UNIVERSITY OF SWAZILAND

FACULTY OF HEALTH SCIENCES

MAIN EXAMINATION PAPER – MAY, 2015

TITLE OF PAPER	:	INTRODUCTION TO MICROBIOLOGY AND IMMUNOLOGY
COURSE CODE	:	HSC 105
TIME	:	2 HOURS
MARKS	:	100

INSTRUCTIONS	:	ANSWER **QUESTION 1** AND **ANY THREE** QUESTIONS
	:	EACH QUESTION CARRIES 25 MARKS
	:	NO FORM OF PAPER SHOULD BE BROUGHT INTO NOR TAKEN OUT OF THE EXAMINATION ROOM
	:	BEGIN THE ANSWER TO EACH QUESTION ON A SEPARATE SHEET OF PAPER
	:	CALCULATORS MAY BE USED BUT THEY MUST BE THE SILENT TYPE
	:	ALL CALCULATIONS/WORK-OUT DETAILS SHOULD BE SUBMITTED WITH YOUR ANSWER SHEET

This question paper consists of 8 printed pages including this one

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QUESTION 1 (All students must answer this question)

a. **MULTIPLE CHOICE**: Write the letter corresponding to your chosen answer among the options provided for each question. (20)

i. Bacterial cells are essentially different from eukaryotic cells in that:
   A. bacterial cells have no nuclear envelope while eukaryotic cells have a nuclear envelope
   B. bacterial cells have cell walls which eukaryotic cells do not have
   C. bacterial cells do not need energy productions while eukaryotic cells have mitochondria for production of all the energy they need
   D. bacteria are single-cellular while eukaryotes are all multi-cellular organisms
   E. bacterial cell genetic material consist of RNA while eukaryotic cell genetic material consists of DNA

ii. Which one of the scientists below is reknown for his contribution to the development of the taxonomy of organisms used today?
   A. Charles Darwin
   B. Carolus Linnaeus
   C. Antony Van Leuwenhoek
   D. Hans Christian Gram
   E. Elie Metchnikoff

iii. The safranin stain, which is used to identify gram-negative bacteria is never used to identify *Mycobacterium tuberculosis*. The reason safranin is never used is because:
   A. *M. tuberculosis* is a gram-positive bacteria
   B. *M. tuberculosis* grows very slowly during culture
   C. *M. tuberculosis* lacks a cell wall for retention of the safranin stain
   D. *M. tuberculosis* is not gram-variable i.e. neither gram-positive nor gram-negative
   E. *M. tuberculosis* is killed immediately during the staining process before it can be coloured by the safranin stain

iv. Which one of the factors listed below DOES NOT influence microbial growth?
   A. oxygen
   B. temperature
   C. pH
   D. availability of moisture
   E. characterics of other organisms present in the culture

v. Consider the gases listed below:
   H_2S, CO_2, NH_3, H_2
   Which one of the statements about autotrophic bacteria is true?
   A. Autotrophic bacteria require all the gases to grow and multiply
   B. Autotrophic bacteria require only ~~CO_2 as~~ a source of their carbon and not the other three gases

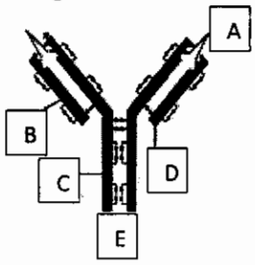
C. Autotrophic bacteria require either H_2S, or NH_3 or H_2 and CO_2 in order to grow and multiply
D. Autotrophic bacteria require only H_2 as a source of hydrogen and not the other gases
E. Autotrophic bacteria do not require all the gases because they can synthesize their own food from organic compounds

vi. One of the fungal infections below is found in soil and sometimes enters the feet of humans through small cuts or abrasions resulting to sepsis or "watering foot". Which one is it?
A. Candidiasis
B. Mycetoma
C. Aspergillosis
D. Chromoblastomycosis
E. Sporotrichosis

vii. A laboratory technologist performs analysis of blood from an infected patient and identifies a large number of cells similar to the one shown belhrow.

The type of cell shown is a:
A. basophil
B. eosinophil
C. neutrophil
D. T lymphocyte
E. Macrophage

viii. Shown below is a diagram of an immunoglobulin. Which of the sites marked A – E is recognises and binds to foreign organisms?



ix. Which one of the following molecules are important in fighting and killing viruses in the body of man?
A. Lysozymes
B. Inteferon gamma
C. Lactoferrin
D. Macrophages

E. Immunoglobulin E

x. A group of cells among the granulocytes are important in killing large microbes such as worms outside the cells following release of microbicidal contents into the immediate environment. The cells are likely to be:
   A. microphages
   B. B cells
   C. T cells
   D. neutrophils
   E. eosinophils

b. Write **T** (for true) and **F** (for false) for each of the following statements: (5)
   i. The electron microscope always operates in a vacuum and specimens must be dead
   ii. Some bacteria are used to make antibiotics
   iii. A microorganism that has a LD_{50} of 1000 is 100 times more virulent that one with an LD_{50} of 10
   iv. Natural Killer (NK) cells are important in destruction of infecting bacteria inside the bodies of humans
   v. Insulin-dependent diabetes mellitus is a condition that may arise in association with a certain immunologic disorder.

[25 marks]

QUESTION 2

a. Not all bacteria are pathogenic to human beings, some are used in industries for major contributions to human life. List THREE uses of bacteria in industries. (3)
Some industries use bacteria to:

b. A woman wants to purchase milk from the local supermarket and finds two types: one labelled "UHT" (in cartons) and another labelled "Pasteurised Milk" in plastic bottles.
   i. What is the difference between the UHT and Pasteurised Milk? (2)
   ii. What is the advantage of the UHT milk compared to the Pasteurised milk with respect to preparation prior to adding the two types of milk in the container (prior to packaging)? (2)
   iii. What is the advantage of the Pasteurised milk over the UHT milk? (2)

c. A great Scientist, Robert Koch (1876), followed Louis Pasteur and made significant contributions towards proving Louis Pasteur's theories by establishing procedures that later became known as Koch's postulates. Write down the FOUR postulates that Robert Koch established and each time include the exceptions that were later established to each postulate. (16)

[25 marks]

QUESTION 3

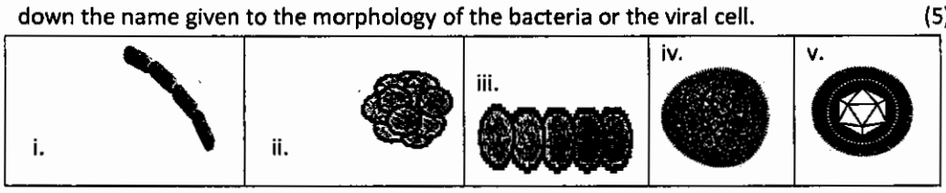
A laboratory technician prepares to culture a sample from a patient. He uses a wire loop and heats it over a Bunsen burner for a few seconds before briefly cooling and then inoculating the medium with the sample in a petri dish. He then tightly closes the petri dish and transfers it into an oven. He leaves it in the oven for 48 hours after which he uses a wire loop heated over a Bunsen burner again to remove a small sample from the culture and place it on a microscope slide to identify any microorganisms that may have grown in the culture.

a. Discuss TWO features of a safety cabinet that makes it suitable for the laboratory technician to work under. (4)
b. Explain why it is important for the laboratory technician to heat the wire loop before transferring the sample to the culture medium? (3)
c. Why does the laboratory technician allow the wire loop to briefly cool? (2)
d. Explain why the laboratory technician heats the wire loop again before using it to transfer a sample of the culture onto a microscope slide? (2)
e. Why is it important for the laboratory technician to view the growth after 48 hours and not maybe after 2 weeks when he has more time? (4)
f. Other instruments commonly used by microbiologists during study of bacterial and viral cell morphology include the light and electron microscope.
   i. Which one of the two microscopes is used to study viral cells. Give a reason for your answer. (2)
   ii. List TWO similarities between the light microscope and the electron microscope. (4)
   iii. List TWO main differences in the construction and operation between the light and the electron microscopes. (4)

[25 marks]

QUESTION 4

a. Shown below are structures of bacterial and viral cells. Examine each structure and write down the name given to the morphology of the bacteria or the viral cell. (5)



b. Besides morphology, bacteria can be identified using the staining technique originally developed in the 17th century by one scientist. Outline the FOUR steps followed during the staining process developed by this scientist, also explaining how the different types of bacteria may be determined through the results. (6)
c. Microbistatic and bacteriostatic agents are sometimes used to control the growth of microorganisms.
   i. What are microbistatic agents? (2)
   ii. What are bacteriostatic agents? (2)

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iii. Give TWO examples of microbistatic agents commonly used to control growth of microorganisms. (2)

iv. A woman defrosts meat, cuts part of it for cooking and then returns the rest back to the freezer. Explain why this is not a good practice. (3)

d. The Human Immunodeficiency virus (HIV) requires one type of cells for replication.

i. Name the human cells inside which HIV replicates. (1)

ii. Describe the process of entry of the HIV into the cells mentioned in (i) above. (2)

iii. What is the importance of reverse transcriptase in the replication cycle of HIV? (2)

[25 marks]

QUESTION 5

a. Briefly discuss the concepts developed by Louis Pasteur in relation to immunology. (5)

b. Antibodies form an important part of the humoral immunity against infecting microbes.

i. Explain what antibodies are. (2)

ii. Describe how antibodies facilitate recognition of antigen and activation of phagocytic cells of the immune system. (4)

iii. When the same antigen enters the body of a host in future, memory T cells induce development of antibodies that respond to this specific antigen. Outline the steps through which these antibodies respond and inactivate the re-infecting antigen. (6)

c. A microbiologist performs a blood analysis and counts about 800 of the nucleated immune cells shown below per mm^3 of blood. The granules of the cell are found to stain red with a particular stain used for leukocytes.

i. What is the name of this cell? Explain your answer. (2)

ii. What interpretation would the microbiologist make from the number of cells counted? (2)

iii. What is the function of these cells? (4)

[25 marks]

QUESTION 6

a. Certain chemical barriers form the first line of defence against infecting microbes in the human body. Explain how the following chemical produce defence against microbes:
   i. Lactoferrin (2)
   ii. Defensins (2)
   iii. Peroxidase enzymes (2)

b. List TWO body fluids from which each of the chemicals below is secreted:
   i. Lactoferrin (2)
   ii. Peroxidase enzymes (2)
   iii. Lysozyme (2)

c. Define the following immunology terminologies as discussed in immunology lessons, citing example in each case.
   i. Immunization (1)
   ii. Type IV Hypersensitivity (3)
   iii. Passive artificial immunization (3)

d. Cell-mediated immunity consists of three stages.
   i. Mention the three stages of the cell-mediated immunity. (3)
   ii. Dendritic cells are involved in cell mediated immunity because they possess three types of receptors they use to identify foreign antigens. Name the three types of surface receptors found on the dendritic cells. (3)

[25 marks]