UNIVERSITY OF SWAZILAND

Faculty of Health Sciences
Department of Environmental Health Science

DEGREE IN ENVIRONMENTAL HEALTH SCIENCE

MAIN EXAMINATION PAPER 2021

TITLE OF PAPER	:	INTRODUCTION TO MICROBIOLOGY AND IMMUNOLOGY
COURSE CODE	:	EHS127
DURATION	:	2 HOURS
MARKS	:	100
INSTRUCTIONS	:	READ THE QUESTIONS & INSTRUCTIONS CAREFULLY
	:	**QUESTION ONE IS COMPULSORY,** THEN ANSWER ANY OTHER THREE QUESTIONS
	:	EACH QUESTION **CARRIES 25** MARKS.
	:	WRITE NEATLY & CLEARLY
	:	NO PAPER SHOULD BE BROUGHT INTO THE EXAMINATION ROOM.
	:	BEGIN EACH QUESTION ON A SEPARATE SHEET OF PAPER.

DO NOT OPEN THIS QUESTION PAPER UNTIL PERMISSION IS GRANTED BY THE INVIGILATOR.

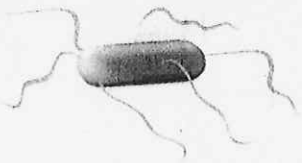
QUESTION 1 COMPULSORY – ALL STUDENT MUST ANSWER THIS QUESTION

a. **MULTIPLE CHOICE**: Indicate your responses to the items this question by writing the letter corresponding to your chosen answer. (20)

i. Humans use bacteria in all of the following ways EXCEPT to:
   A. clean up small oil spills
   B. make butter and cheese
   C. recover minerals from the ground
   D. synthesize drugs
   E. break down organic waste during water treatment processes

ii. Which one of the scientists below suggested that the nucleus was a structure of important function in the cells of microorganisms following observation of its presence in almost all cells of microorganisms?
   A. Robert Hooke
   B. Robert Brown
   C. Theodore Schwann
   D. Mathias Schleiden
   E. Anton van Leeuwenhoek

iii. Shown below is the structure of a bacterium showing a type of arrangement of flagella.



This type of arrangement is called:
   A. Monotrichous
   B. Lopotrichous
   C. Amphitrichous
   D. Peritrichous
   E. Amphilophotrichous

iv. Which one of the cells below are responsible for the processing and presentation of foreign antigens to phagocytic cells during an immune response?
   A. Neutrophils
   B. Eosinophils
   C. Dendritic cells
   D. T – helper cells
   E. Natural Killer cells

v. An exaggerated or inappropriate immune response may lead to various hypersensitivity disorders (Type I, II, III or IV). Which one of the following disorders results from Type II hypersensitivity?
   A. Asthma
   B. Blood transfusion reaction
   C. Rheumatoid arthritis
   D. Allograft rejection
   E. Systemic lupus erythematosus (SLE)

vi. Which of the two stains below are used as primary and secondary stains during endospore staining?
   A. Crystal violet and safranin
   B. Malachite green and safranin
   C. Carbol-fuschin and methylene blue
   D. Methylene blue and safranin
   E. Crystal violet and nigrosine stain

vii. What is the dilution factor if 2 mL of a stock solution is added to 38 mL of diluent?
   A. 1:9
   B. 1:20
   C. 1:18
   D. 1:40
   E. 1:200

viii. Study the diagram of the bacterial colony shown below:

The bacterium is likely to be:
   A. *Staphylococcus aureus*
   B. *Streptococcus pyogenes*
   C. *Nesseria gonorrhoea*
   D. *Treponema pallidum*
   E. *Bacillus antracis*

ix. Who accidentally identified the antimicrobial action of penicillin?
   A. Robert Koch
   B. Louis Pasteur
   C. Alexander Fleming
   D. Edward Jenner
   E. Joseph Lister

x. Of the following, which is the least likely to be involved in cell-mediated immunity?

A. antibodies
B. cytokines
C. macrophages
D. T cells
E. Neutrophils

b. Write **T** (for true) or **F** (for false) to indicate your responses to each item in this question. (5)

i. Archaeabacteria are useful in water treatment plants
ii. Rickettsia, like viruses are obligate intracellular parasites
iii. The best primary stain used to identify *Mycobacterium tuberculosis* is the crystal violet stain
iv. Bacteria are microorganisms capable of growing and multiplying in practically all ecologic environments
v. Enterferons are substances that kill infecting viruses but have no effect on bacteria

[25 marks]

QUESTION 2

a. During investigation of bacteria, negative staining may be conducted to characterise bacterial capsules.

i. Of what benefit is the capsule to the bacterial cell? (7)
ii. Explain what you understand by the phrase 'negative staining'. (2)
iii. Name one dye used during negative staining of bacteria containing capsules. (1)
iv. Explain why negative staining is conducted for bacteria containing capsule instead of using basic or acidic dyes? (2)

b. Three types of endospores are commonly identified during staining of bacteria containing endospores.

i. Write down TWO genera of bacteria commonly found containing endospores. (2)
ii. Describe these three types of endospores. (3)
iii. Describe the staining technique used to differentiate endospores from the vegetative cells of bacteria. (4)

b. The gram-staining technique is never used to identify *Mycobacterium tuberculosis* in a patient sputum sample.

i. Explain why the gram-staining technique is never used to determine infection of patients of tuberculosis. (2)
ii. Name the staining technique and the stain commonly used to identify *Mycobacterium tuberculosis* from a patient sputum sample. (2)

[25 marks]

QUESTION 3

a. Define the following terms as used in Microbiology:
   i. Pathogenicity (2)
   ii. Virulence (2)
   iii. LD_{50} (2)

b. A laboratory technologist wants to determine whether a gram-positive bacteria is present in a patient's sample. He decides to fix the bacteria before staining.
   i. What purpose is served by fixing the bacteria before staining? (3)
   i. Outline the staining procedure the laboratory technologist has to follow to reach a conclusion. (5)
   ii. If the bacteria was gram-negative, what difference would the laboratory technologist expect in order to assist its viewing. (2)

c. A microbiologist wants to visualize *Mycobacterium tuberculosis* cells in a sample of a host sputum to determine if infection is present.
   i. Explain why these steps are chosen as opposed to those chosen by the laboratory technologist in b(i)?. (4)
   ii. What colour will the *Mycobactrium tuberculosis* show when successfully visualized in the method suggested in (i) above. (1)
   iii. Name one other bacterium that may be identified using the same procedure and reagents? (1)
   iv. Treatment for *Mycobacterium tuberculosis* infection requires a long and laborious method compared to enteric bacteria such as *Salmonella typhi*. Explain why the difference. (3)

[25marks]

QUESTION 4

a. Viruses are simple microorganisms, containing both DNA and RNA molecules. TRUE OR FALSE (1)
b. The Human Immunodeficiency virus (HIV) and the Coronavirus type 2 (SARS CoV-2) are two viruses responsible for the two pandemics currently resulting in new cases and thousands of deaths globally. Copy and complete the two columns on the right of the table below with appropriate information for each virus:

Property	HIV	SARS CoV-2
i. What is general shape of the virus? (2)	•	•
ii. Name one natural reservoir of the virus (2)	•	•
iii. Describe one method of transmission from the natural reservoir to humans (2)	•	•

iv. Describe one common method of transmission from infected persons to susceptible human hosts? (4)	•	•
v. Name the host cells that the cells enter and multiply inside. (2)	•	•
vi. Describe the methods of recognition and attachment into host cells. (4)	•	•
vii. Discuss TWO methods you would recommend to prevent human-to-human transmission of the virus. (8)	•	•

[25 marks]

QUESTION 5

a. A healthy adult is walking on a dusty street on a winter day and suddenly has mucous continuously running down his nose.
   i. Do you think the adult is ill? Explain? (2)
   ii. Explain what purpose is served by the mucous secreted? (6)

d. Explain how peristalsis serves to destroy microbes that accidentally enter the body with food. (3)

e. Dendritic cells serve important immunologic functions in bodies of healthy humans.
   i. Where are dendritic cells located? (3)
   ii. Describe the mechanism through which dendritic cells protect humans against infectious bacterial agents? (5)
   iii. What is the relationship between dendritic cells and lymphadenitis? (3)

f. Other immune cells that perform the same function as dendritic cells are the Kupffer cells.
   i. Where are Kupffer cells located? (1)
   ii. Briefly describe the function of Kupffer cells. (2)

[25 marks]

QUESTION 6

a. Explain what you understand by the term "antibody". (2)
b. What cells produce antibodies? (1)
c. What is the importance of antibodies in the immune response? (5)
d. A child receives two doses of the oral polio vaccine at birth and at 6 months. Draw and label the antibody responses likely to be elucidated in the blood of the child following receipt of these doses. (6)
e. Antibodies also prevent pathologic effects of toxins. Explain how antibodies achieve this. (2)
f. Interferons are an important class of cytokines that are important in the immune response to viruses.
   i. What cells secrete inteferons? (1)
   ii. List THREE functions of inteferons. (3)
g. Explain what immunological memory is and how it is effected following encounter with a pathogen that has not been encountered before. (5)

[25 marks]