

## SESSION 8: VIRUSES AND BACTERIA

### Key Concepts

In this session we will focus on summarising what you need to know about:

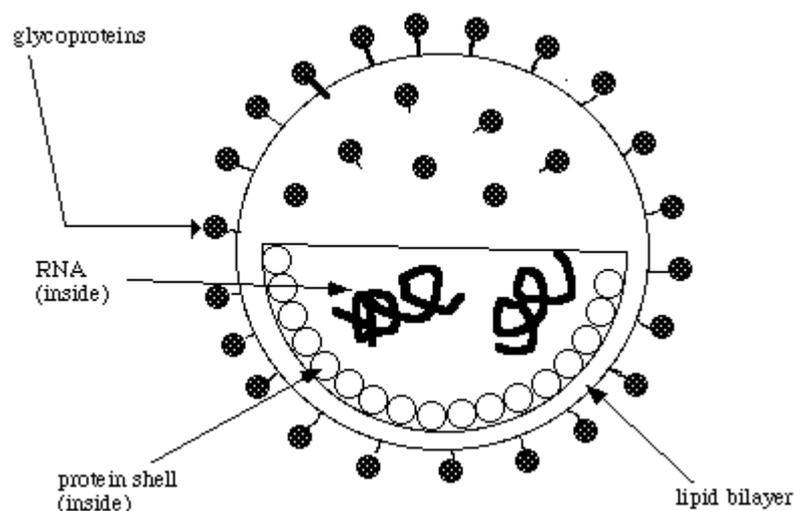
- Viruses
  - Basic structure and general characteristics
  - Diseases
  - Medical biotechnology
- Bacteria
  - Basic structure and general characteristics
  - Ecological role
  - Economic use
  - Diseases
  - Medical biotechnology

### Viruses

#### Terminology & definitions

- **Immunity:** having resistance to a particular infection
- **Micro-organisms:** organisms that can be seen only with the aid of a microscope
- **Parasite:** an organism which feeds off another living organism causing harm to that organism
- **Pathogen:** a disease causing organism
- **Prokaryote:** single-celled organism having no nuclear membrane or organelles
- **Vaccination:** artificially exposing the body to antigens to create immunity to disease

#### Key Concepts and Diagram



## X-planation

### Basic structure and general characteristics

- A virus is a microscopic organism.
- Viruses generally have a central core of DNA if they attack animals, or RNA if they attack plants.
- A protein capsule called a capsid surrounds each central core. (They are not made up of cells. They have no nucleus and no cytoplasm).
- Viruses are non-cellular; they do not feed, respire, grow, excrete or show any form of metabolism.
- They are prokaryotes; no organised nucleus.
- They only reproduce in living antiviral or plant cells.
- All viruses are **parasites** living in plants, animals or bacteria.
- Viruses are **absolutely specific** with regard to their host, i.e. a particular virus will only live on a particular host, e.g. the tobacco mosaic virus will only live within the leaves of tobacco plants; the mumps virus lives only in the salivary glands of humans.
- Viruses **cause many diseases** in plants and animals, e.g. AIDS, rabies, mumps, measles, small pox, poliomyelitis, yellow fever and the common cold.
- Viruses reproduce by transforming the host's nucleic acids into virus nucleic acids when they multiply.
- Antibiotics and other medicines are not effective against viruses since viruses are not living.
- For convenience, viruses are usually classified as Monera.
- Microbiologists observed the behaviour of viruses long before they could see them.

### Diseases

E.g. rabies, HIV/AIDS, influenza

Disease	Cause	Effects (symptoms)	Management	
			Prevention	Treatment
Rabies	Virus that can infect both humans and domestic animals (also cattle and the yellow mongoose). Rabies is carried in the saliva of the infected animal. A rabid animal must bite the victim to spread the disease. The virus then replicates and moves via the nerves to the spinal cord and then to the brain.	The infected animal first becomes nervous, irritable and aggressive. During this stage it might bite other victims and infect them. Then paralysis sets in. The animal becomes unable to swallow and may start foaming at the mouth. Then the rest of the body becomes paralysed and death soon follows. Once the symptoms begin to show, no treatment will work.	Pets must be vaccinated against rabies.	A person bitten by a dog or a wild animal must go to a hospital or clinic immediately. The wound must be cleaned and an injection against tetanus must be given.

### Medical biotechnology

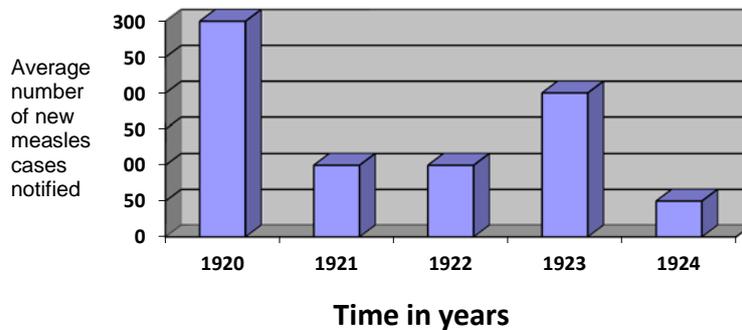
- When a person is immunised, he/she is given a weak form of virus; this causes the body to produce antibodies which remain within the person. Later, when the person is infected by the virus, the antibodies destroy the virus before they can multiply and cause disease.

## X-ample Questions

### Question 1

(Adapted from Free State, NSC, June 2011, Grade 11, Paper I, Question 2.3)

Measles is caused by a virus. Study the graph below and answer the questions that follow.



- 1.1 In which two years did the number of cases constitute an epidemic? (2)
- 1.2 Suggest a reason for the pattern of the graph from 1921 to 1923. (2)
- 1.3 Explain the information given in the graph. (2)

### Question 2

(Adapted from GDE, NSC, November 2009, Grade 11, Paper I, Question 1.5)

Read the following passage regarding flu and answer the questions that follow.

Flu, or influenza, is a highly infectious disease caused by viruses. Research has shown that there are different types of flu viruses. When you get flu, your body builds up immunity against a second flu attack from the same type of virus. However, you are not immune to any other strains of flu viruses. Flu injections, which protect against flu infections, are also not 100% effective because flu viruses are able to mutate.

Therefore, the vaccine against flu must be adapted continuously.

The flu virus strains usually differ only slightly from one year to the next. Sometimes a new viral strain develops that is different from the previous forms so that existing vaccines are not effective against it. These viruses usually cause worldwide pandemics.

- 2.1 Why is flu considered to be a highly infectious disease? (2)
- 2.2 What is the incubation period for flu? (1)
- 2.3 According to the passage “your body builds up immunity against a second flu attack”. Why can a person get flu over and over again? (2)
- 2.4 What is a pandemic? (2)

**Question 3**

(Adapted from GDE, NSC, June 2009, Grade 11, Paper I Question 1.4 )

The figures given in the table below are projections formulated by a South African life insurance company in 1998. They may differ slightly from other available figures, but they clearly show the relevant trends.

	1998	2000	2002	2004	2006	2008	2010
Adult HIV %	10.7	14.0	16.5	18.6	20.2	21.1	21.7
HIV prevalence (millions)	2.7	3.6	4.4	5.1	5.6	6.0	6.1
AIDS cases (1000s)	108	203	331	477	620	734	813
<b>AIDS deaths (1000s) Total</b>	<b>86</b>	<b>156</b>	<b>245</b>	<b>343</b>	<b>433</b>	<b>505</b>	<b>551</b>
-adults	67	125	203	291	373	437	478
-children	19	31	42	52	60	68	73
Orphans	96	217	425	734	1123	1543	1936

- 3.1 In many African countries the rate of infection is slower in the rural areas than in the urban areas. Suggest why is this not the case in South Africa? (2)
- 3.2 In 1998 HIV in fact infected approximately 3 million people. By how many cases was this projection incorrect? (1)
- 3.3 It was projected that in the year 2000 there would be 3.6 million HIV positive people in South Africa. There were, however, in fact about 4.2 million affected people in the year 2000. Does this suggest that the prevalence of HIV/AIDS is decreasing? (2)
- 3.4 How many AIDS orphans are there projected to be in South Africa in the year 2010? (1)
- 3.5 In what year is it projected that approximately half a million South Africans will die from AIDS? (1)
- 3.6 Using the information given in the above table, draw a bar graph showing the number of AIDS deaths (5)

**X-ercise**

1. Viruses are considered to be non-living because:
  - A they do not locomote.
  - B they cannot reproduce independently.
  - C they do not mutate and, therefore, cannot adapt.
  - D their nucleic acid does not code for protein.

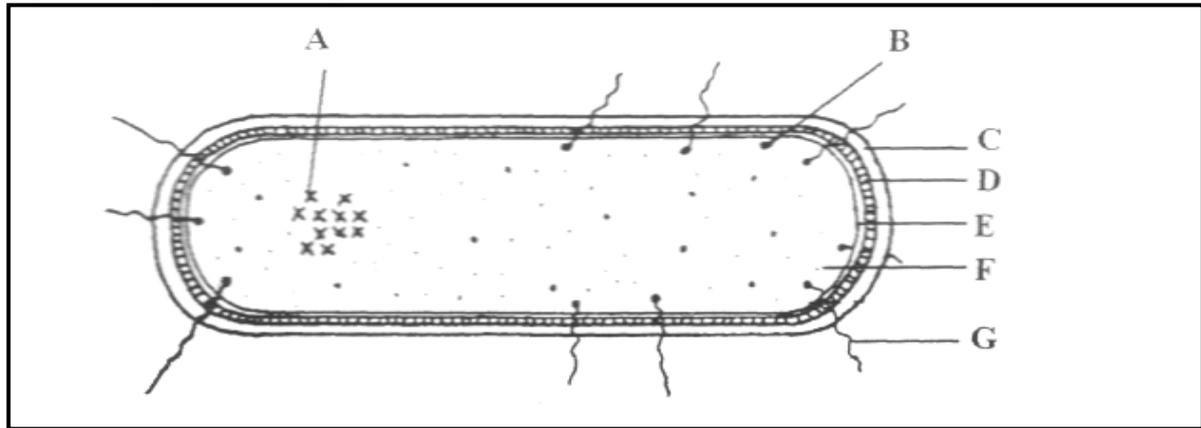
2. Viruses have a ...
  - A DNA-containing nucleus and a lipid envelope.
  - B nucleic acid core and a plasma membrane.
  - C DNA core and a protein coat.
  - D nucleic acid core and a protein coat.
  
3. Viruses are wandering genes as they.....
  - A. cause disease.
  - B. contain nucleic acid molecules.
  - C. cause common flu.
  - D. are able to escape the main action of antibiotics.
  
4. Viruses are able to reproduce
  - A. because they possess chromosome material
  - B. because they can multiply independently of a living cell
  - C. because they are symmetrical in shape
  - D. due to the presence of DNA and RNA
  
5. Viruses are biologically important because they
  - A. can photosynthesise
  - B. cause illness
  - C. transforms nitrogen into nitrates
  - D. cannot reproduce

## Bacteria

### Terminology & definitions

- **Antibiotics:** chemical substances that stop the growth of bacteria
- **Antiseptic:** a chemical used to kill bacteria
- **Decomposer:** an organism that rots/breaks down organic matter
- **Saprophyte:** organism that feeds on dead organic matter
- **Autotrophic:** having the ability to manufacture its own food
- **Mutualism:** symbiotic relationship between two organisms in which both benefit

## Key Concepts and Diagram



- A – Nucleoid
- B – Ribosome
- C – Slime capsule
- D – Cell wall
- E – Cell membrane
- F – Cytoplasm
- G – Flagellum

## X-planation

### Basic structure and general characteristics

Bacteria are very small, unicellular organisms that can only be seen with a microscope. You find them almost anywhere – in soil, air and water, and on and inside yourself and other organisms.

They have no organelles inside their single-celled bodies, and no true nucleus. They lack a nuclear membrane and their nuclear contents are not organised into chromosomes.

For this reason bacteria are known as prokaryotes.

Shapes: coccus, bacillus, spirillum and vibrio.

Structure:

- Slime capsule: protects from drying out
- Cell wall: on the outside, made up of polysaccharides, proteins and lipids
- Flagella: responsible for movement in liquid
- Cytoplasm: within the cell wall
- Plasmalemma: beneath cell wall, covers cytoplasm
- No nucleus but a nucleoid
- Ribosomes: in cytoplasm

## Ecological role

### a) The role of bacteria as decomposers in maintaining balance in the environment

- Bacteria are decomposers in the food chain.
- Bacterial decomposers are saprophytes.
- They break down the dead remains of organisms to obtain energy.
- They use some of the nutrients for themselves and some are released such as nitrates into the soil.
- As decomposers they enrich the soil and improve its fertility.
- Bacteria play an important role in the breakdown and purification of sewage.

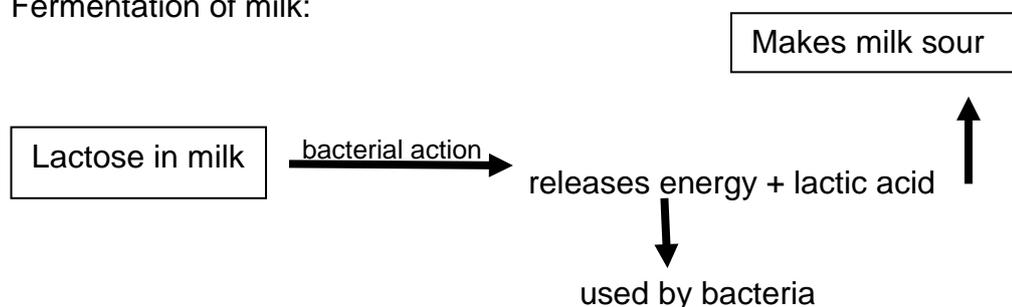
### b) The role of bacteria in symbiotic relationships

- **Nitrogen-fixing bacteria in plants**
  - Bacteria play an important role in the nitrogen cycle.
  - The bacteria in the nitrogen cycle are autotrophic.
  - They use chemicals such as nitrogen, sulphur and phosphorus as a source of energy. They convert these minerals into forms that are useful to other organisms: Toxic ammonia → nitrites → nitrates → nitrogen gas (in atmosphere)  
Nitrogen gas (in ground) → nitrates
- ***E.coli* in the human intestine**
  - Mutualistic bacteria live in the bodies of other organisms, where they obtain a habitat and food. In return they help the organism.
  - The bacterium *Escherichia coli* (*E. coli*) lives in the human intestine.
  - They produce some B vitamins as well as the vitamin K that we need for blood clotting.

## Economic use

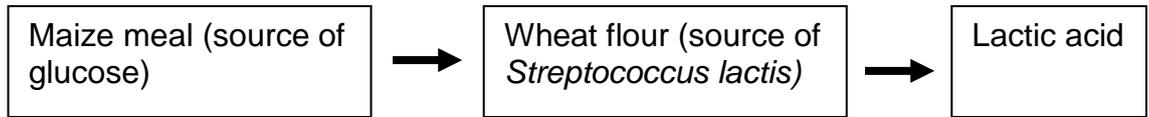
### a) Role of bacteria in biotechnology (dairy, wine and other industries)

- Fermentation of milk:



**b) Role of bacteria in traditional technology (beer, amasi)**

- Fermentation of maize meal:



**Diseases**

e.g. blight (in plants), cholera, tuberculosis, anthrax (in animals)

Disease	Cause	Effects (symptoms)	Management	
			Prevention	Treatment
Tuberculosis	Bacterial infection in humans by <i>Mycobacterium tuberculosis</i> . The bacteria usually attack the lungs.	Coughing up blood. Being short of breath. Pains in the chest. Loss of weight. Loss of appetite. Feeling tired all the time. Night sweats.	Vaccination with BCG. Compulsory for babies in SA.	Can be treated and cured with antibiotics. People with active TB are usually treated with several anti-TB drugs.

**Medical biotechnology**

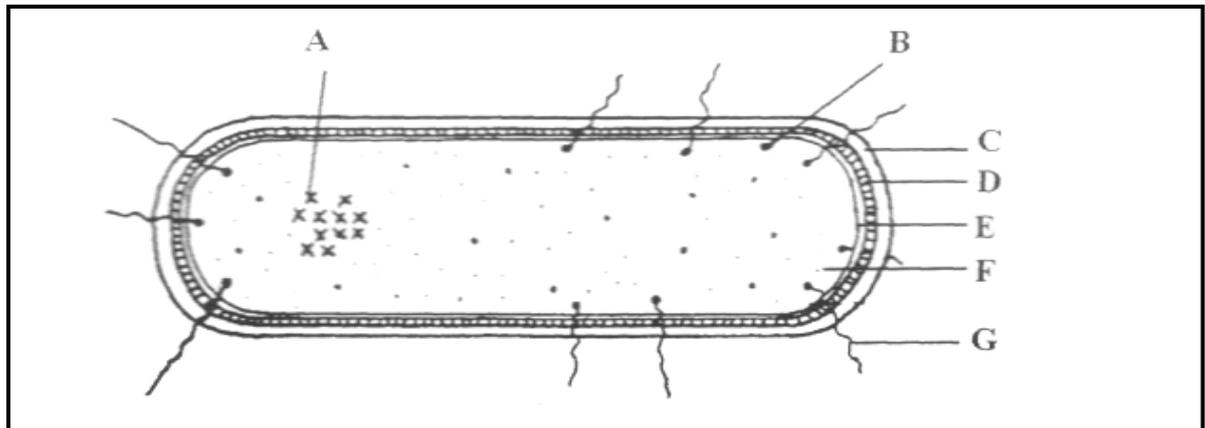
- Bacteria are often used to produce vitamins, antibiotics, proteins and hormones.
- The DNA required to produce whatever is needed is inserted into the bacteria cell.
- The bacteria cell is tricked into producing whatever is needed.
- This technique is called recombinant DNA technology.

## X-ample Questions

### Question 1

(Adapted from GDE, NSC, June 2009, Grade 11, Paper I, Question 1.5)

Study the diagram below of a bacteria cell and answer the questions that follow.

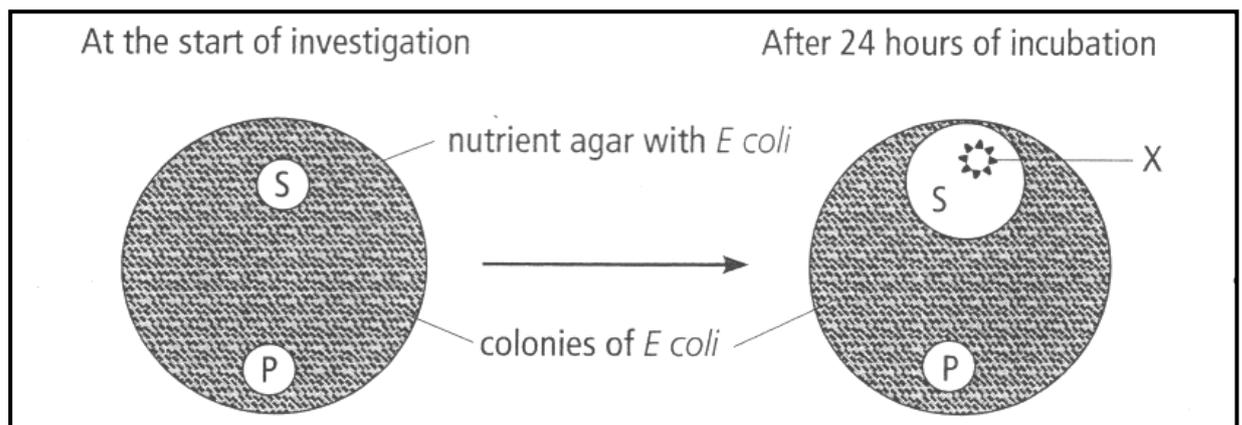


- 1.1 Provide labels for D, G and E. (3)
- 1.2 State the role played by each of part A and G. (2)
- 1.3 Suggest a reason why the disease-causing bacteria have a thick layer of the part labelled C. (2)

### Question 2

(Adapted from GDE, NSC, June 2009, Grade 11, Paper I, Question 3.1)

The diagram below illustrates an experimental design with the bacterium, *Escherichia coli* and two different antibiotics, namely streptomycin (S) and penicillin (P) with the same strength in a petri-dish.



- i) State ONE hypothesis that is being investigated (2)
- ii) State the aim of the above investigation. (2)

- iii) Describe the result/s of this investigation. (2)
- iv) State ONE conclusion from the results of this investigation. (2)
- v) Why is it necessary to incubate the petri-dish? (2)
- vi) X represents a colony of bacteria. Explain the presence of this colony near the streptomycin disc. (2)

**Question 3**

(Adapted from GDE, NSC, June 2009, Grade 11, Paper I, Question 4.1)

TB patients are usually required to take medication every day for a long period of time (usually six months). Many patients do not take their medication for the full period prescribed by the doctor or health worker.

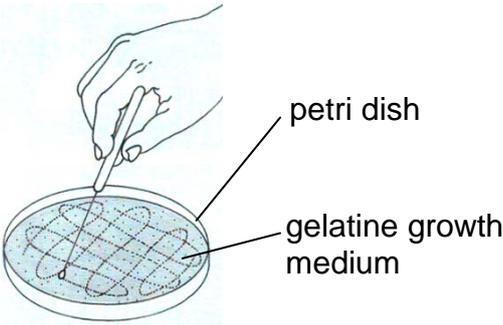
- 3.1.1 State TWO reasons why patients stop their medication early. (2)
- 3.1.2 What are the dangers of not taking the medication for the full prescribed period? (2)
- 3.1.3 Name the programme that uses community workers to help patients take their medicines regularly. Besides helping patients take their medicines regularly, the programme has one other main advantage. What is this advantage? (2)
- 3.1.4 Many of the symptoms of TB are similar to those of other diseases. Therefore, other tests may have to be done to find out whether or not a person has TB. Name THREE of these "other" tests. (3)

**Question 4**

(Adapted from NW, NSC, Nov. 2010, Grade 11, Paper I, Questions 3.2 and 3.3)

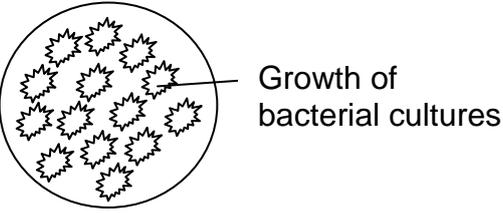
Tuberculosis is a contagious lung disease caused by *Micobacterium tuberculosis*. A biotechnologist investigates the effectiveness of antibiotics on the treatment of tuberculosis (TB) and follows the steps shown below. Study the diagrammes and answer the questions that follow;

**STEP 1**  
The biotechnologist places a sample of the bacteria collected from a TB patient onto a growth medium.



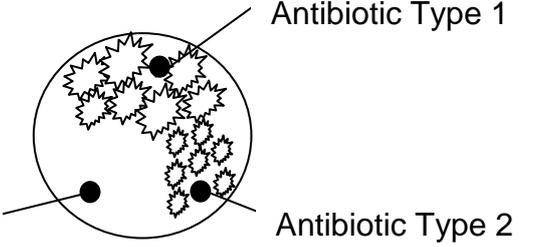
petri dish  
gelatine growth medium

**STEP 2**  
The petri dish is sealed and placed at the correct growth conditions for a few days.



Growth of bacterial cultures

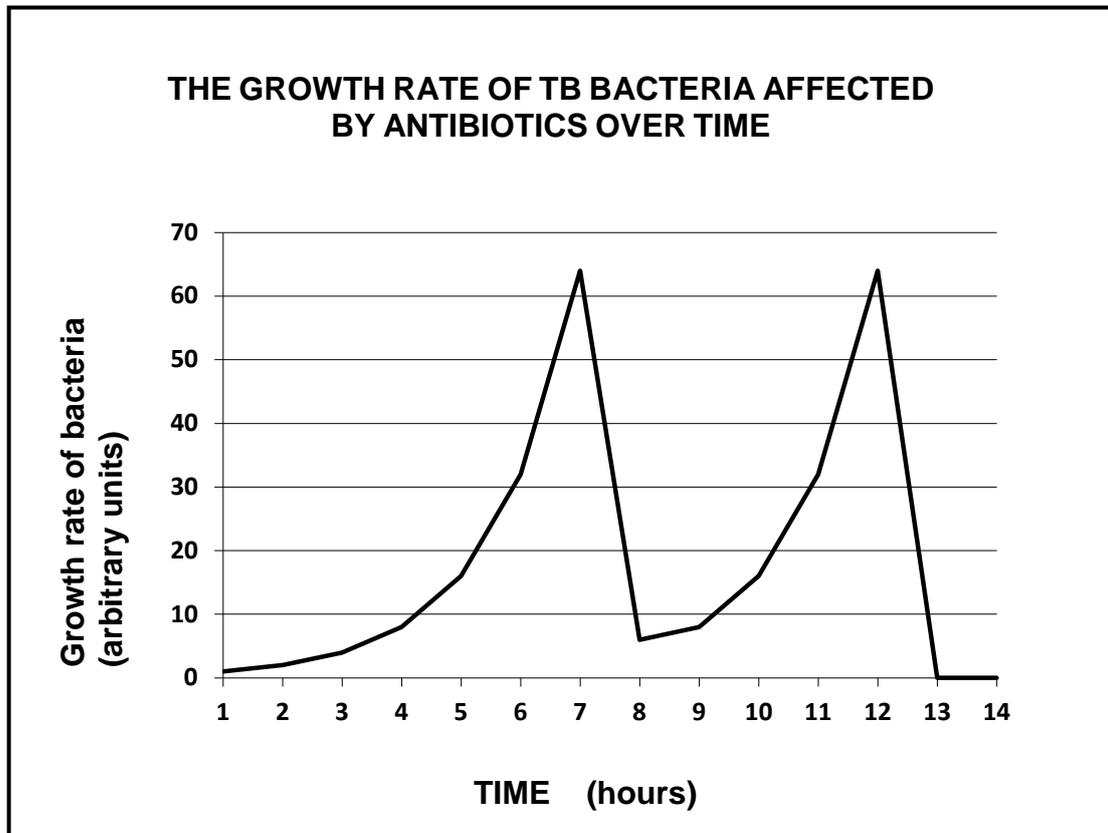
**STEP 3**  
The biotechnologist places three types of antibiotics on disks and places it onto the bacterial colony for a few days.



Antibiotic Type 1  
Antibiotic Type 2  
Antibiotic Type 3

- 4.1.1 Name TWO precautions taken by the biotechnologist during this experiment. (2)
- 4.1.2 Study the results in STEP 3. Write down THREE observations. (3)
- 4.1.3 What is your conclusion after studying the results? (1)

4.2 The biotechnologist mentioned in Question 4.1.1 above did further experiments on the effectiveness of antibiotics on the growth rate of tuberculosis bacteria. He tabulated his results and converted it into a graph. Study the graph and answer the questions that follow.



- 4.2.1 At which points on the graph did the researcher place the antibiotics on the bacterial colonies? (3)
- 4.2.2 Describe the growth rate of TB bacteria during the first 7 hours. (2)
- 4.2.3 Name TWO reasons why it was necessary to place the antibiotic onto the bacterial colonies a second time? (2)
- 4.2.4 What recommendations can this researcher give in his report? (2)
- 4.2.5 How can this researcher make his results more reliable? (2)
- 4.2.6 Do you think there is a possible link between HIV and TB? Give reasons for your answer. (3)

## X-ercise

1. Bacteria in the soil are of great importance because they
  - A. act on organic wastes breaking them down into inorganic material.
  - B. act on nitrates breaking them down into nitrogen.
  - C. live parasitically on the roots of legumes.
  - D. convert nitrates to ammonia.
  
2. Bacteria are ...
  - A unicellular and parasitic in plants and animals.
  - B unicellular and without a nucleus.
  - C microscopic plants with a saprophytic mode of nutrition.
  - D unicellular with a nucleus and parasitic in plants and animals.
  
3. Many people in rural areas get cholera after heavy rains or sudden floods because of .....
  - A. contamination of drinking water.
  - B. increase of mosquitoes.
  - C. swimming in the river.
  - D. the number of viruses in water.
  
4. Which statement is **incorrect** regarding reproduction in bacteria?
  - A It takes place under favourable conditions.
  - B It begins with the duplication of the nucleic acid.
  - C Colonies of bacteria are formed.
  - D Sexual reproduction often takes place.