TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED AND HEALTH SCIENCES

DEPARTMENT OF PURE & APPLIED SCIENCES

UNIVERSITY EXAMINATION FOR:

BACHELOR OF TECHNOLOGY IN MICROBIOLOGY AND BIOTECHNOLOGY

AAB 4401: APPLIED MICROBIAL ECOLOGY

SPECIAL/SUPPLEMENTARY EXAMINATION

SERIES: SEPTEMBER 2018

TIME: 2HOURS

DATE: Pick DateSep2018

Instructions to Candidates

You should have the following for this examination

Answer Booklet, examination pass and student ID

This paper consists of **FIVE** questions. Attemptquestion ONE (Compulsory) and any other TWO questions.

Do not write on the question paper.

Question ONE

a) Explain the benefits of using bio-fertilizers over petrochemical based fertilizers. (5mks)

b) Discuss the symbiotic relationship between ectomycorrhizal fungi and trees. (5mks)

c) Explain the roles of biosensor components. (4mks)

d) State five reasons why microbial mining is gaining popularity today. (5mks)

e) Describe direct leaching approach used by some bacteria in biomining. (6mks)

f) List down five optimal conditions for biogas production. (5mks)

Question TWO

a) What is a microbial control agent? (2mks)

b) Discuss *Bacillus thuringiensis* under the following sub-topics:

i) Toxin production (2mks)

ii) Mode of action of toxins (14mks)

iii) Disadvantages of using *Bacillus thuringiensis*. (2mks)

Question THREE

Discuss the use of the following as biosensors:-

i) Enzymes (10mks)

ii) Antibodies (10mks)

Question FOUR

a) List the major aims of sewage treatment. (3mks)

b) Discuss the use of oxidation ponds in sewage treatment. (17mks)

Question FIVE

Describe biogas production using batch digester. (20mks)

Marking scheme

MARKING POINTS IN BOLD

Question ONE

a) Contain a wide **range of naturally chelated plant nutrients** and trace elements. Contain **growth promoting substances**. Act as **soil conditioners** by stimulating microbial activity by increasing air water relationships. Makes **soil less prone to compaction and erosion**. Makes **crops resist environmental stress**

b) Fungi forms **a sheath round the root tip**. It gains **carbon and other organic substances** from the tree. In return the plant is helped to **get water, mineral salts and metabolites**. The fungus also helps the **plant fight off parasites, predators and pathogens**. The plants are also able to **grow well in areas of poor soil fertility.**

c) Biosensors are made up of a **biological component** which can be an **enzyme or antibody** and an **electronic device (transducer**). The transducer is able to **convert the biological signal into a measurable output**. The **biological part reacts with a particular substance of interest (an analyte)** to produce **a physical or biochemical change** that is **detected and converted into an electrical signal by the transducer**. An **amplifier is then used to increase the intensity** of the signal to a level that **can easily be measured.**

d) Continued **depletion of high grade mineral** resources, Mining is being **extended deeper underground**, growing **awareness associated with environmental** problems, **problems of burning fossil fuels**, **costs of conventional recovery methods**.

e) The bacteria use **enzymes to attack minerals that are susceptible to oxidation.** The bacteria **cause electrons to be transferred from iron or sulphur to oxygen**. The **more oxidized compound formed is more soluble**. However, **inorganic ions never enter the bacteria cell** but instead the **electrons released by the oxidation reaction are transported through a protein system in the cell membrane**. These electrons **give up energy which is coupled to the formation of ATP**.

f) There should be no oxygen. (ii) Optimum temperature is 15-35 ^{0} C. (iii) Water should comprise about 90% of slurry weight. (iv) Neutral or mildly alkaline conditions. (v) C:N ratio should be 25:1 to 30:1.

Question TWO

a) This is the use of a **microbe alone or together with their toxic products** to **control pests/** Use of **entomopathogenic microbes** and or their products **to cause death to insect pests**.

b) Bacillus thuringiensis

i) Toxin production- The bacteria produces two toxins. **Delta endotoxin** and **theta exotoxin.**

ii) Mode of action. Delta endotoxin is associated with a **parasporal which is protoxin**. It becomes **toxic only when digested** and broken down into smaller particles **in the gut of lepidopterans**.

This is because the gut of lepidopterans have the **correct conditions (alkaline pH, salt concentration and presence of proteolytic enzymes**. The small fragments **bind on the surface of the mid-gut** where they increase permeability and **cause gut paralysis.** It takes about **60 minutes to kill the larvae**. The larvae must however **eat the bacteria with the food**. Toxicity varies with **the strain of Bt used** and the **fermentation conditions**.Theta exotoxin is **thermostable**. It can survive in an autoclave for 10 minutes at a temperature of 121^0C. It is **active against a wide range of insect species**. It acts by interfering with the **production of DNA dependent polymerase** leading to **deformed larvae**.

iii) Its application is **affected by environmental factors like UV light** and solar radiation. It **does not establish persistence spreading infectious population** and therefore **behaves like a chemical**.

Question THREE

Biosensors:

i) Enzymes:- Are **biological catalysts** which are **capable of recognizing a particular target analyte in a specific way**. It attaches itself to the analyte and **converts it to a chemically different product**. The new product is usually something that **can be detected easily** eg a substance that **emits light**. An example of such an enzyme **is luciferase** which occurs naturally in fireflies and is **responsible for their glow**. The enzyme **reacts with the compound luciferin in the presence of oxygen and ATP to make oxyluciferin** which is **chemically different product that emits light**. This reaction is used in a number of commercially **available biosensors eg to detect toxicity or bacterial contamination.**

ii) Antibodies:- These are **proteins produced by the immune system** of living organisms in **response to the presence of foreign proteins**. Unlike enzymes, antibodies don't catalyze reactions but **recognize and bind to specific molecules.** Generally they **can be tailored and produced for the detection of specific industrial substances eg. Benzene**. In an immunosensor, **antibodies are immobilized onto the surface of a transducer** where they form a **coating**. The transducer **measures the binding of the antibodies to the target analyte** by either a tiny **change in mass or a change in the optical properties**. This change can **be quantitative allowing the concentration of the target substance to be determined.**

Question FOUR

a) The major aims of sewage treatment are:- To **reduce organic matter**, **reduce human pathogens**, **remove toxic chemicals** where possible.

b) Oxidation ponds:- These are **shallow ponds 3-6 feet deep which receive sewage water**. They depend on **natural diffusion of air** from the atmosphere for oxidative process. They therefore have **long retention period**. Are common in developing countries. There are four ponds: **Anaerobic pond**- this is where **anaerobes work on organic matter eg. Methanogenic bacteria**. The pond therefore acts **as a septic tank**. **Facultative pond:-** BOD is removed by both **aerobic and anaerobic organisms**. Aerobic works in the upper layers of water while anaerobic

are found in the **lower layers**. **Algae also grow upto where light penetrates up** to which is important as it **provides oxygen**. **Aerobic ponds**:- Contain only aerobic microbes. **Water is clear**. Most of the oxygen diffuse from the atmosphere. **Teriary pond**:- Characterised by **little algae growth**. Water is clear. The major event is **chemical treatment to remove phosphates as precipitate of calcium and iron**. Nitrogen salts are also removed accompanied by **chlorination to get rid of pathogenic microbes**. Water is then released to the natural water system. At the point of release a bacteria called **Sphaerotilus natans which is fungal like with a slimy mycelia grows indicating rich water.**

Question FIVE

Any size of a container can be used. The most common however is **200L metal drum** with a **large and a small threaded holes at the top**. The drum should be in a good shape and able **to seal with no leaks**. The larger hole can be used for **filling the drum with slurry and then it is capped**. The small hole is used as a **gas outlet**. The drum should be **cleaned well with soapy water especially if it contained a petroleum product**. It is then rinsed and allowed to dry. A **shut off valve and a gas line should be connected to the small threaded hole**. The other end of the gas line is **connected to a gas collector**. Once the drum's gas line and gas collector are prepared, the **drum is filled almost to the top with slurry and then sealed**. When the unit starts producing biogas, the **gas should be released for the first one week** before trying to use it to ensure that there is **no air left in the system**. This is critical because **oxygen mixed with methane can be dangerous if ignited**. Once sealed, a **batch digester can produce biogas for several months**. Within the digester, most **microbial activity takes place near the surface** of the slurry and therefore **periodical agitation of the** digester should be done to mix the slurry hence improve the effectiveness of the microbes. Once the unit is no **longer producing gas, it should be emptied** and refilled with fresh slurry. The **old slurry can be used as a fertilizer** but a small **amount can be added to the fresh slurry** to help it start faster.