MARKING GUIDE
P530/2
BIO

SECTION A (40 MARKS)

1. The figure 1 below shows the effects of non-competitive and competitive inhibitors on the rate of an enzyme catalysed reaction. Also included in the experiment is the rate of the enzyme when there is no inhibitor. Temperature of the reaction was maintained constant at optimum. Study the figure and answer the questions that follow.

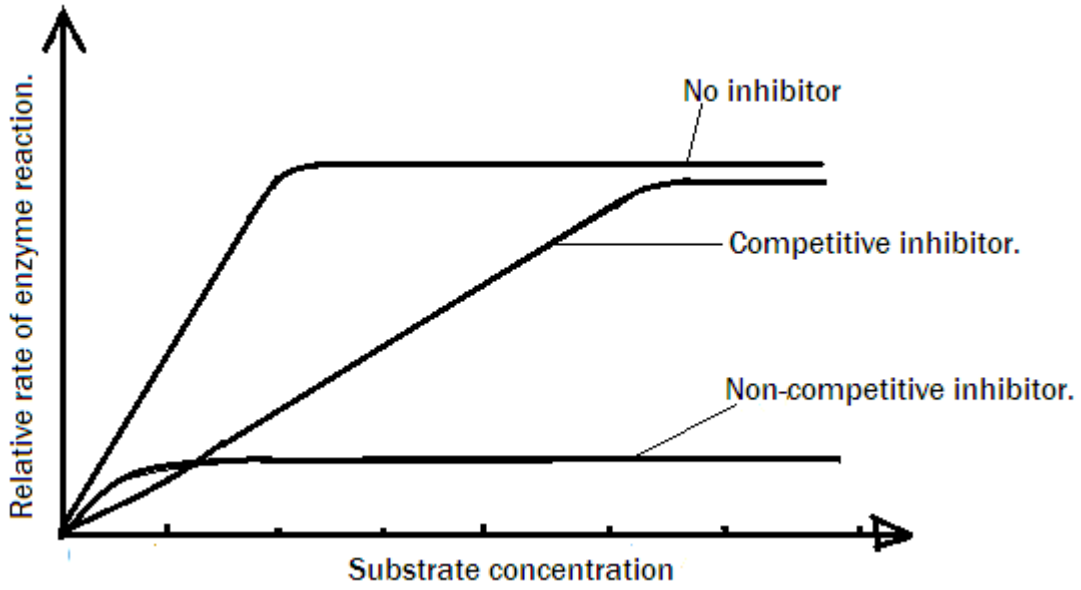

Figure 1.

(a)Compare the rate of enzyme reactions for competitive and non-competitivee inhibition at varying substrate concentration. **(09marks)**

Differences in the rate of enzyme reactions under,

Competitive Inhibition,	**Non-competitive Inhibition,**
- Is lower at lower substrate concentration at the start, - Is higher at moderate and higher substrate concentration, - Increases rapidly with increase in substrate concentration towards and in the middle,	- Is higher at lower substrate concentration at the start ; - Is relatively lower at moderate and higher substrate concentration ; - Remains constant with increase in substrate concentration towards and in the middle ;

- Reaches its maximum at higher substrate concentration, - Increases gradually untill maximum,	- Reaches its maximum at lower substrate concentration ; - Increases rapidly untill maximum ;

@ 1 mark,max = 04 marks

Similarities,

In both/both rate of enzyme reatcions for competitive and non-competitive Inhibitions,

- Increases ; to the maximum with increase in substrate concentrations ;
- Increased with increase in substrate concentration at first ;
- Remained constant with increase in substrate concentration at the end ;
- Is very low at very low substrate concentrations ;
- Remained lower than the rate of enzyme reaction when there is no inhibitor ;

@ 1 mark , max = 05 marks

(b) Explain the trend of the rate of enzyme reactions under,

(i) Competitive inhibitor. (12 marks)

(ii) Non-competitive inhibitor. (10 marks)

b(i)

The relative rate of enzyme reactions was very low at very low substrate concentration at the start ; this is because at first there was very few substrate molecules to bind onto available active sites of the enzymes ; and instead many of these active sites were occupied by the inhibitors ; resulting into very few enzyme-substrate complexes and products are formed ;

The relative rate of enzyme reactions under competitive inhibitors increase rapidly with increase in substrate concentrations untill maximum ; this is because there are more/many substrate molecules to bind onto the available active sites of the enzymes ; thereby outcompeting the inhibitors ; for the same active sites of the enzymes for which they both compete for ; since the substrate and the inhibitors have similar shapes that can equally fit into the active sites ; so more substrate molecules succeed to bind onto the active sites than the inhibitors to form many enzyme-substrate complexes and products ;

The rate of enzyme reaction increased untill maximum with increase in substrate concentration ; this is because most of the active sites of the enzymes are almost fully

saturated with substrate molecules ; less enzyme-substarte complexes and products are formed ;

The rate of enzyme reactions remained constant with increase in substrate concentration in the end ; this is because all the active sites of the enzymes are fully engaged with substrate molecules ; and no more enzyme-substrate complexes and products are being formed.

@ 1 mark , max =12 marks

b(ii)

The relative rate of enzyme reactions for non-competitive inhibitors increased gradually until maximum with increase in substrate molecules at the start ; this is because increase in substrate molecules did not have much effect on the rate of enzyme reaction ; because the substrate molecules and the inhibitors have different shapes and can not compete for the same active sites ; the inhibitor instead bind onto an allosteric sites other than the active sites of the enzyme ; causing the shape of the enzyme and that of its active sites to change ; preventing the substrate molecules to fit into active sites ; and formation of enzyme-substrate complexes and products are prevented ; at first only few enzymes had there allosteric sites not engaged with the inhibitors ;

The rate of enzyme reactions remained constant with increase in substrate concentrations ; this is because the inhibitor quickly and easily bind onto allosteric sites of all the enzymes ; the shapes of the all the enzymes and that of their active sites change rapidly ; the substrate molecules no longer fit into the active sites and no more enzyme-substrate complexex and products are formed ;

@ 1 mark, max = 10 marks

(c) Explain why,

(i) The rate of reaction was determined when there was no inhibitor. (03marks)

(ii) It is important to keep temperatures constant at optimum. (03marks)

C(i) It is a control experiment ; enabling comparison to be made with the experimental set up ; sothat, it is clearlly proven that the differences in the rates of the enzyme reactions observed arise only due the factors under investigations and not any others ; this permits accurate conclusions to arrive at ;

@ 1mark = 03 marks

C(ii) Enzyme activity is lowered when temperatures are below or have exceeded the optimum temperature of $40^{o}C$ **;** Enzymes are inactivated below the optium while above the optimum enzymes are denatured **;** maintaining temperatures constant at the optimum, maintains enzyme ativity at the maximum **;** this eliminates experimental errors that may arise due to the effects of the temperature variations other than those caused by the enzyme inhibitors **;**

@ 1 mark = 03marks

(d) Explain briefly useful applications of Inhibitors. (03 marks)

- Control of metabolic activities within cells , like in end product inhibition where the excess of the end product , inhibits further reactions until the amount of the products formed is lowered back normal **;**
- Used in the action of drugs and medecines, for example the anti-biotic sulphonide is based on competitive inhibition **;**
- Control of enzyme reactions, for example higher concentrations of the competitive inhibitors than that of the substrate, lowers enzyme activity and the enzyme reaction proceed rapidly when the concentration of the substrate molecules become higher than that of the inhibitors ;

@ 1 mark=03 marks

TOTAL = 40 MARKS

SECTION B (60 MARKS)

2. (a) Distinguish between action and absorption spectra in plants. (02 marks)

Action spectrum is a graph showing rate of photosynthesis of each photosynthetic pigments with varying wavelengths of light ; while absorption spectrum is the graph showing variation of percentage absorption of light by different photosynthetic pigments with varying wavelengths of light ;

@ 1 mark = 02 marks.

(b) Describe mechanisms of synthesis of ATP molecules in the thylakoids of chloroplasts of a green plant. (09 marks)

Chlorophyll molecules in both photosysms I and II absorb light energy ; they become excited and emit electrons ; electrons from photosystem I are accepted by electron acceptor ferredoxin while electrons from photosystem II is accepted by electron acceptor plastoquinone ; the electrons are then carried through chain of electron carriers from higher to a lower energy ; some energy is emitted ; which is used to combine adenosine diphosphate (ADP) with a phosphate unit to form Adenosine Triphosphate (ATP) molecules ;

Protons from photolysis of water molecules are actively pumped into the lumen of the thylakoid ; until proton gradient exists ; protons begin to diffuse back into the stroma of the chloroplast ; through the chemiosmotic channels ; arranged from higher to lower energy levels and in the process some energy is emmited ; these energy is used to combine ADP with phosphate unit to form ATP ;

@ 1 mark, max = 09 marks.

(c) Explain how photorespiration is avoided by C4 plants. (09 marks)

C4 plants posses two different types of chloroplasts , The mesophyll and bundle sheath chloroplasts within each there are different kinds of carbondioxide acceptor molecules ; stroma of mesophyll chloroplasts contain phosphoenol pyruvate carboxylase (PEP Carboxylase) whose active sites combine with only carbondioxide ; and does not combine with oxygen ; PEP carboxylase catalyses reaction between carbondioxide and PEP to form oxaloacetic acid (OAA) a stable product of photosynthesis even when oxygen, light intensities and temperatures are quite high ;

C4 plants store large amounts of carbondioxide inform of mallic acid ; mallic acid is constantly and actively pumped into the bundle sheath cells ; where it undergoes decarboxylation to release large amounts of carbondioxide molecules ; this keep concentration of carbondioxide much higher than that of oxygen in the stroma of bundle sheath chloroplasts ; enabling Ribulose Biphosphate(RuBP) carboxylase to more efficiently combine with only carbondioxide ; RuBP combines with carbondioxide to form molecules of phosphoglyceric acid (PGA) the first stable product of photosynthesis ;
Bundle sheath chloroplast where RuBP carboxylase is present lack granna/thylakoids / no light reactions take place and no production of oxygen ; there is no oxygen or its concentration kept very low that RuBP has no chance to combine with oxygen ; RuBP is prevented from being oxidized to carbondioxide and water ;

@ 1 mark, max = 09 marks

3. (a) Discuss the structures of the cochlea for its efficient functions. (09 marks)

- Contain sensory hair cells whose stimulations result into perception of sound (process of hearing) ;
- Branches of auditory nerves present to transmit impulses to brain ;
- Sensory receptors are of variable threshold values increasing the range within which they can be stimulated/they can respond to stimuli of different intensities ;
- Tectorial membrane to which sensory hair of the sensory receptor is embedded is fixed/rigid while basilar membrane is flexible causing sensory hair to be stretched and receptor cell to become distorted upon displacement of the basilar membrane ; and the sensory receptor is stimulated ;
- Contains the endolymph inside and surrounded by perilymph which are fluids that transmit vibrations within the cochlea ;
- Supporting cells keep sensory cells in position and prevent them from being unnecessarily displaced and stimulated ;
- The base of the cochlea is narrow and therefore have high tension and the basilar membrane in this region vibrates at high frequency and stimulation of sensory receptors in this region will result into perception of sound of high frequency ; while The apex of the cochlea is broader and therefore have low tension and the basilar membrane in this region vibrates at low frequency and stimulation of sensory receptors in this region will result into perception of sound of low frequency ;
- Cochlea is coiled to increase surface area to receive vibrations ; and permit larger part of it fit within small space in the inner ear ;

@ 1 mark, max = 09 marks.

(b) Explain the inhibition of transmission of an impulse across a chemical synapse.

(11 marks)

In inhibitory synapse, neurotransmitter substances bind to specific receptor molecules on post synaptic membrane ; causing sodium gates to close ; while potassium ion and chloride ion gates to open ; potassium ions diffuse rapidly outside into synaptic cleft ; while chloride ions diffuse rapidly inside the postsynaptic neurone from synaptic cleft ; the outside of the membrane becomes more positive than the original while the inside of the membrane becomes more negative than original ; the post synaptic membrane becomes hyperpolarized leading to inhibitory post synaptic potential which is more negative than the original resting potential ; a threshold is not reached and no action potential generated preventing transmission of impulses ;

When electrical impulses arrive at the synapse at a high frequency ; resynthesis of neurotransmitter substances do not take place adequately ; they become exhausted in the synaptic cleft ; and depolarization of the post synaptic potential is not possible without neuro-transmitter substances ; there will be no action potential and no impulses are transmitted across the synapse ;

@ 1 mark, max= 11 marks

TOTAL = 20 MARKS

4. (a) Differentiate,

(i) polyploidy and Aneuploidy. **(06 marks)**

(ii) Sex linkage and Epistasis. **(04 marks)**

a(i)

Differences between,

Polyploidy	Aneuploidy
- Addition of the whole sets of chromosomes in the cell like n, 2n, 3n etc, - Caused by non-disjunction due to failure of spindles to form ; in prophase I, - More common in plants than Animals , - Leads to increase in size of of cells/organisms, - Associated with advantageous features in organisms ,	- Addition of the extra number of chromosomes ; /reduction in the number of chromosomes in the cell ; - Caused by non-disjunction due to failure of one of the homologous pair of chromosomes to seperate ; during anaphase I of meiosis ; - More common in Animals than in plants ; - Cell cell or parts of the organism may remain almost the same ;

- Rarelly causes death of an individual , - Can naturally be induced or chemically induced by use of colchicine,	- Associated ofteny with disadvantageous features in organisms ; - Can cause death of an individual ; - Naturally induced mainly ;

@ 1 mark= 07 marks

a(ii)

Differences that exist between,

Sex linkage	**Epistasis,**
- The Genes are carried on sex chromosomes, - Each gene determines a single character/genes or alleles control characteristics independently, - The presence of a gene on one gene locus does not suppress the effect of any other gene at a different gene locus, - Different genes are locatedon the same chromosome,	- The genes are carried on autosomal chromosomes ; - Two or more genes interact to determine a single ; - The presence of a gene on one gene locus suppresses the effect of a different other gene at another gene locus, - Different genes are located on different chromosomes ;

@ 1 mark= 04 marks

(b) In an Onion bulb, when atleast both dominant allele R and W are present in the genotype, the colour of the onion is red. And when atleast dominant allele W is present while the other alleles being recessive in the genotype, the colour of the onion is yellow. When allele w is homozygous in the genotype, the onion is white.

(i) Give possible genotypes for the Red, yellow and white colours of the Onions. (03marks)

(ii) **A cross between onions with red and yellow colours, produced onions with Red, Yellow, and white colours in the ratio of 3Red .3Yellow .2White respectively. Explain this results. Assuming no linkage. (07marks)**

b(i)

Phenotype of an onion.	**Genotype.**
- Red colour.	RRWW ; RrWW ; RrWw ; RRWw ;
- Yellow colour.	rrWW ; rrWw ;
- White colour.	RRww ; Rrww ; rrww ;

Award @ ½ mark for any two correct genotypes for @ phenotype = 03 marks

Parents, phenotype : Onion with Red colour X Onion with yellow colour ;

Parents Genotype : RrWw ; rrWw ;

Meiosis ; ↓ ↓

Gametes, : RW , Rw , rW , rw ; rW , rw ;

@ ½ mark =03 marks

Random fertilisation shown by the punnet square below,

Gametes	RW	Rw	rW	rw
rW	RrWW , Red colour ;	RrWw Red colour ;	rrWW Yellow colour ;	rrWw Yellow colour ;
rw	RrWw Red colour ;	Rrww White colour ;	rrWw Yellow colour ;	Rrww White colour ;

@ ½ mark = 04 marks.

Phenotype ratio is 3 Red . 3 Yellow . 2 White ;

TOTAL = 20 MARKS

5. (a) Describe the processes of locomotion without the use of muscles in organisms.

(10 marks)

Amoeboid/pseudopodial/cytoplasmic streaming locomotion; Flagellary locomotion; and cilliary locomotion ;
In amoeboid locomotion, for forward locomotion to occur, pseudopodium is formed anteriorly ; plasmosol or sol in the endoplasm flows forward into the pseudopodium formed /a process called cytoplasmic streaming ; at the anterior end of the pseudopodium, plasmosol is converted into a more rigid fluid called plasmogel/gelation occurs at the anterior end ; The plasmogel or gel flows backwards into the posterior end along the ectoplasm ; at the posterior end, plasmogel is converted into plasmosol in a process called solation ; plasmosol flows forward in the endoplasm pulling the posterior end forward too ;
In cilliary locomotion, for forward locomotion to be achieved, the cilia move backwards/effective stroke rapidly occurs ; when cilia are more rigid and extended in a complete arc ; this exerts a greater resistance to the medium or water/a push or thrust force is exerted onto the water ; this in turn generates a propulsive forward force ; the wave of effective stroke begins from points on the membrane/basal body and spreads in a single direction ; then the cillia move forward/recovery stroke occurs ; where the cillia is more flexible and returns slowly in a more folded ; creating no thrust or resistance to water ;

In flagellary locomotion, the flagella cause wave like (undulating) movements ; which spread from the base upto the tip of the flagella ; exerting a push on the water/thrust force ; resulting into forward propulsive force ;

@ ½ marks = 10 marks

(b) Give an account of secondary thickening in flowering plants. (10 marks)

Results into increase in diameter /girth/thickness of part of plant such as stem ; it occurs due to rapid mitotic cell division of the lateral meristem ; lateral meristem are of two types vascular cambium and cork cambium ; in stems , vascular cambium grows to form a ring around the stem called intervascular cambium ; the cells of the vascular cambium towards the outside/fusiform initials divide mitotically to form protoxylem,then metaxylem/xylem tissue ; while cells of the vascular cambium(fusiform initials) towards the outside divide mitotically to form protophloem, then metaphloem/phloem tissue ; more meta xylem/xylem is formed than the meta phloem/phloem tissue ;
Cells of the vascular cambium called ray initials also divide mitotically to form parenchyma between the xylem and phloem ;

Cells of the cork cambium towards the outside called phellogen divide mitotically to form cork cells beneath the epidermis ; cork cells become deposited with suberin to form the periderm ; the outer most layer form the bark which replaces the old epidermis ; loosely arranged cork cells that permit gaseous exchange form the lenticels ; mitotic cell division of the cork cambium towards the inside form parenchyma/collenchyma ; as they give rise to primary and secondary cortex ;

@ 1 mark, max = 10 marks.

TOTAL = 20 MARKS.

6. (a) What is meant by the term "Economic damage threshold" **of pests. (02 mark)**

Economic damage threshold of pests is the pest population level where control methods are required; to prevent the population of the pest to reach level that can cause maximum damage to the crops;

@ 1 mark = 02 marks

(b) Describe various cultural methods to control pest population on the rise. (07 marks)

Cultural methods of pest control are;

- Weeding, is where weeds (unwanted plants) are removed, this expose the pests on the desired crops to their predators ;
- Cultivation of the garden (tillage) ,this over turns the soil and expose the pests to their predators ;
- Crop rotation which disrupts the reproductive cycles of the pests ;
- Removing the remains of damaged crops which may harbor pests ;
- Creating physical barriers like sticky bands which are placed on apple plants to protect the plants from their potential pests ;
- Mulching which prevents light reaching the seeds of the weeds that could harbor the pests ;
- Growing or harvesting crops at a particular time in the life cycle of the pests when they are least active ;
- Intercropping where two different crops are planted on the same field, an organism attracted by one crop may predate on pests on the other crop ;

@ 1 mark, max = 07 marks.

(c) Explain the sequence of changes that will occur in a previously burnt piece of land from its initial stages until a climax community. (11 marks)

Its secondary succession ; pioneer organisms are fast growing annual herb plants ; like Bidens pilosa/ commelina species ; and animals such as Insects/ detritivores (earth worms) ; these organisms die ,decompose and add organic matter into the soil ; a few years later, perennial herbs ; such as Lantana camara begins to replace the annual herbs and establish them in the area ; Many years after, shrubs like acacia replace the perennial herbs ; birds begin to inhabit areas where acacia is present ; the litter from the falling Leaves accumulate in the area whose decomposition add more organic matter into the soil ; thickness of soil is increased ; this creates favourable conditions for the trees to grow and larger animals live in and climax community is attained ;

@ 1 mark, max = 11 marks.

END