrane of B cells.
   5) lyse foreign antigens.

3. MHC class I and class II molecules are closely related in overall structural organization. Which of the following correctly describes their shared features?
   1) Both MHC class I and class II molecules are heterodimers.
   2) Both MHC class I and class II molecules have immunoglobulin-like domains.
   3) Both MHC class I and class II molecules are unstable in the absence of bound peptide or chaperon proteins.
   4) Both MHC class I and class II molecules have two transmembrane domains.
   5) The peptide-binding groove in both MHC class I and class II is formed by the \( \alpha_1 \) and \( \alpha_2 \) domains.

4. Peptides that bind to MHC class I molecules...
   1) are usually 8-10 amino acid long.
   2) are stabilized at both ends of the peptide-binding cleft by their amino and carboxy termini.
   3) usually have hydrophobic or basic residue at the C-terminus.
   4) are generated in the cytosol.
   5) may require an additional cleavage in the endoplasmic reticulum by the aminopeptidase ERAAP.

5. Which of the following are events associated with the exogenous (MHC class II) pathway of antigen processing and presentation?
   1) Binding of MHC molecules to tapasin.
   2) Protein digestion by cathepsins.
   3) Binding of antigenic peptide to \( \beta_2 \) microglobulin.
   4) Binding of invariant chain (Ii) trimer to MHC molecules.
   5) Binding of a complex of chaperon proteins (Erp57 and calreticulin) to MHC molecules.
6. Which of the following statements correctly describe the genetics and expression of MHC molecules?

1) MHC class I molecules are expressed on essentially all nucleated cells.
2) The gene that encodes TAP contributes to the polymorphism of MHC class I molecules.
3) Since the expression of MHC alleles is codominant, each individual simultaneously expresses MHC molecules inherited from both parents.
4) MHC locus contains complete set of genes encoding MHC class I and MHC class II molecules.
5) The most polymorphic gene of HLA locus is HLA-DRA that encodes alpha chain of HLA-DR molecules.

7. A person has a genetic defect that leads to the production of a defective HLA-DM protein. Which of the following will happen to the antigen presenting cells of this individual?

1) Invariant chain cleavage will not occur in the MIIC.
2) There will be no expression of MHC class I molecules on the cell surface.
3) MHC class I molecules will dissociate from calnexin upon binding of β2 microglobulin in the ER.
4) There will be no efficient binding of antigenic peptides to the MHC class II molecules.
5) The 9 chain MHC class II – invariant chain complex will not be formed.

8. Immunoevasins are...

1) viral proteins that interfere with antigen presentation by MHC class II molecules.
2) essential proteins of the complement system.
3) viral proteins that enhance antigen presentation by MHC class I molecules.
4) viral proteins that prevent antigen presentation to CD8 T cells.
5) cytokines that stimulate the assembly of immunoproteasomes.

9. The invariant accessory molecules of a B cell receptor complex...

1) are essential for the surface expression of a fully assembled B cell receptor complex.
2) directly participate in specific antigen recognition.
3) are involved in signal transduction following B cell receptor cross-linking by specific antigen.
4) harbor ITAM motifs each containing two leucine residues that become phosphorylated immediately after B cell receptor cross-linking.
5) are expressed in the form of an Igα/Igα homodimer.

10. Which of the following molecule(s) is/are part(s) of a B cell co-receptor complex?

1) CD19
2) CD21
3) CD81 (TAPA-1)
4) Igα
5) CD5
11. Which of the following statements(s) is/are correct about bacterial lipopolysaccharide (LPS) and LPS-induced B cell responses?
   1) Human B cells are more responsive to LPS than mouse B cells.
   2) LPS is a thymus-independent (TI)-2 antigen.
   3) The binding of LPS to Toll-like receptor (TLR)-4 leads to signal transduction through CD14 eventually resulting in B cell activation.
   4) At high concentrations, LPS acts as a polyclonal B cell activator.
   5) The recognition of LPS by B cells induces isotype switching from IgM to IgA.

12. Bone marrow stroma contributes to B cell development through …
   1) adhesive interactions between developing B cells and stromal cells.
   2) growth factors, cytokines and chemokines required for B cell development.
   3) elimination of autoreactive immature B cells.
   4) elimination of autoreactive mature B cells.
   5) continuous renewal of B-1 cell pools.

13. Which of the following statement(s) is/are correct about the pre-B cell receptor?
   1) A pre-B cell receptor is composed of two heavy chains, two surrogate light chains and two invariant accessory chains.
   2) Each surrogate light chain is composed of one VpreB chain and one λ5 chain.
   3) The VpreB and λ5 chains are non-covalently linked.
   4) The VpreB and λ5 chains are the equivalents of the light chain constant (C) and variable (V) regions, respectively.
   5) Pre-B cell receptor is first detectable at the early pro-B cell stage.

14. B-1 cells …
   1) have a highly diverse B cell receptor (BCR) V-region repertoire.
   2) are self-renewing and their pools do not need to be replenished by bone marrow.
   3) need T cell “help” in order to produce antibodies.
   4) are found mainly in the peritoneal and pleural cavities.
   5) constitute the vast majority of all B cells in human and most mammals.

15. Plasma cells in normal individuals …
   1) are typically found in the bone marrow and the medullary cords of lymph nodes.
   2) are capable of dividing thus giving rise to many plasma cells that can secrete structurally identical immunoglobulin molecules.
   3) are unable to undergo somatic hypermutation.
   4) express high levels of MHC class II molecules and can thus activate CD4+ T cells.
   5) contain Auer rod-like inclusions in their cytoplasm.
16. A former 3300A student who now works as an oncologist has been asked for her/his expert opinion on a 70-year-old male demonstrating “punch-out” lesions in his bone X-ray. The patient has been suffering from anemia and recurrent infections. In his bone marrow biopsy, around 25% of the cells exhibit a distinct morphology (a large halo adjacent to an eccentric nucleus displaying a “cart-wheel” chromatin pattern). Which of the following statement(s) is/are correct about the physician’s diagnosis and/or the disease?

1) The patient is likely to have multiple myeloma.
2) The cancerous cells produce large quantities of a structurally intact or defective monoclonal immunoglobulin.
3) The cancerous cells are of plasma cell origin.
4) The cancerous cells are aggressive but not capable of dividing.
5) The cancerous cells are undifferentiated B cells.

17. Which of the following statement(s) is/are correct about antibody-dependent cell-mediated cytotoxicity (ADCC)?

1) The main effector cell for ADCC is a natural killer (NK) cell.
2) The main effector cell for ADCC is a cytotoxic T lymphocyte.
3) ADCC is mediated by IgG1 and IgG3 antibodies.
4) The antibody molecules that are involved in ADCC bind FcγRIII (CD16) expressed by the target cell.
5) The effector cell involved in ADCC is part of the adaptive immune system and directly recognizes target cells in an antigen-specific manner.

18. Which of the following statement(s) is/are correct about T cell co-receptors?

1) CD4 exists as a dimer.
2) Each CD8 chain has four immunoglobulin-like domains.
3) CD4 and CD8 bind MHC molecules near their peptide-binding groove.
4) Each mature T cell expresses either CD4 or CD8.
5) In the presence of the T cell co-receptor, T cells need much higher amounts of antigen in order to become activated.

19. Which of the following statement(s) is/are correct about costimulation in T cell responses?

1) Antigen recognition by naïve T cells in the absence of costimulatory interactions results in T cell anergy or apoptotic death.
2) Costimulatory interactions in the absence of specific antigen recognition through T cell receptor (TCR) have no effect on T cells.
3) Responsiveness of memory and activated T cells is not strictly dependent on costimulatory interactions.
4) Costimulatory interactions constitute “signal 1” for T cell activation.
5) The main costimulatory interaction is the one involving B7 molecules found on T cells and CD28 expressed by antigen-presenting cells.
20. Superantigens …
1) are plant-derived lectins that bind and cross-link carbohydrate moieties found on the surface of many T cells.
2) induce polyclonal T cell activation without being processed by antigen-presenting cells.
3) bind non-specifically to the Vα region of many CD4+ T cells.
4) cause massive T cell activation and cytokine secretion leading to systemic toxicity and immunosuppression.
5) can be exemplified by toxic shock syndrome toxin (TSST)-1, which is a viral superantigen.

21. Which of the following statement(s) is/are correct about T cell receptor (TCR) gene rearrangements?
1) The α chain gene rearrangement precedes the β chain gene rearrangement.
2) VDJ rearrangements for the β chain start at the double-positive (CD4+CD8+) stage.
3) Thymocytes that express the primitive T cell receptor (pre-TCR) leave the thymus.
4) The primitive T cell receptor (pre-TCR) is composed of a β chain and a surrogate α chain.
5) The primitive T cell receptor (pre-TCR) is expressed predominantly by γδ T cells, which constitute only a minor subset of T cells in an adult T cell repertoire.

22. Negative selection during T cell development …
1) is called negative selection because it occurs at the double-negative stage.
2) deletes both autoreactive αβ and γδ thymocytes.
3) ensures that T cells with too low avidity for self peptide:MHC complexes are selected against and die by apoptosis.
4) dictates central tolerance to self components.
5) is carried out by thymic epithelial cells found in the thymic cortex.

23. Bare Lymphocyte Syndrome due to the deficiency of human leukocyte antigens (HLA) class II …
1) is an autosomal dominant immune deficiency disorder.
2) is caused by mutations of the genes encoding HLA class II proteins.
3) leads to the absence of CD8+ T lymphocytes in the periphery.
4) is accompanied by impaired antibody production.
5) does not affect the patient’s life expectancy.

24. Immature dendritic cells …
1) are extremely potent in taking up foreign antigens.
2) are extremely potent in antigen presentation and naïve T cell activation.
3) express less costimulatory molecules than mature DCs do.
4) are found only in central lymphoid organs.
5) activate naïve CD4+ T cells but not naïve CD8+ T cells.
(A) 1, 2, 3  (D) 4 only
(B) 1 and 3  (E) 1, 2, 3, 4, and 5
(C) 2 and 4

25. CD8$^+$ cytotoxic T lymphocytes (CTLs) …
   1) recognize their target cells in an antigen-non-specific manner and through Fc receptors.
   2) kill their target cells by apoptosis thus avoiding the induction of a local inflammatory response.
   3) often go into a resting state after one round of killing.
   4) do not need costimulatory signals for their effector function.
   5) release their granule contents in their microenvironment, which leads to non-specific killing of neighboring cells.
Illegible writings will not be evaluated
Provide:
Question number, rationale as to why you think it ambiguous, your interpretation, AND your answer(s) based on such interpretation.
CODE 111
MICROBIOLOGY AND IMMUNOLOGY 3300A

Test 3
(December 8, 2008, 2:00-4:00 p.m.)
A-Wong, AH 201
Yang-Z, AH Stage

Instruction:
1. You are provided with ONE Question Book.

2. Check that your Question Book contains Questions 1 to 50. Total 12 pages including this cover page. Multiple choice questions are to be answered using the following code:
   (A) 1, 2, 3    (C) 2 and 4    (E) 1, 2, 3, 4, and 5
   (B) 1 and 3    (D) 4 only

3. Provide answers to questions on SEPARATE Scantron sheet. Fill in the EXAM CODE on the Scantron sheet.

One blank is enclosed at the back of each of the Question Books. If you think that a question is ambiguous, you MUST provide: the Question number and your answer code on this cover page. On the blank page, provide a rationale as to why you think it ambiguous, what is your interpretation, AND your answer(s) based on such interpretation in the blank pages provided. Illegible writings will NOT be evaluated.

IF you have provided answers in the blank page (page 12), you must place the:
question #______ answer code_______
question #______ answer code_______
question #______ answer code_______
question #______ answer code_______
question #______ answer code_______
question #______ answer code_______

Student ID Number: ____________________________________________

Student Name: _________________________________________________
1. The TLRs that are localized to intracellular compartments such as endosomes are those that mainly recognize:
   1) dsRNA.
   2) Lipoproteins and lipoteichoic acid.
   3) unmethylated repeats of the dinucleotide CpG.
   4) Flagellin.
   5) LPS.

2. Small complement-cleavage products such as C5a and C3a …
   1) are known as anaphylatoxins.
   2) increase vascular permeability.
   3) recruit inflammatory cells to the site of infection.
   4) play the central role in opsonization.
   5) trigger the assembly of the membrane attack complex (MAC).

3. How does the acidification of the endosomal and lysosomal compartments contribute to antigen processing and presentation?
   1) stimulate the expression of MHC class I molecules on the cell surface.
   2) helps with the degradation of intravesicular pathogens.
   3) induces the expression of HLA-DM on the cell surface.
   4) activates cathepsins.
   5) catalyses the release of CLIP from MHC class II complex.

4. Two antibodies, A and B, have identical CDR1, CDR2, and CDR 3. Which of the following description(s) is/are consistent with this observation?
   1) A and B are of the same isotype.
   2) A and B have the same effector functions.
   3) A and B contain J chains.
   4) A and B exhibit the same antigen specificity.
   5) A and B are associated with the SC component.

5. C-reactive protein…
   1) is produced by liver cells (hepatocytes) under the influence of macrophage-derived interleukin 6 (IL-6).
   2) is a component of innate immunity.
   3) can bind C1q and initiate the complement cascade in the absence of antibodies.
   4) is the main acute phase protein in both humans and mice
   5) is a complement regulatory (control) protein.

6. Protectin…
   1) prevents the final assembly of the membrane-attack complex on the surface of pathogens.
   2) is a glycosylphosphatidylinositol (GPI)-anchored protein.
   3) fails to function in patients with paroxysmal nocturnal hemoglobinuria (PNH).
   4) prevents the formation of C4b2a (C3 convertase).
   5) dissociates C1r and C1s from the active C1 complex.
7. Which of the following describes VEGF-C?
   1) it is a major lymphangiogenic factor.
   2) it acts on VEGFR-3 receptors located in lymphatic vessels.
   3) it is a member of a large family of growth factors controlling vascular development
   4) its production can be stimulated by some inflammatory factors
   5) it can be constitutively secreted by certain types of cancer cells.

8. Immunoproteasomes….
   1) are induced by interferons.
   2) generate peptides that bind specifically to MHC class II molecules.
   3) allow for cleavage of polypeptides after hydrophobic residues at C-terminus.
   4) generate antigenic peptides of specifically 13-17 amino acids long.
   5) are essential multicatalytic protease complexes of lysosomes.

9. Mannose-binding lectin (MBL)…
   1) is an inhibitor of the complement system.
   2) is a pattern recognition receptor.
   3) is a transmembrane protein.
   4) is associated with serine proteases.
   5) is an essential protein of adaptive immunity.

10. Both nude and scid mice are known to have specific genetic defects that prevent normal T cell development. How would you restore the maturation of T cells in these mice using tissue grafts?
   1) I would transplant the bone marrow tissue from nude mice to scid mice.
   2) I would transplant the bone marrow tissue from scid mice to nude mice.
   3) I would transplant a scid thymus into nude mice.
   4) I would transplant a nude thymus into scid mice.
   5) I would transplant a nude lymph node into scid mice.

11. Which of the following statements about inflammation is (are) TRUE?
   1) Inflammation is initiated by response of macrophages to pathogens.
   2) Inflammation provides a means for concentrating the body's defensive agents at the site where they are needed.
   3) Inflammation is associated with an increase in vascular permeability and recruitment of immune cells to the site of infection.
   4) Inflammation is caused by fluid and cells leakage into the blood and out of the affected tissues.
   5) Inflammation makes the infected tissue thinner.

12. Which of the following statements about immunoglobulin domains is (are) TRUE?
   1) each domain is composed of three beta sheets held together by disulfide bonds.
   2) $V_L$ and $V_H$ domains are never paired together.
   3) H chain has typically two immunoglobulin domains.
   4) each domain is about 110 amino acid long.
   5) glycosylation is a characteristic feature of V domains.
13. Which antibodies have no clear function?
   1) IgGs
   2) IgEs
   3) IgMs
   4) IgDs
   5) IgAs

14. Which of the following is thought to be part of the mechanism of somatic hypermutation?
   1) IFN-γ-induced lysosomal thiol reductase
   2) recombinases RAG-1 and RAG-2
   3) acid proteases
   4) an enzyme that converts cytosine in DNA to uracil
   5) an enzyme that adds nucleotides randomly to the ends of the coding DNA after hairpin cleavage

15. What kind of interactions/bonds never occur between antigens and antibodies?
   1) hydrophobic interactions
   2) covalent interactions
   3) van der Waals interactions
   4) disulfide bonds
   5) hydrogen bonds

16. Which of the following is a characteristic or component of an MHC class II molecule?
   1) antigen presentation to CD8 T cells
   2) covalent interactions hold alpha and beta chains together
   3) the peptide-binding cleft is closed at both ends
   4) a heterodimer with both subunits are encoded within MHC locus
   5) β2-microglobulin

17. Which of the following is responsible for the generation of diversity in antigen-binding sites of antibodies?
   1) the presence of multiple V exons, J exons & D exons in the DNA of the germ line
   2) variability in V-J & V-D-J joining.
   3) the enzymatic insertion of nucleotides.
   4) chemical alteration of antibodies after their translation
   5) isotype switching

18. Which of the following are necessary steps for antigen presentation to human CD4 T cells?
   1) antigen is degraded in the cytosol
   2) catalysis of the release of CLIP by HLA-DM
   3) TAP-mediated transport of antigenic peptide to the endoplasmic reticulum (ER)
   4) Antigen is degraded in endosomes and bound to the peptide-binding groove of MHC class II molecules in MIIC.
   5) Peptides generated by the proteasome are bound to β2 microglobulin in the ER.
19. Which of the following is/are true about tumor necrosis factor-α (TNF-α)?
   1) it controls the development and organization of peripheral lymphoid tissues
   2) it controls the development and organization of central lymphoid tissues
   3) it activates endothelial cells and increases vascular permeability
   4) it inhibits the inflammatory response
   5) it is never produced by macrophages

20. According to the “clonal selection” theory of immunity …
   1) Antigens serve as a template for biosynthesis of polypeptides with complementary combining sites
   2) Antigens are recognized by clones that are selected from lymphocyte repertoires containing many pre-existing clones, each of which has a unique specificity
   3) Antigens select only memory cell clones from B cell and T cell repertoires.
   4) Clonal selection applies to both antibody-mediated and T cell-mediated immune responses
   5) Self-reactive clones are selected by antigens and mount an immune response

21. Lipid rafts …
   1) serve as membrane platforms for signal transduction.
   2) are detergent-soluble microdomains of the cell membrane
   3) can be experimentally disrupted by reagents that remove or sequester cholesterol.
   4) are highly dynamic structures that can be clustered in B cells, but not in T cells.
   5) contain low quantities of glycosylphosphatidylinositol (GPI)-anchored proteins and high quantities of Src family protein tyrosine kinases

22. Which of the following statement(s) is/are correct about the B cell co-receptor complex?
   1) B cell responses could still occur in the absence of B cell co-receptor ligation
   2) CD19 serves as a receptor for the complement degradation product C3d
   3) CD21 has a short cytoplasmic tail and does not directly participate in signal transduction
   4) CD19 belongs to the tetraspanin family of proteins
   5) CD81 is a glycosylphosphatidylinositol (GPI)-anchored protein

23. Which of the following substance(s) is/are considered thymus-independent (TI-2 antigen(s))?
   1) Pneumococcal capsular polysaccharide
   2) Lipopolysaccharide (LPS) of the cell wall of gram-negative bacteria
   3) Salmonella polymerized flagellin
   4) Soluble and non-polymerized foreign proteins
   5) All proteins of bacterial origin
(A) 1, 2, 3  (C) 2 and 4  (E) 1, 2, 3, 4, and 5
(B) 1 and 3  (D) 4 only

24. Which of the following molecule(s) serve(s) as important kinase(s) for B cell development in the bone marrow?
   1) FMS-like tyrosine kinase 3 (FLT3)
   2) Kit (CD117)
   3) Bruton’s tyrosine kinase (btk)
   4) ζ chain-associated protein kinase 70 (ZAP-70)
   5) CXCL12

25. X-linked agammaglobulinemia (XLA) …
   1) is an autosomal recessive disorder found exclusively in men.
   2) is associated with the lack of IgG, but not other immunoglobulin classes, in the serum
   3) is caused by mutations in Kit (CD117).
   4) results from a maturation arrest at the pre-B cell stage
   5) is characterized by normal primary, but deficient memory B cell responses

26. Which of the following characteristics of normal plasma cells distinguish(es) them from normal plasmablasts?
   1) their lack of major histocompatibility complex (MHC) class II surface expression
   2) their failure to divide
   3) their failure to undergo isotype switching
   4) their high-rate immunoglobulin secretion
   5) their morphology under a light microscope

27. Which of the following statement(s) is/are correct about counter-stimulation through CTLA-4 (CD152)?
   1) CTLA-4 is constitutively expressed on the surface of all naïve T cells
   2) CTLA-4 enhances the expression of Bcl-XL, thereby contributing to T cell survival
   3) CTLA-4 inhibits T cell responses by binding to CD28
   4) The avidity of CTLA-4 for B7 is higher than the avidity of CD28 for B7 molecules
   5) The amino (N)-terminal portion of CTLA-4 has negative signaling properties that contribute to the dampening of T cell responses

28. Positive selection in the thymus …
   1) occurs at the double-positive (CD4+CD8+) stage.
   2) is the mechanism by which potentially autoreactive T cells are deleted.
   3) dictates the rule of “MHC restriction”.
   4) is carried out mainly by dendritic cells and macrophages located at the corticomedullary junction of the thymus.
   5) applies to both αβ and γδ thymocytes.
29. Which of the following antigen presenting cells (APCs) is/are capable of activating naïve CD4\(^+\) and CD8\(^+\) T cells?
   1) B cells
   2) Macrophages
   3) Plasmablasts
   4) Dendritic cells
   5) Kupffer cells (liver macrophages)

30. Natural killer T (NKT) cells …
   1) are developed in the thymus and express both T cell receptor (TCR) and natural killer (NK) cell markers.
   2) recognize foreign peptide:MHC complexes in a similar fashion to conventional T cells.
   3) contain pre-formed mRNA for both T\(\text{H}1\)- and T\(\text{H}2\)-associated cytokines.
   4) are professional antigen-presenting cells that promote the T\(\text{H}1\) differentiation program.
   5) have a highly diverse T cell receptor repertoire.

31. T\(\text{H}17\) cells …
   1) have a double positive (CD4\(^+\)CD8\(^+\)) phenotype.
   2) are developed when naïve CD4\(^+\) T cells interact with dendritic cells secreting IL-17.
   3) express a signature transcription factor called GATA-3.
   4) contribute to neutrophil recruitment to the site of infection with extracellular bacteria.
   5) are suppressed by a cytokine milieu containing transforming growth factor (TGF)-\(\beta\) and IL-6.

32. Medullary epithelial cells of the thymus …
   1) express peripheral self antigens under the control of a transcription factor called Aire.
   2) are missing in a disease called autoimmune polyendocrinopathy-candidiasis-ectodermal dystrophy (APECED).
   3) can present peripheral self antigens directly or indirectly to autoreactive thymocytes leading to the deletion of these thymocytes.
   4) migrate from the thymus and home to stomach, retina and ovaries where they induce peripheral tolerance to self antigens found in these tissues.
   5) are involved in the process of positive selection.

33. Naturally occurring regulatory T (nTreg) cells …
   1) are a subset of CD4\(^+\) T lymphocytes.
   2) constitutively express the interleukin-2 receptor \(\alpha\) chain (also known as CD25).
   3) express a transcription factor called Forkhead P3 (FoxP3).
   4) are missing in patients with IPEX (immune dysregulation, polyendocrinopathy, enteropathy, X-linked) syndrome.
   5) are thymus-derived but contribute to peripheral tolerance.
34. Which of the following is/are factors that may contribute to the disposal of a virus-infected cell.
   1) Encounter of the infected cell with an activated CD8+ CTL recognizing specific Ag on the cell surface
   2) Direct killing by Th-1-type cells
   3) Release of granzymes
   4) The direct effect of IL-2.
   5) Activation of the alternative complement pathway

35. Which of the following is/are products of the innate immune system involved in the defence against pathogenic organisms?
   1) Reactive Nitrogen Intermediates
   2) Reactive Oxygen Intermediates
   3) TNF alpha
   4) IgG
   5) IgM

36. A pathogenic bacterium has been covered by an IgM antibody. Which of the following strategies would the immune system use to dispose of the infection?
   1) Activation of CD4+ T cells
   2) Increased phagocytosis
   3) Activation of the MB-lectin Complement pathway
   4) Activation of the classical complement pathway
   5) Release of chemokines by vascular endothelial cells

37. Which of the following immune response(s) would predominate after an infection with *Mycobacterium tuberculosis*?
   1) Production of IgA antibodies
   2) Activation of the alternative pathway of the complement cascade
   3) Infiltration of the infected site by PMN neutrophils
   4) Activation of CD4+ Th-1 lymphocytes
   5) Production of IgM antibodies

38. A patient suffers from recurrent infections with *Herpes simplex* virus (cold sore). You find out that the interval between overt symptoms is variable but in most cases they are preceded by either stress or by an infection with another pathogen. How do you explain to your students the reason of these recurrences.
   1) The patient is infected repeatedly with a new Herpes virus
   2) After the initial infection, the herpes virus becomes re-activated as a result of a transient immune deficiency
   3) The virus has undergone an antigenic shift
   4) The virus has the capacity to hide in the basal ganglia of the trigeminal nerve by becoming latent
   5) The virus hides by covering itself with Ab and complement
39. A patient with Type I airway hypersensitivity to ragweed:
   1) May develop acute allergic rhinitis during the ragweed season
   2) May develop bronchial asthma
   3) May benefit from treatment with anti-histamines
   4) May develop a wheal and erythema reaction when injected intradermally with a
      minute amount of ragweed allergen
   5) May benefit from desensitization therapy with ragweed antigen

40. Which of the following is/are conditions that may lead to IgE production by B cells?
   1) Encounter of a naïve T cell with an IL-4-producing and allergen-presenting DC
   2) Presentation of the allergen to a CD4+ Th cell by an MHC class-I molecule
   3) Interaction between a B cell presenting an allergen peptide and an IL-4-
      producing Th2 T cell that expresses the appropriate TCR
   4) Infection with intracellular pathogens
   5) The prior activation of CD8+ CTLs

41. A Type IV or Delayed Type Hypersensitivity reaction in the skin can be distinguished
    from a Type I reaction:
    1) By the time of appearance of the skin reaction
    2) By the histological aspect of the skin reaction
    3) By the patient’s medical history
    4) By the amount of IgE antibody in the serum
    5) By the number of CD8+ T cells in the circulation

42. Which of the following constitute(s) evidence that autoimmune diseases have a genetic
    basis?
    1) There is clear association between the expression of the HLA-II alleles DR3 and
       DR4 in the development of Juvenile Diabetes
    2) There is clear evidence that the frequency of appearance of an autoimmune
       disease in identical twins is higher than among non-twin siblings
    3) The position 57 in the DQbeta1 chain of HLA-class II differs in amino acid
       residues between IDDM and non-IDDM individuals
    4) The passive transfer of antibodies from one MS patient to another
    5) The transfer of CD4+ T cells from one MS patient to another

43. Which of the following could be considered as possible pathogenetic mechanism(s)
    (cause) in autoimmune diseases?
    1) An infectious disease that releases auto-antigens from the affected organ or
       tissue
    2) An infectious disease that allows sequestered (trapped) auto-antigen to reach the
       peripheral lymphoid system
    3) Super-activation of APCs through Toll-like Receptors
    4) Low number of Treg cells
    5) Defective function of T reg cells
44. Multiple Sclerosis (MS) is an autoimmune disease of the central nervous system (CNS). Its animal model (EAE) is identified by the following criteria:
   1) It can be induced by the transfer of serum from one animal with EAE to a normal animal of any genetic background
   2) It can be induced by the transfer of CD4+ T cells from an animal undergoing EAE, to a naïve animal of the same MHC genotype
   3) Histological examination of the CNS (brain and/or spinal cord) reveals a massive infiltrate with PMN neutrophils
   4) There is myelin loss
   5) There is increased glucose in blood (hyperglycemia)

45. Which of the following cell type(s) is/are affected by the immune attack in IDDM?
   1) The glucagon-producing alpha cell of the pancreas
   2) The somatostatin-producing delta cell of the pancreas
   3) The Adrenocorticotropic hormone (ACTH)-producing cells of the pituitary
   4) The insulin-producing beta cell of the pancreas
   5) The cortisone-producing cells of the adrenal gland

46. The mixed leukocyte reaction (MLR):
   1) Is a test considered the in vitro equivalent of allograft rejection
   2) Involves the stimulation of T lymphocytes by irradiated allogeneic APCs
   3) Requires that the stimulators (APCs) be incubated with the responder (T) cells for 48-72 hr
   4) The read-out is based on the incorporation of a radioactive nucleotide isotope into the DNA of the responder population
   5) The test is considered positive when the radioactive counts of the test culture (T cells grown with allogeneic APCs) are at least 3 times greater than those of the control culture (T cells in the presence of self APCs)

47. In allograft rejection, antigen presentation is crucial for the activation of anti-allogeneic T cells in vivo:
   1) It operates mainly through recognition of the allo-MHC presented by the donor APCs that are part of the allograft
   2) Operates rarely and inefficiently by indirect presentation
   3) Is most effective when the allogeneic APC is a Dendritic cell (DC)
   4) It requires the presence of opsonizing IgG antibodies to operate properly
   5) Occurs only if B cells are present in the allograft

48. Which of the following is/are major hurdles for achieving success in xenotransplantation?
   1) The risk of inserting new pathogenic organisms into the human population
   2) The high likelihood of severe hyperacute rejection
   3) The presence of naturally-occurring antibodies to antigens expressed by foreign species
   4) The difficulty of adapting an organ from a foreign species to function properly in a human host
   5) The present difficulty of achieving permanent and specific xenograft tolerance
(A) 1, 2, 3   (C) 2 and 4   (E) 1, 2, 3, 4, and 5
(B) 1 and 3   (D) 4 only

49. In your animal colony you have a monkey that received a kidney graft that was rejected within 12 hours after transplantation. What would you suspect regarding a) the origin of the graft and b) the mechanism of rejection.
   1) The kidney could be a xenograft
   2) The kidney could be an allograft transplanted a few months after a previously rejected allograft that expressed the same MHC
   3) The rejection was due mainly to anti-graft antibodies and complement
   4) The rejection was due mainly to minor histocompatibility antigens
   5) The rejection was due mainly to the effect of cytotoxic T cells

50. How do tumours evade the immune response of the host?
   1) An antibody response against tumour antigens leads to the disappearance of the tumour rejection antigens from the cell surface
   2) The tumours themselves release immunosuppressive molecules
   3) Most tumours do not possess co-stimulatory molecules
   4) Many tumours have down-regulated their class-I MHC molecules
   5) Many tumours create physical barriers around themselves that prevent access to the immune system
Illegible writings will not be evaluated

Provide:
Question number, rationale as to why you think it ambiguous, your interpretation, AND your answer(s) based on such interpretation.
MICROBIOLOGY AND IMMUNOLOGY 4200B

MIDTERM EXAM
February 12, 2009
MSB 282  8:30 – 10:30

Answer ALL questions on test booklet. You may use BOTH sides of the paper or on extra sheets. This booklet contains 8 single sided pages.
Answer all questions with the BEST POSSIBLE answer.

Question 1 ____________________/ 20
Question 2 ____________________/ 10
Question 3 ____________________/10
Question 4 ____________________/24
Question 5 ____________________/36
Total  ____________________/ 100

Name (Print) ______________________________
Name (Signature) __________________________
Student Number ____________________________
1. Briefly describe in one or two sentences the contribution of the following to Virology. (20 Marks)

a) M. Delbruck

b) J. Enders

c) G.R. Wyatt and S.S. Cohen

d) A. Sabin

e) K. Landsteiner

f) F. H. d’Herelle

g) Walter Reed

h) H. Eagle

i) J.M. Bishop and H. Varmus

j) Federick W. Twort
2. Describe the effect of “good” sanitation on the incidence of paralytic polio in the absence of polio vaccine. Describe the reasons for this effect. (10 Marks)

3A. Describe three advantages of a “killed” polio virus vaccine. (10 Marks)

i)

ii)

iii)

3B. Describe 3 advantages of a “live” polio virus vaccine.

i)

ii)

iii)
4. Answer EITHER 4A OR 4B. Do NOT answer both. (24 Marks)

A. Compare and contrast the pathogenesis and replication of Hepatitis B and Hepatitis C virus including the following:

i) The clinical results of infection.

ii) The nature of the virions and the viral genomes. **Describe if the viral capsid has cubic or helical symmetry.**

iii) The viral life cycles. (You are encouraged to use diagrams).

iv) How the viruses overcome the polycistronic message problem.

**OR**

B. Compare and contrast Measles and Influenza virus Viruses including:

i) The virion structure and the nature of the genome. **Describe if the viral capsid has cubic or helical symmetry.**

ii) How the viruses enter the cell

iii) The life cycle of the viruses (You are encouraged to use diagrams).

iv) Why a vaccination against Measles gives life time immunity while vaccination against Influenza virus does not. How is this difference connected with how the viruses solve the “polycistronic message problem”?
INDICATE WHICH QUESTION YOU ARE ANSWERING.
5. Answer BOTH 5A AND 5B. (36 Marks)
A. An imaginary virus X can cause tumors in cats with a short latency period. Its genomic nucleic acid is not sensitive to DNAase. However drugs that prevent DNA replication prevented the replication of virus X in cat cells. The viral genomic nucleic acid can serve as a messenger RNA under laboratory conditions. The virus can enter the cell under neutral pH. It CAN NOT replicate in an enucleated cell (cell without nucleus). The virus is inactivated by a mild detergent solution. The virus does not bud out from the plasma membrane.

Describe the following AND explain your answer in light of the given information:

i. How does the virus enter the cell?

ii. Diagram how the virus replicates its nucleic acid.

iii. Diagram the life cycle of replication of the virus

iv. Describe how the virus causes cancer in cats.

AND

B. After extensive passage of the virus in tissue culture at a high multiplicity of infection, the virus now causes tumors in cats with a long latency period.

i. Explain this observation.

ii. Outline an experiment to test your explanation.
INDICATE WHICH QUESTION YOU ARE ANSWERING.
INDICATE WHICH QUESTION YOU ARE ANSWERING.
MICROBIOLOGY AND IMMUNOLOGY 4200B
FINAL EXAMINATION -- APRIL 15, 2009
SSC 3018

3 HOUR EXAMINATION 9:00 – 12:00 p.m.
ANSWER ALL QUESTIONS ON THE TEST PAPER. YOU MAY USE BACK OF THE SHEETS—LABEL WHICH QUESTION YOU ARE ANSWERING

There are 19 pages in four sections. Please put your name on each page.

SECTION I DR. V.L. Morris

5 total marks in Section I

Allow Approximately 10 minutes

Pages 1-2

PRINT NAME(print):_______________________________

SIGNATURE:____________________________________

STUDENT NUMBER:______________________________
FILL IN BLANKS FOR ONLY 5 OUT OF TEN QUESTIONS:
(5 MARKS – allow approximately 10 minutes)

1. Hepatitis D virus requires coinfection with __________________________ virus to replicate.

2. Name two Filovirus (Marburg or Ebola) proteins that the virus synthesizes.
   a. __________________________
   b. __________________________

3. Norwalk Virus was named for a city in what US state __________________________?

4. Name an animal that is currently believed to be a reservoir for SARS
   ____________________________.

5. Name two proteins synthesized by rabies virus.
   a. __________________________
   b. __________________________

6. Bovine Spongiform Encephalopathy (BSE or Mad Cow Disease) is caused by
   what kind of agent ____________________________?

7. What type of nucleic acid does Hantavirus have (RNA or DNA; plus or negative sense;
   segmented or not; single or doubled stranded)?
   ______________________________________.

8. How many Herpes B virus genes have no sequence homology with HSV-1?
   ____________________________

9. What type of Avian Flu poses the greatest danger to humans? ____________________________

10. Name one way in which replication of Eastern Equine Encephalitis differs between
    vertebrate and invertebrate hosts.
    ________________________________________.
MICROBIOLOGY AND IMMUNOLOGY 4200B
FINAL EXAMINATION-- APRIL 15, 2009

3 HOUR EXAMINATION
ANSWER ALL QUESTIONS ON THE TEST PAPER. YOU MAY USE BACK OF THE SHEETS—LABEL WHICH QUESTION YOU ARE ANSWERING

SECTION II  DR. J. MYMRYK

25 total marks in Section II
Allow Approximately 40 minutes

Pages 3-8

PRINT NAME(print):_______________________________

SIGNATURE:_____________________________________

STUDENT NUMBER:___________________________
SECTION II – DR. J. MYMRYK
(25 total marks in Section II) Allow approximately 40 minutes

1) Group adenovirus, papillomavirus and polyomavirus by the following criteria:
   (8 marks total)
   a) Genome size (rank in order of decreasing or equal size; eg A>B=C)

   b) Genome structure
      (1) circular

      (2) linear

   c) Dependence on host cell DNA polymerase
      (1) dependent

      (2) not dependent

   d) Requirement for integration into the host genome as a normal part of life cycle
      (1) normally integrates

      (2) does not normally integrate

   e) Ability to induce oncogenic transformation in tissue culture systems
      (1) able

      (2) not able
f) Causative agent of human cancers
   (1) major causative agent of specific cancers
   (2) not proven to be associated

g) Availability of a vaccine
   (1) available
   (2) not available

h) Has been incorporated into a mouthwash
   (1) incorporated
   (2) not incorporated

2) Viral Life Cycle (3 marks total)
   a) List four differences between adenovirus DNA replication and polyomavirus DNA replication.
      i) 
      ii) 
      iii) 
      iv)
b) What is the major difference between the papillomavirus and polyomavirus life cycle?

3) Pathogenesis (1.5 marks total)

Identify a human disease that is commonly associated with infection by adenovirus, papillomavirus or polyomavirus (ONE disease for each virus).

(1) disease for adenovirus

(2) disease for papillomavirus

(3) disease for polyomavirus

4) Viral Oncogenesis and Cell Cycle (4 marks total)

a) identify the adenovirus oncogene(s)

b) identify the human papillomavirus oncogene(s)

c) identify the mouse polyomavirus oncogene(s)

d) identify a cellular regulatory protein that is a common target of the oncoproteins of adenovirus, SV40 and papillomavirus

e) explain the role of the protein identified in d) in host cell regulation
5) Alterations in Growth Factor Signaling. (4 marks total)
ANSWER EITHER 5a OR 5b. DO NOT ANSWER BOTH. INDICATE WHICH QUESTION YOU ARE ANSWERING.

a) Papillomaviruses have evolved an interesting way of enhancing EGF signaling. Identify the viral protein responsible and describe the mechanism(s) by which this occurs in detail.

OR

b) In class, we discussed an adenovirus protein that blocks TNF-alpha induced apoptosis. Identify this protein and describe the mechanism by which it functions in detail.
6) Evasion of interferon-α response (1.5 marks)
   (a) identify the adenoviral product(s) that we discussed in class that block interferon-α response.

   (b) what is the cellular target of these products and what is its function?

7) Genomic Instability Induced by Human Papillomavirus Infection (3 marks total)
   a) identify the human papillomavirus protein that we discussed in class that is responsible for inducing genomic instability.

   b) identify the cellular structures that are present in excess in cells expressing the protein identified in a)

   c) explain how excess numbers of these structures may contribute to genomic instability
SECTION III – DR. G. DEKABAN

(25 Total Marks in Section III) Allow approximately 40 minutes

Students must answer ONLY 2 of the three questions (Give complete answers; marks will be allocated according to the format of the answer). Indicate which question you are answering.

1. Describe human spumavirus replication and identify which aspects may or may not be sensitive to host restriction mechanisms.

2. Compare and contrast how HTLV-I and HIV-I become involved in altering or influencing apoptosis in infected host cells and how this impacts on the pathobiology of each virus.

3. Identify the HIV genes that contribute most directly to HIV disease pathogenesis, but not necessarily to HIV replication, and justify your choices.
EXTRA PAGE FOR SECTION III  -- DR. G. DEKABAN CONTINUED.
Indicate which question you are answering.
EXTRA PAGE FOR SECTION III -- DR. G. DEKABAN CONTINUED.
Indicate which question you are answering.
MICROBIOLOGY AND IMMUNOLOGY 4200B
FINAL EXAMINATION-- APRIL 15, 2009

3 HOUR EXAMINATION
ANSWER ALL QUESTIONS ON THE TEST PAPER. YOU MAY USE BACK OF THE SHEETS—LABEL WHICH QUESTION YOU ARE ANSWERING

SECTION IV  Dr. Laura Hertel

45 total marks in Section IV
Allow Approximately 80 minutes

Pages 13-19

PRINT NAME(print):_______________________________

SIGNATURE:_____________________________________

STUDENT NUMBER:_________________________
SECTION III: Dr. L. Hertel
45 marks total (allow 80 minutes for this section)

1. Define in one or two sentences the following (10 MARKS):
   a) IMV

   b) Latency

   c) LANA

   d) Tegument

   e) Kaposi’s sarcoma

   f) Shingles

   g) Gancyclovir

   h) Vhs

   i) US3

   j) LAT
2. Upon delivery of poxvirus DNA in a permissive cell by transfection, will viral progeny be obtained? Explain the reasons why yes or why no in detail (5 MARKS).

3. Describe the key differences between variolation and vaccination (4 MARKS).
4. Name the three main classes of herpesvirus genes and summarize how they are utilized during the viral replication cycle (4 MARKS).

5. Compare and contrast the latency and reactivation mechanisms of VZV, HSV-1 and HSV-2 (3 MARKS).
6. Describe the molecular mechanisms used by human cytomegalovirus to inhibit NK cell recognition of infected cells lacking MHC class I (5 MARKS).

7. Describe the stages of poxvirus replication, from entry into the cell to production and release of new progeny (5 MARKS).
8. Describe the key clinical features of smallpox, beginning from initial infection and ending with recovery or death (3 MARKS).

9. Describe the key differences between the symptoms of smallpox and those of chickenpox. (2 MARKS)
10. Explain and diagram why the smallpox genome appears linear and double-stranded in non-denaturing conditions but circular and single stranded in denaturing conditions. (4 MARKS)
### APPENDIX B5 – TEACHING IN UNDERGRADUATE COURSES for 2009/10

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* Includes 33 hours of laboratory time
** Includes 18 hours of laboratory time
*** Includes 12 hours of tutorial time
**** Includes 24 hours of tutorial time
### APPENDIX B6 – FACULTY COMPLEMENT

P = Professor  
F = Primary Appointment  
AP = Associate Professor  
J = Joint Appointment  
A = Assistant Professor  
C = Cross Appointment  
L = Lecturer  
PR = Post Retirement  
LD = Limited Duties  
IS = Institute Scientist

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# APPENDIX B7: STAFF COMPLEMENT

AA = Administrative Assistant  
AO = Administrative Officer  
T/L = Technical Laboratory

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