Welcome to Pathology 467 online!

This course is designed for those wishing to have a better understanding of the microbiological and infectious disease basis of infection control practices. It is recognized by CHICA (Community and Hospital Infection Control Association-Canada) and it is a 3-credit course.

Whether you are a seasoned distance learner and a computer whiz or a brand new, computer-shy distance education student, we hope to make this an enjoyable learning experience. Since this course is designed with flexibility in mind, we will try to accommodate incoming students' wide range of computer expertise. If you are comfortable using the Internet and Email, you should find that you have no difficulty using the course website which is organized within software developed by WebCT. Navigation of the pages of the website follows a familiar design used by most webpages. The listing on the left-side navigation bar will take you to the important pages of the course such as the course contents (lessons) and the assignments and the pages attached to this "Welcome" message.

Don't be discouraged by the amount of material in the course! The lessons may look dense at the start, but each lesson is broken into sections. Use that to your advantage to cover manageable amounts of information in a logical sequence. As a general rule, read through the text on the website and then go to the required reading and/or CD-ROM.

If you have technical problems with this website at any time, do not hesitate to contact helpdesk@det.ubc.ca. You will receive an answer within 24 hours, except on week-ends.

Mandatory Exercise:

During the first week of the course please send an Email message to Dr. Fred Roberts telling him whether you have received your course package containing course information and the CD-ROMs and telling him that you have been able to access the course website.

About the Course

The course contains 9 lessons and you have 20 weeks to complete them. At the end of the course there will be a final exam.

Lessons consist of:

- Reading material provided online
- Reading chapters in the textbook
- Viewing of the CD-Roms where indicated (note: they must be returned to DE&T)
- End-of-lesson quizzes
- Problems for Discussion in week 2 of each lesson

Textbook

You are required to purchase *Medical Microbiology* Cedric Mims et. al. Third Edition 2004, Mosby Publishers, ISBN 0-7234-3259-7. You must also have access to or own Heymann, D. 18th Ed. (2004). *Control of Communicable Diseases Manual*, American Public Health Association. (Available through http://www.chapters.ca/ if the UBC Bookstore does not have any copies available) and *Red Book 2003: Report of the Committee on Infectious Diseases*, 26th Edition. Elk Grove Village, Illinois: American Academy of Pediatrics.

CD-ROM

You will receive from Distance Education & Technology, in a package of materials, two CD-ROMs that are required viewing during the course. The first CD is divided into two segments. The first segment contains section 1 of a video showing basic laboratory methods. The second segment contains the transcript of the narration of the video (the transcript is also available as a Microsoft Word document on the course website). The transcript can be printed so that you can follow along when viewing the filmed sections on laboratory methods and so that you can make notations or highlight important areas. The second CD contains two video sections: one demonstrates tests used to identify common clinical isolates and the other covers special methods used for some specimens and some organisms.

Please note: You need to return the two CDs to Distance Education and Technology. There is a charge of $50 if they are not returned.

Supplemental Reading Material

There is a variety of supplemental material available to help students understand topics and concepts presented in this course. Some of the best sources are as follows:

Texts: (topic - Infection Control)

Mayhall, CG (2004) *Epidemiology and Infection Control*. 3rd edition. Lippincott Williams and Wilkins.

Bennett, JV, and Brachman, PS. *Hospital Infection*. 4th Edition. Philadelphia: Lippincott-Raven.

Wenzel, RP. (2003). *Prevention and Control of Nosocomial Infections*. 4th Edition. Baltimore: Williams and Watkins.

Damani NN. (2003) *Manual of Infection Control Procedures*. 2nd Edition. Greenwich Medical Media.

Texts: (topic - Laboratory Methods)

Koneman, EW et al. (1997) *Color Atlas and Textbook of Diagnostic Microbiology*. 5th Edition. Philadelphia: J.B. Lippincott.

Murray, PR *et al*. (1999) *Manual of Clinical Microbiology* 7th Edition. Washington, DC: American Society for Microbiology.

Online:

U.S. Department of Health and Human Services, Public Health Service, CDC. Morbidity and Mortality Weekly Report (MMWR). Atlanta, Georgia. http://www.cdc.gov/mmwr/

Through UBC Library:

Mandell et al. *Principles and Practice of Infectious Diseases*, 5th ed. New York: Churchill Livingstone, 2000. (MD Consult)

Assignment

See the Assignment page (on the left-side navigation bar) for details concerning all assignments, quizzes, and the exam.

Course Instructors

Information about your course instructors can be found on the next page of this website. You have the Email address of each instructor and you may contact them at any time with questions or comments.

How the Course Works

Every two weeks a new lesson will be released on a Sunday. During those two weeks you are expected to familiarize yourself with the topic and ensure that you have met the objectives. On the second Sunday of the two week lesson period, a problem relating to the lesson will be released. We would like you to post your answers to the Problem Questions in the Discussion Forum (click on the Discussion Forum link on the Course Menu). Please post your answers under the appropriate Lessons. This is also a great place to ask your fellow students and/or instructors any questions that you may have thought of while studying the material. All discussion should end by Thursday noon.

You will also be expected to assess yourself by doing the quizzes in a timely fashion (we would expect you to do these over the next two weeks, that is, by the end of the next lesson).

Evaluation is based on participation in the lesson Discussion Forums and by answering the quiz questions in a timely fashion (20%), by a final exam (60%), and by completing an assignment (20%).

Course Schedule (2007)

Item	Date Available	Due Date/Wrap Up
Lesson 1	**January 8**	
Discussion Question/Problem	January 12	January 19
Quiz	January 12	January 19
	January 15	
Discussion Question/Problem	January 22	January 26
Quiz	January 22	January 26
Lesson 3	**January 29**	
Discussion Question/Problem	February 5	February 9
Quiz	February 5	February 9
Lesson 4	**February 12**	
Discussion Question/Problem	February 19	February 23
Quiz	February 19	February 23
Lesson 5	**February 26**	
Discussion Question/Problem	March 5	March 9
Quiz	March 5	March 9
Lesson 6	**March 12**	
Discussion Question/Problem	March 19	March 23
Quiz	March 19	March 23
Lesson 7	**March 26**	
Discussion Question/Problem	April 2	April 6
Quiz	April 2	April 6
Lesson 8	**April 9**	
Discussion Question/Problem	April 16	April 20
Quiz	April 16	April 20
Lesson 9	**April 23**	
Discussion Question/Problem	April 30	May 4
Quiz	April 30	May 4
Final Examination	**May 14 - 18**	

Lesson 1: Introductory Microbiology and Infection Control

Introduction

This lesson contains information that provides a basis for the following lessons. **Do not** concentrate on detail but attempt to achieve a general knowledge of the organization and principles involved. Learn where reference information is located in the books so that you can return to it later when topics are covered in detail. Acquaint yourself with the way the three reference texts are structured. In subsequent lessons you will sometimes be referred to all three books to read the same topic. There will be some repetition so learn early to recognize what is unique to each book.

If you have access to a hospital laboratory make sure you take advantage of the opportunity to talk to the staff there. The more you can see of actual laboratory procedures the more the information in this course will mean to you.

The following objectives may help you in setting your priorities for topics to be learned.

Objectives

By the end of this lesson you should be able to:

1. Define terms used in Infection Control such as pathogen, epidemic, outbreak, virulence, communicable disease, normal flora, carrier state etc.
2. Describe the different sources of infection and the methods of spread.
3. Describe the body's defence methods. Do not try to memorize all the details of the different systems.
4. Give the general principles of classifying organisms. Know the structural differences between bacteria, fungi, viruses and parasites.
5. Describe the basics of viral structure, classification and reproduction.
6. Describe, generally, the classification of bacteria. Learn to think of bacteria in terms of their major groups (e.g., gram positive cocci) as this will help when studying topics such as antibiotics that are effective for certain groups. It is also helpful in clinical assessment when the first and only information concerning an infection is the appearance of the organism in a gram stained smear.
7. Define the function of important bacterial structures (e.g. cell wall, cell membrane, pili, flagella, and spores).

8. Describe how a hospital laboratory processes specimens. Do not attempt to learn all the specific procedures.

Outline

The complete set of readings is listed here and in future lesson outlines for your convenience. You may read them all before the lesson if you choose, but they follow a more logical and relevant sequence if read the textbook material that corresponds to where you are in the lesson. The Compile tool allows you to download and/or print the whole lesson if you are limited in online time, and you can then work through the lesson at your leisure.

Required Reading & Viewing

Topics	**Text & CD-ROM** **Mims**
Microbial Classification	Text: 1-55
Laboratory Techniques	Text: 555-560
Laboratory Techniques	CD-ROM #1, Part 1

Internet Sources for Additional Information

- Microbiology Webbed Out

  http://www.bact.wisc.edu/microtextbook/index.html

- Neal Chamberlain's Look at Microbes!

  http://www.geocities.com/CapeCanaveral/3504/

Introduction to Microbiology

Knowledge of medical microbiology is the scientific foundation of infection control practices. Awareness of host factors that predisposes to infection together with an understanding of the characteristics of microorganisms will enable the infection control practitioner to develop policies and procedures that will enhance the safety of patients, staff and the general public.

In modern medical practice the state of health of the patient is a critical determinant of risk. The extremes of life are associated with special hazards. Degenerative disease of the elderly; failure of immunization in children; cancer and chemotherapy; invasive procedures; trauma, implant and transplant surgery are all part of the host condition. Nutrition and life style are major concerns in considering some infections. We are all constantly living in a world of microbes and have successfully adapted to it. When the balance between host resistance and organism virulence becomes altered we develop infections and sometimes are clinically ill.

Organisms that were considered harmless (nonpathogenic) or of low virulence are now recognized as important pathogens. *Staphylococcus epidermidis* and *Serratia marcescens* are organisms once

considered nonpathogenic that are now of increasing importance. Each year new agents such as HIV, Legionella, human parvovirus B19, hepatitis C are being recognized.

Modern medical advances have introduced new reservoirs and routes of infection. Intravascular catheters, hemodialysis machines, microscopic surgery, respirators, disinfection and sterilizing equipment are all examples of devices that can play a significant role in infections.

The use of increasingly powerful antimicrobials has resulted in the selection of a hospital flora that is genetically altered to be more resistant. The current problems of MRSA (Methicillin Resistant *Staphylococcus aureus*) and VRE (Vancomycin Resistant Enterococci) are examples. The use of these antibiotics has also resulted in the emergence of serious problems of superinfections such as *Clostridium difficile* and yeast infections.

The history of medical microbiology and infectious diseases is that for every success that is enjoyed in the area of prevention and treatment, a new challenge arises to be addressed. This is part of the reason that the level of nosocomial infection has remained constant at about 6% of hospital admissions in the past few decades. Strategies for combating newly emerging problems require a level of microbiological sophistication in infection control practitioners adequate to meet these future problems. Without knowledge of the organisms involved and factors involved in their ability to cause infections and outbreaks of infection we cannot hope to be successful as infection control practitioners.

Determining the Significance of Microbial Isolates

The isolation of an organism in the laboratory depends on technical ability while its significance is related to many clinical and microbiological factors. There is a tendency for the less experienced individual to think that all organisms can be easily divided into "good" (nonpathogenic) and "bad" (pathogenic).

While some organisms such as those causing tuberculosis, syphilis, etc., are always clinically significant, the majority of organisms may be pathogenic or nonpathogenic depending on the specimen, number of organisms, and clinical setting.

Specimen

Some specimen types such as sputum, feces, etc. will always contain organisms as "normal flora" and potential pathogens must be separated from them. Other specimens including blood and CSF are normally sterile so all isolates are clinically significant, are contaminants, or represent a transient loss of sterility (transient bacteremia).

The isolation of Gram-negative bacilli from sputum may reflect pneumonia or contamination of the sputum with saliva from a mouth that is colonized. The isolation of the same organism from blood is nearly always associated with clinical infection somewhere, often in the urinary tract. A common sequence of events seen in wounds, burns and sputum specimens is a progression from colonization to infection.

The method used in procuring the specimen is also important. A coughed up sputum will always be contaminated with saliva. A bronchoscopy specimen will often have little or no contamination with saliva. A transtracheal aspiration or aspiration through the chest wall will have none.

Quantitative Values

The quantity of organisms is usually expressed as colony forming units per liter (CFU/L). It may be useful in separating contamination from infection in some situations. Most attempts to use quantitative information in evaluating sputum have not been clinically useful. Urine specimens are routinely cultured using a quantitative technique. Initially counts greater than 10^8 CFU/L were considered evidence of urinary tract infection and counts less than 10^6 CFU/L considered contamination. The latter value may be of value in certain groups of patients but more recent studies have shown that counts of 10^6 CFU/L or lower may be very clinically significant and must be evaluated. This will be discussed in Lesson 6.

A second area where quantitative counts have been used clinically is in assessing burn wound and skin ulcers. Counts greater than 10^5/gram of tissue suggest that skin grafting will not be successful and the probability of bacteremia is high.

Number of Positive Cultures

Another consideration that can be of value in interpreting cultures is the occurrence of other specimens from the same or different sites growing the same organism. Several specimens taken at different times from the same site growing the same organism suggest colonization or infection rather than contamination. It is often difficult to assess this clinically, as the use of antibiotics will interfere with the ability to obtain positive cultures. The same organism isolated from blood and another site suggests bacteremia arising from infection at that site.

Clinical Findings

Signs and symptoms of infection are the most important factors in interpreting cultures. The presence of dysuria and frequency of urination are more important than the urine quantitative count in diagnosing urinary tract infection. The chest x-ray is a basic tool in separating colonization of upper respiratory flora from pneumonia in interpreting sputum cultures.

The patient's history may also contribute to the interpretation of cultures. The presence of a prosthetic heart valve increases the likelihood of coagulase negative staphylococcus in a blood culture representing endocarditis than when the patient has no history of heart surgery.

Patients that are immunosuppressed, on steroids or neutropenic have a greater chance of infection and may have infections with "opportunistic pathogens." The isolation of aspergillus from the sputum of a neutropenic patient has more serious implications than in the normal host.

The Organism

As mentioned earlier, certain organisms must always be considered clinically significant. The isolation of *Salmonella typhi* represents enteric fever when isolated from blood. When found in feces it may represent acute infection (enteric fever) or the persistence of the organism after infection. If it persists long enough and the patient is asymptomatic then it signifies a carrier. This is still significant even though the person is well because a carrier represents a risk of spreading the disease to others.

Sometimes the occurrence of certain mixtures of organisms can be useful in their interpretation. The isolation of organisms consistent with feces from the peritoneal cavity suggests fecal peritonitis from a perforated bowel or leaking anastomosis.

In interpreting culture results it is necessary to gather as much information as possible. In some instances, the prognostic significance influences the interpretation that must be accepted. For example in a neutropenic bone marrow transplant patient all organisms can be potential pathogens because untreated infections in these patients carries a high mortality rate.

It is important to know the capabilities and the policies of the laboratory to identify organisms. All laboratories must decide what is an appropriate degree of identification for their needs. A small laboratory with limited resources may identify an isolate from a urine culture to the Genus level only and provide an antibiotic sensitivity report. The report might read "growth of $>10^8$ *Proteus species*." A few laboratories may even just report the growth of a Gram-negative bacillus and not identify it as *Proteus*. Most laboratories would take the identification to the next level and speciate it. It would then be reported as *Proteus mirabilis*. Few laboratories would take it beyond this level as a routine procedure. If the organism is part of an outbreak then comparison of the antibiotic sensitivity patterns (antibiogram) and comparison of some of the biochemical tests used in identifying it (biotyping) may be valuable. If more testing is required to compare strains then a variety of tests can be performed such as serotyping, phage typing etc. These tests are often performed only in a reference center. Some techniques can be used in the hospital laboratory if the need arises. It is important to realize that these methods do exist and to determine what would be available to you in investigating an outbreak. Interpreting the results of these tests can be very difficult. The definition of what constitutes a single strain is often a problem. The same strain may show variations in antibiotic sensitivity if it develops resistance. Different strains may share the same antigens making serology indistinct. In many situations it results in the comparison of multiple tests with some tests more important than others and a limit to the number of variations acceptable in defining one strain.

Readings

Gao SJ and Moore PS. Molecular Approaches to the Identification of Unculturable Infectious Agents. EID 1996 Vol. 2, No. 3.

CD ROM

Now turn to your CD-ROM (# 1) and view: *Part 1 - Introduction to Laboratory Methods* and complete the Video Quiz (see link under Quizzes in the Course Menu on the left).

Body Responses to Infection

This section is designed to help those that have not recently taken courses that include basic immunology principles. Read it to get an overview of how the body responds to infection before getting to the more detailed information in the text. You are not expected to know all the details of the various response mechanisms so don't try to memorize things like the complement pathways. Try to understand the different types of response that can occur and how they relate to one another.

Inflammation

This is a nonspecific response to any type of injury or to the presence of any substance recognized as foreign to the body. It results in increased blood flow (erythema), increased passage of fluid into the tissues (edema) and increased numbers of white blood cells. The large number of white blood cells promotes phagocytosis (ingestion of organisms) and provides cells capable of initiating an immune response.

Antigen Processing

Macrophages are capable of incorporating antigenic material from organisms and passing it on to both B cell and T cell lymphocytes. A defect in macrophages leads to a severe reduction in the host's ability to respond to infection.

Serological Response

B cell lymphocytes are capable of taking the processed antigen from macrophages and using it to produce antibodies that are released into the surrounding serum. After the infection some of these cells will persist and if the antigen is reintroduced will become stimulated and multiply to produce large amounts of antibody. The antibody combines with the antigen on the surface of organisms creating antigen-antibody complexes. These complexes make phagocytosis more efficient and trigger the complement mechanism.

Complement System

The complement system is a series of serum components that when activated result in substances that will improve phagocytosis and also is capable of destroying the walls of organisms and killing them. The commonest triggering factor is the antigen-antibody complex but other substances can also be responsible.

Cell Mediated Immune Response

Processed antigen can also be passed on to T cell lymphocytes. These will become sensitized to the antigen and can act in a number of ways to destroy the organisms or cells containing the organism or its antigen. This mechanism is the body's way of dealing with organisms not destroyed by the other mechanisms. It often ends up with damage to the host as well as the organisms as can be seen in tuberculosis when cavities are produced. With the persistence of antigen stimulation the earlier acute inflammatory response consisting mostly of neutrophils changes so that lymphocytes and macrophages dominate. These are often arranged in a specific pattern known as a granuloma.

Lesson Quiz

Complete the Lesson 1 Quiz (see link under Quizzes in the Navigation sidebar â€“ Course Menu