# MMBS 111: Introductory Microbiology

## Prior Learning Assessment (PLA) Study Guide

## Resources

The following are resources that you may want to make use of as you review for this PLA.

1. The textbook we are currently using for MMBS 111 is Microbiology Fundamentals: A Clinical Approach by Cowan/Bunn. You can find a copy in the CWI Library.
2. You may access lectures that Teresa Rich has recorded and posted on YouTube. You can find them on her YouTube channel at https://www.youtube.com/channel/UCsi5XuHNv6apuXrCgFfHeGg?view_as=subscriber.

## Topics & Objectives

### Introduction to Microbes and Their Building Blocks

1. Be able to list the six types of microbes.
2. Know the differences between the different types of microbes.
3. Be able to describe the role and impact of microbes on the earth.
4. Point out three characteristics all cells share.
5. Differentiate among the terms nomenclature, taxonomy, and classification.
6. Create a mnemonic device for remembering the taxonomic categories.
7. Correctly write the binomial name for a microorganism.
8. Draw a diagram of the three major domains.
9. Explain the difference between traditional and molecular approaches to taxonomy.
10. Explain the theory of evolution.
11. Be able to define “theory” as it is used in the scientific community.
12. Explain why the theory of evolution still called a theory.
13. Explain the ways that humans manipulate organisms for their own uses.
14. Summarize the relative burden of human disease caused by microbes.
15. Differentiate between prokaryotic and eukaryotic microorganisms.
16. Identify a third type of microorganism.
17. Compare and contrast the relative sizes of the different microbes.
18. Name the four main families of biochemical.
19. Know the structure and function of each biochemical family.
20. Provide examples of cell components made from each of the families of biochemical.
21. Explain primary, secondary, tertiary, and quaternary structures as seen in proteins.
22. List the three components of nucleic acids.
23. Name the nucleotides of DNA and RNA.

24. List the three components of ATP.

## Chapter 3: Prokaryotic Structure

1. Name the structures of all bacteria possess.
2. Name three structures some, but not all, bacteria possess.
3. Describe three major shapes of prokaryotes.
4. Describe the structure and function of four different types of bacterial appendages.
5. Explain how a flagellum works in the presence of an attractant.
6. Differentiate between the two main types of bacterial envelope structure.
7. Know the steps in the Gram stain and how it relates to bacterial envelopes.
8. Discuss why gram-positive cell walls are stronger than gram-negative cell walls.
9. Name a substance in the envelope structure of some bacteria that can cause severe symptoms in humans.
10. Identify five things that might be contained in bacterial cytoplasm.
11. Name the functions of the five things that might be contained in bacterial cytoplasm.
12. Detail the causes and mechanisms of sporogenesis and germination.
13. List some differences between archaea and bacteria.
14. List some similarities between archaeal and eukaryotes.
15. Explain what a bacterial species is.
16. Know some bacterial adaptions.

## Eukaryotic Structure

1. Relate both prokaryotic and eukaryotic cells to the Last Common Ancestor.
2. Discuss some of the evidence for the theory of endosymbiosis.
3. List the types of eukaryotic microorganisms.
4. Differentiate between cilia and flagella in eukaryotes, and between flagella in prokaryotes and eukaryotes.
5. List which eukaryotic microorganisms have a cell wall.
6. List similarities and differences between eukaryotic and prokaryotic cytoplasmic membranes.
7. Describe the important parts of a nucleus.
8. Diagram how the nucleus, endoplasmic reticulum, and Golgi apparatus act together.
9. Explain the function of the mitochondria.
10. Explain the importance of ribosomes, and differentiate between eukaryotic and prokaryotic types.
11. List and describe the three main fibers of the cytoskeleton.
12. Know the characteristics of fungi, protozoa, and helminthes.
13. List two detrimental and two beneficial activities of fungi (from the viewpoint of humans).

14. List some general features of fungal anatomy.
15. Differentiate among the terms heterotrophic, saprobe, and parasite.
16. Connect the concepts of fungal hyphae and a mycelium.
17. Describe two ways in which fungal spores arise.
18. Use protozoan characteristics to explain why they are informally placed into a single group.
19. List three means of locomotion by protozoa.
20. Explain why a cyst stage might be useful to a protozoan.
21. Give an example of a disease caused by each of the four types of protozoa.
22. List the two major groups of helminthes and then the two subgroups of one of these groups.
23. Describe a typical helminth lifestyle.

**Viral Structure & Life Cycles**

1. Explain what it means when viruses are described as “filterable”.
2. Identify better terms for viruses than “alive” or “dead”.
3. Discuss the size of viruses relative to other microorganisms.
4. Describe the function and structure(s) of viral capsids.
5. Distinguish between enveloped and naked viruses.
6. Explain the importance of viral surface proteins, or spikes.
7. Diagram the possible configurations that nucleic acid viruses may possess (double-stranded DNA, single-stranded DNA, etc.).
8. Diagram the five-step life cycle of animal viruses.
9. Explain what cytopathic effects are.
10. Discuss both persistent and transforming infections.
11. Provide a thorough description of of lysogenic and lytic bacteriophage infections.
12. Name two noncellular infectious agents besides viruses.
13. Analyze the relative importance of viruses in human infection and disease.
14. Discuss the primary reason that antiviral drugs are more difficult to design than antibacterial drugs.

**Microbial Nutrition and Growth**

1. Be able to list the essential nutrients of a bacterial cell.
2. Be able to differentiate between macronutrients and micronutrients.
3. Be able to construct four different terms that describe an organism’s sources of carbon and energy.
4. Be able to define saprobe and parasite.
5. Be able to discuss diffusion and osmosis.

6. Be able to identify the effects on a cell of isotonic, hypotonic, and hypertonic conditions.
7. Be able to name two types of passive transport and three types of active transport
8. Know the environmental influences on microbes (temperature, gases, pH, osmotic pressure, radiation, hydrostatic/atmospheric pressure, and other organisms) and their effects on the microbes.
9. Be able to name five types of bacteria based on their temperature preferences.
10. Be able to explain how different organisms deal with oxygen.
11. Be able to name three physical factors besides temperature and oxygen requirements that microbes must contend with.
12. Be able to list and describe the five types of associations microbes can have with their hosts.
13. Be able to discuss characteristics of biofilms that differentiate them from planktonic bacteria.
14. Be able to describe the main way that bacteria divide.
15. Be able to define doubling time and how it relates to exponential growth.
16. Be able to compare and contrast the four phases of growth in a bacterial growth curve.
17. Be able to identify three methods besides a growth curve to count bacteria.

**Microbial Metabolism**

1. Describe the relationship among metabolism, catabolism, and anabolism.
2. Fully define the structure and function of enzymes.
3. Differentiate between constitutive and regulated enzymes.
4. Diagram some different patterns of metabolism.
5. Describe how enzymes are controlled.
6. Name the chemical in which energy is stored in cells.
7. Create a general diagram of a redox reaction.
8. Identify electron carriers used by cells.
9. Know how ATP is the repository of energy in the cell.
10. Name three basic catabolic pathways, and give an estimate of how much ATP each of them yields.
11. Write a summary statement describing glycolysis.
12. Describe the Krebs cycle.
13. Discuss the significance of the electron transport system.
14. Point out how anaerobic respiration differs from aerobic respiration.
15. Provide a summary of fermentation.
16. Describe how noncarbohydrate compounds are catabolized.
17. Be able to provide an overview of the anabolic stages of metabolism.
18. Be able to define amphibolism.

**Microbial Genetics & Genetic Engineering**

1. Define the terms genome and gene.

2. Differentiate between genotype and phenotype.
3. Draw a picture of a length of DNA, including all important chemical groups.
4. Explain how DNA replication takes place. Know the enzymes.
5. Use Okazaki fragments to explain leading and lagging strands.
6. Relate the new and old versions of the "central dogma."
7. Identify important differences between RNA and DNA.
8. Draw a picture of the process of transcription, including the enzymes and nucleic acids involved.
9. Draw a picture of the process of translation, including the enzymes and nucleic acids involved.
10. List the three types of RNA directly involved in translation.
11. Be able to use a codon chart.
12. Define codon and anticodon.
13. Identify on which molecules the promoter, the start codon, and the A and P sites appear.
14. Indicate how eukaryotic transcription and translation differ from these processes in prokaryotes.
15. Be able to define recombinant.
16. Be able to describe three forms of horizontal gene transfer used in bacteria.
17. Be able to describe the actions of transposons.
18. Be able to define the term mutation, and discuss its importance.
19. Be able to differentiate among frameshift, nonsense, silent, and missense mutations based on the original gene sequence compared to a mutated gene sequence..
20. Be able to explain the importance of restriction endonucleases to genetic engineering.
21. Be able to list the steps in the polymerase chain reaction.
22. Be able to describe how you can clone a gene into a bacterium.

**Physical and Chemical Control of Microbes**

1. Clearly define the terms sterilization, disinfection, decontamination, sanitization, antisepsis, and degermation, endospore, vegetative cell, trophozite, and cyst.
2. Identify the microorganisms that are most resistant and least resistant to control measures.
3. Define "-static" and "-cidal".
4. Name four categories of cellular targets for physical and chemical agents.
5. Name six methods of physical control of microorganisms.
6. Discuss both moist and dry heat methods, and identify multiple examples of both.
7. Define thermal death time and thermal death point.
8. Explain methods of moist heat control.
9. Name the desirable characteristics of chemical control agents.
10. Discuss chlorine and iodine and their uses.
11. List advantages and disadvantages to phenolic compounds.
12. Explain the mode of action of chlorhexidine.
13. Explain the applications of hydrogen peroxide agents.
14. Identify some heavy metal control agents.
15. Discuss the disadvantages of aldehyde agents.

16. Identify applications for ethylene oxide sterilization.

**Antimicrobial Treatment**

1. Be able to state the main goal of antimicrobial treatment.
2. Be able to identify the sources for most currently used antimicrobials.
3. Be able to describe two methods for testing antimicrobial susceptibility.
4. Be able to define therapeutic index, and identify whether a high or a low index is preferable.
5. Be able to explain the concept of selective toxicity.
6. Be able to list the five major targets of antimicrobial agents.
7. Be able to identify which categories of drugs are most selectively toxic and why.
8. Be able to distinguish between broad-spectrum and narrow-spectrum antimicrobials, and explain the significance of the distinction.
9. Be able to identify the microbes against which the various penicillins are effective.
10. Be able to explain the significance of beta-lactamases.
11. Be able identify two antimicrobials that act by inhibiting protein synthesis.
12. Be able to explain how drugs targeting folic acid synthesis work.
13. Be able to identify one example of a fluoroquinolone.
14. Be able to name a drug that targets the cellular membrane.
15. Be able to discuss how treatment of biofilm infections differs from that of nonbiofilm infections.
16. Be able to name the four main categories of antifungal agents.
17. Be able to explain why antiprotozoal and antihelminthic drugs are likely to be more toxic than antibacterial drugs.
18. Be able to list the three major targets of action of antiviral drugs.
19. Be able to discuss two possible ways that microbes acquire antimicrobial resistance.
20. Be able to list five cellular or structural mechanisms that microbes use to resist antimicrobials.
21. Be able to discuss at least two novel antimicrobial strategies that are under investigation.
22. Be able to distinguish between drug toxicity and allergic reactions to drugs.
23. Be able to explain what a superinfection is and how it occurs.

**Interactions between Microbes and Humans**

1. Be able to differentiate between colonization, infection, and disease.
2. Be able to enumerate the sites where normal biota is found in humans.
3. Be able to discuss how the Human Microbiome Project will change our understanding of normal biota.
4. Be able to point out how microbial antagonism can be helpful to the human host.
5. Differentiate between pathogenicity and virulence.
6. Define opportunism.
7. List the steps a microbe has to take to get to the point where it can cause disease.
8. List several portals of entry.
9. Define infectious dose.

10. Describe three ways microbes cause tissue damage.
11. Differentiate between endotoxins and exotoxins.
12. Provide a definition of virulence factors.
13. Draw a diagram of the stages of disease in a human.
14. List several different modes of transmission of infectious agents.
15. Define healthcare-associated infection, and list the three most common types.
16. List Koch's postulates, and when they might not be appropriate in establishing causation.
17. Be able to differentiate the science of epidemiology from traditional medical practice.
18. Be able to identify the need for some diseases being denoted "notifiable."
19. Be able to define incidence and prevalence.
20. Be able to discuss point-source, common-source, and propagated epidemics, and predict the shape of the epidemic curves associated with each.

**Host Defenses: Overview and Nonspecific Immunity**

1. Summarize what the three lines of defense are.
2. Identify three components of the first line of defense.
3. Define marker, and discuss its importance in the second and third lines of defense.
4. Name four body compartments that participate in immunity.
5. List the components of the reticuloendothelial system.
6. Describe the structure and function of the lymphatic system.
7. Name three kinds of blood cells that function in nonspecific immunity and the most important function of each.
8. Name two kinds of lymphocytes involved in specific immunity.
9. List the four major categories of nonspecific immunity.
10. Outline the steps in phagocytosis.
11. Outline the steps in inflammation.
12. Discuss the mechanism of fever and what it accomplishes.
13. Name four types of antimicrobial proteins.
14. Compose one good overview sentence about the purpose and the mode of action of the complement system.

**Host Defenses: Specific Immunity and Immunization**

1. Describe how the third line of defense is different from the other two.
2. List the four stages of a specific immune response.
3. Discuss the role of cell markers in the immune response.
4. Describe the two different types of major histocompatibility complex (MHC I and MHC II) and identify which kinds of cells have MHC I and which have MHC II.
5. Summarize the maturation process of both B cells and T cells.
6. Explain how our bodies are equipped with lymphocytes capable of responding to nearly any antigen imaginable.
7. Describe the B-cell receptor and the T-cell receptor.

8. Contrast the way T cells recognize antigen with the way B cells do.
9. Outline the processes of clonal selection and expansion.
10. Compare the terms hapten, antigen, immunogen, and epitope.
11. List characteristics of antigens that optimize their immunogenicity.
12. List the types of cells that can act as antigen-presenting cells.
13. List the three major types of cells that T cells will differentiate into after stimulation.
14. De3scribe the main functions of these three types of T cells.
15. Explain how Tc cells kill other cells.
16. Diagram the steps in the B-cell response.
17. Make a detailed drawing of an antibody molecule.
18. Explain the various end results of antibody binding to an antigen.
19. List the five types of antibodies and important facts about each.
20. Describe the memory response.
21. List and define the four different descriptors of specific immune states.
22. Discuss the qualities of an effective vaccine.
23. Name the two major categories of vaccines and then the subcategories under each.
24. Discuss the pros and cons of killed (or inactivated) versus attenuated vaccines.
25. Describe the principle behind DNA vaccines.

**One Health: The Interconnected Health of the Environment, Humans, and Other Animals**

1. Know how the environment, humans, human activity, and other animals can influence each other.
2. Define microbial ecology.
3. Summarize why our view of the abundance of microbes on earth has changed in recent years.
4. Outline the basic process used to perform metagenomic analysis of the environment.
5. Differentiate between classic and current zoonotic infections. Give an example of each.
6. Diagram the hydrologic cycle.
7. Discuss what metagenomic sampling of oceans has revealed.
8. Define eutrophication, and discuss its consequences.
9. Outline the steps in water purification.
10. Differentiate water purification from sewage treatment.
11. Describe the primary and secondary phases of sewage treatment.
12. List five important pathogens of drinking water.
13. Explain why indicator bacteria have been used as surrogates for pathogenic bacteria in examination of water safety.
14. Discuss why microorganisms themselves might be useful as food products.
15. Report the 10-year trends in food-borne illnesses.
16. Outline basic principles of using temperature to preserve food.
17. List mechanisms other than temperature that are used to preserve food.
18. State the general aim(s) of industrial microbiology.

19. List five different types of substances produced from industrial microbiology, and their applications.