

Low concentration of blood glucose stimulates the pancreas to produce hormone called glucagon.

ADVANCED LEVEL BIOLOGY NATIONAL EXAMINATION PAPER 2011
(BCG, MCB, PCB)

SECTION A: Answer ALL questions /70 marks

01. a) Water enters plant cells by the process of osmosis. Explain why the cells don't burst during this process. 2 marks
b) Why is cell membrane described as a bilayer? 1 mark
c) How does the membrane structure help to keep solutions apart? 2 marks

Answer:

- a) Plant cells do not burst because they have cell wall.
b) Cell membrane is described as bilayer because is composed by two layers of phospholipids.
c) Cell membrane is selective and is composed by phospholipid bilayer which has head (hydrophilic) and tail (hydrophobic).
02. a) What is the function of mitochondrion? 1 mark
b) Explain why muscles have a high number of cristae per mitochondrion 2 marks

Answer:

- a) Mitochondrion is the site of cell respiration
b) It has higher number of cristae per mitochondrion in order to increase the surface where respiration takes place which result to the production of high amount of energy.
03. Suggest the cellular processes that would be taking place in the following cells.
a) A cell in which the membrane contained many microvilli. 1 mark
b) A cell with many rough endoplasmic reticulum. 1 mark
c) A cell with a large number of golgi bodies. 1 mark
d) A cell with much smooth endoplasmic reticulum. 1 mark

Answer:

- a) Absorption
b) Protein photosynthesis
c) Formation of vesicles
d) Lipid metabolism
04. The diagram below represents a flower



- a) Give the letter of the structure which:
- becomes the fruit wall. 1 mark
 - becomes the testa. 1 mark
 - produces pollen grains. 1 mark
- b) Explain two ways shown in the diagram in which this flower is adapted for insect pollination. 2 marks

Answer:

a) i) G

ii) E

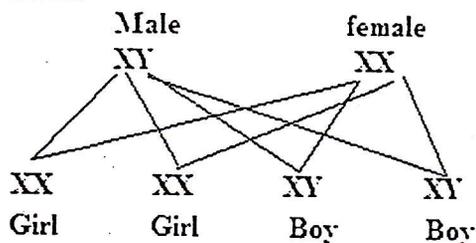
iii) B

b) Ways:

- Large petals (Collora)
- Stigma and anther are inside the flower/ they are curved by the petals
- The flower is open so insect can have access inside it.
- The flower is bisexual (hermaphrodite)

05. Draw a well labeled diagram to show that there is an equal chance of parents producing a baby boy or girl. Use the symbols X and Y for the chromosomes. 4 marks

Answer:



Girl: 2/4 : 50 %

Boy: 2/4: 50%

Boy and girl have equal chances of 50%

06. a) Describe the functions of centromere during mitosis. 2 marks
b) List three similarities between mitosis and meiosis. 3 marks

Answer:

- a) In eukaryotes, acentromere is a region of DNA that is responsible for the movement of the replicated chromosomes into the two daughter cells during mitosis and meiosis. There is one centromere on each chromosome, and centromeres are responsible for two major functions. In prophase of mitosis, specialized regions on centromeres called kinetochores attach chromosomes to spindle fibers. The centromere is the part of a chromosome that links sister chromatids or a dyad. During mitosis, spindle fibers attach to the centromere via the kinetochore. One major function of a centromere is joining the sister chromatids. The two copies of a replicated chromosome are called sister chromatids, and they must stay joined together until it is time for them to be physically pulled into the two future daughter cells. This ensures that each daughter cell will get exactly one copy of each chromosome.

b)

Mitosis and meiosis are multistage processes involving division of the cell. They both involve cellular DNA duplication, splitting the chromosomes into the daughter cells. They both involve degradation and reformation of the nuclear membrane.

While mitosis creates two daughter cells that have identical chromosomes to the parent cell, meiosis forms four daughter cells with varying degrees of the parent cell's chromosomes. Two of the cells have either maternal or paternal homologue chromosomes, and the other two have mixed degrees of these two types of homologue.

Mitosis occurs in many different tissues of animals, but meiosis only happens in specialized tissues. During mitosis, the changes in the chromosomes are asexual. Meiosis produces gametes, such as sperm and eggs.

07. a) Give two similarities between transcription and DNA replication. 3 marks
 b) If the diploid number of chromosomes for a specie is 46, how many chromosomes are present in:
 i) Spermatogonium 1 mark
 ii) a primary Oocyte 1 mark
 iii) a secondary Oocyte 1 mark

Answer:

- a) During DNA replication, a DNA polymerase, or the molecule responsible for making a DNA polymer, uses one of the DNA strands to make a complementary strand using the base-pairing rules. Similarly, transcription also relies on the base-pairing rules to make a corresponding RNA with a complementary sequence.
 b) i) 46
 ii) 46
 iii) 23
08. Explain the main difference between the lock and key and the induced fit models of enzyme action. 3 marks

Answer:

Lock and key state that the active site of an enzyme has the same shape as the one of substrate but induced enzyme does not have direct shape as the one of substrate so in order to fit there is first of all collision in order to fit.

09. a) Name the gaseous exchange surface in:
 i) Humans 1 mark
 ii) Plants 1 mark
 iii) Fish 1 mark
 b) Explain how efficient gas exchange is achieved in plants. 3 marks

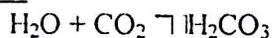
Answer:

- a) i) Alveolus, lung, skin, capillaries
 ii) Stomata cuticle, epidermis, lenticles, leaf
 iii) gills, lamella, lung
 b) Efficient gas exchange is achieved in plant because of:
 - Large leaves

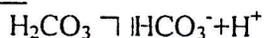
- Thin leaves
- Number of stomata
- Spongy mesophyll cell

10. The following equations summarise three reversible reactions that occur in mammalian blood:

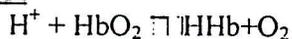
Equation 1:



Equation 2:



Equation 3:



- a) Which of these reactions involves the enzyme carbonic anhydrase? **1 mark**
- b) What is the function of hydrogen carbonate ions produced in equation 2? **2 marks**
- c) What effect do the reactions left to right in equation 1 and 2 have on the oxygen dissociation curve of haemoglobin? **1 mark**
- d) In which component of the blood do all the above reactions occur? **1 mark**

Answer:

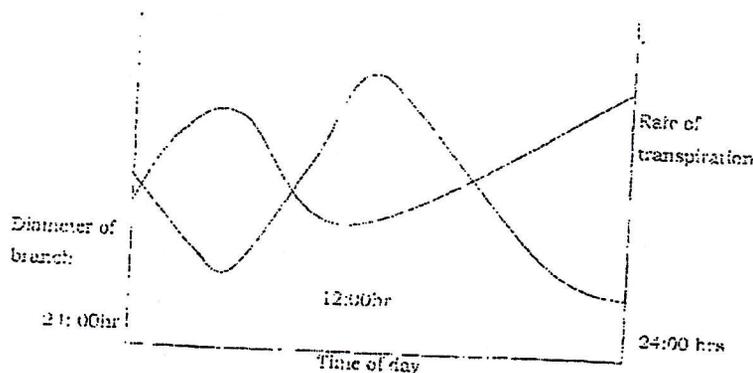
- a) $\text{H}_2\text{O} + \text{CO}_2 \rightleftharpoons \text{H}_2\text{CO}_3$
- b) - Transport of CO_2
- Balance of the pH
- Reduce the amount of acid
- c) The curve shifts to the right
- d) Red blood cell (RBC, erythrocyte)

11. Land plants have most stomata on the lower leaf surface. Floating aquatic plants have many stomata on the upper surface of their leaves. Suggest some advantages of this arrangement. **4 marks**

Answer:

The location of stomata on lower surface side of land plant leaves reduces the rate of transpiration (loss of water in form of vapour) whereas floating aquatic plant must have many stomata on the upside in order to allow efficient gaseous exchange.

12. The graph below shows the relationship between the rate of transpiration and the diameter of a branch.



- a) Explain the graph. **2 marks**
- b) Explain why Carbohydrates are transported as sugars and not starch. **2 marks**

Answer:

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- a) Transpiration rate is high when the diameter of the branch is small. Water goes up faster in the thin branch or capillarity. Transpiration rate is low when the diameter of branch is big. Water goes up slowly in the wide branch.
- b) Carbohydrates are transported as sugars and not starch because:
 - Sugars are small molecules, soluble
 - Starch is large molecule, insoluble, storage food.
13. State one function of each of the following compounds in an organisms.
- a) Phospholipid
 b) Collagen
 c) Cellulose
 d) Globular protein 4 marks

Answer:

- a) - Basis of cell membrane
 - Produce energy

Phospholipids consist of a hydrophilic (or 'water loving') head and a hydrophobic (or 'water fearing') tail. Phospholipids like to line up and arrange themselves into two parallel layers, called a phospholipid bilayer. This layer makes up your cell membranes and is critical to a cell's ability to function.

Phospholipids are composed of a hydrophilic head, which is attracted to water, and two hydrophobic tails, which repel water. Because these cells contain molecules that simultaneously attract and resist water, they are considered amphipathic (both water-soluble and non-water-soluble Phospholipids perform vital functions within the body. These important cellular barriers support all cognitive function, cardiovascular health, nerve health, liver function, and digestion. During the digestive process, phospholipids form clusters to help move vitamins, nutrients and fat-containing molecules through the body.

- b) - Build connective tissues (bones, tendons, skin, blood vessels)
 - Provide amino acid, energy

Collagen is an important component of the body's connective tissues, which perform a variety of functions in the body. ... Connective tissues also impart great support and strength to structures such as the bones and tendons.

Collagen is a protein found abundantly throughout the bodies of animals, including humans. In fact, collagen makes up about one-third of the total body weight. Collagen is an important component of the body's connective tissues, which perform a variety of functions in the body. These tissues provide the framework, or internal scaffolding, for various organs such as the kidneys and lymph nodes. Connective tissues also impart great support and strength to structures such as the bones and tendons. Blood, an important type of connective

tissue, transports oxygen and nutrients throughout the body. Connective tissue is composed of a nonliving, gel-like material called a matrix, in which living cells are embedded. The matrix is composed of different kinds of protein fibers, the most common of which is collagen.

- c) - Main constituent of cell wall
 - Facilitate the movement of food faeces in the alimentary canals
 - Reduce the risk of cancer
 - Provide energy

Cellulose is a very important polysaccharide because it is the most abundant organic compound on earth. Cellulose is a major component of tough cell walls that surround plant cells, and is what makes plant stems, leaves, and branches so strong.

The role of cellulose in Plants; It is the structure of cellulose that makes it so useful. Cellulose is a structural polysaccharide, and makes up about 30% of the plant cell wall, which serves many functions including: connecting cells to form tissues. Cellulose is a polysaccharide (a form of carbohydrate) that has a structural role in animals and plants. In plants, cellulose is the compound that gives rigidity to the cells. The bonds between each cellulose molecule are very strong, which makes cellulose very hard to break down.

Because there are so many plants in the world (think of all the flowers, trees, weeds, grasses, vines, and bushes), cellulose, which is found in every cell of every plant, is the most abundant organic compound on earth.

Most animals can't digest cellulose because it is so hard to break down. Animals that eat only plants (herbivores) have special sacs in their digestive system to help break down cellulose.

Humans can't digest cellulose either. (The proof is in the toilet the day after you eat corn, for example.) Because cellulose passes through your digestive tract virtually untouched, it helps maintain the health of your intestines. One way cellulose helps the intestines is that it clears materials from the intestinal walls, keeping them clear, which may help to prevent colon cancer. Cellulose is the *fiber* (or *roughage*) of which your cereal box says you need more.

- d) - It is an enzyme: a repair, a receptor, a carrier hormone, antibody
 - It is a constituent of the cell membrane
 - Provide the amino acid, energy.

Globular proteins play many biological roles, including acting as enzymes, hormones, immunoglobulins, and transport molecules. Hemoglobin is a globular protein found in red blood cells. It is made of four polypeptide chains, each containing a heme group that binds and transports oxygen through the blood stream.

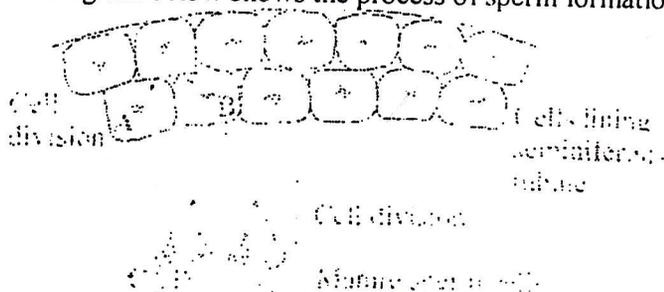
14. a) What does the term oxidative phosphorylation mean? 2 marks

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b) Describe the function of the electron transport chain. Where is it located in the mitochondrion? 3 marks

Answer:

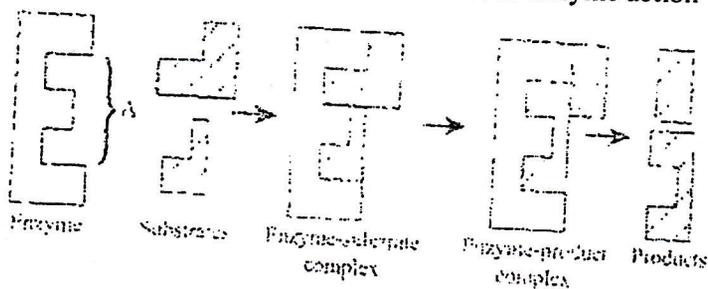
- a) The term oxidative phosphorylation means the formation of ATP from ADP and inorganic phosphate (P); by a process of oxidation/ oxidation of hydrogen and electron carriers; forming water.
- b) The function of electron transport chain is to generate ATP; re-oxidation of the reduced electron/ hydrogen carriers; to oxidize hydrogen to form water; the electron transport chain takes place on the inner membrane/ cristae.
15. The diagram below shows the process of sperm formation in a mammalian Testis.



- a) Explain why cells A and B are genetically identical. 1 mark
- b) Describe two ways in which cell division leads to cells C and D being genetically different.

Answer:

- a) Formed as result of mitosis
- b) Crossing over – independent assortment of chromosome- mutation
16. The diagram below illustrates one model of enzyme action



- a) Name the part of the enzyme labeled A. 1 mark
- b) Explain how this model can account for enzyme specificity 2 marks
- c) With reference to the model, explain the effect of a competitive inhibitor on an enzyme-catalysed reaction. 2 marks

Answer:

- a) A = active site
- b) Each enzyme has an active site with a particular shape, specific substrate
- c) It fits into active site of enzyme and remains there preventing the true substrate from fixing to its active site, so this reduces, stops, slows the rate of enzyme, catalyzed reaction.

SECTION B: ATTEMPT ANY THREE QUESTIONS. (30 MARKS)

17. a) List Four similarities between DNA and RNA 4 marks
 b) Explain why the genetic code of must be triplet and not doublet. 2 marks
 c) What is the significance of protein synthesis? 4 marks

Answer:

- a) - Are Polymers
 - Are nucleic acid
 - Are in the nucleus
 - Contain some nitrogeneous bases (GCA)
 - Consist of stand or chain
 - Are genetic materials
- b) It must be triplet because each has 3 nitrogeneous base code as specific amino acid.
 A doublet produces 16 combinations which are not enough to code for 20 amino acids and the triple produces 64 combinations which are enough to code for 20 amino acids. Because the triplet specifies a particular amino acids.
- c) The significance of protein synthesis is the manufacture of:
 - Enzyme
 - Hormone
 - Antibody
 - Blood clotting factors
 - Carrier
18. a) State two functions of mitosis. 2 marks
 b) Write a brief account of the process of mitosis in an animal cell 8 marks

Answer:

- a) Functions of mitosis
- It promotes the growth
 - It promotes the repair or replacement of cells or damaged tissues
 - It promotes asexual reproduction in prokaryotes, protocista and fungi
 - It is involved in the gamete formation in gametophytic generation of plants.
- b) There are four steps:
- In prophase;
Chromosomes appear; become thicker and shorter; two chromatids visible, held together at centromere; nucleolus disappear; nuclear membrane breaks up; spindle appears.
 - In metaphase;
Chromosomes become attached to spindle fibres by centromeres; lined up along equator of spindle; at right angle to the poles.
 - In anaphase;
Spindle fibres become shorter; centromeres divide and are pulled towards the poles; this separates the chromatids.
 - In telophase;

Chromatids uncoil; are now chromosomes; they are no longer visible; nuclear membrane forms around each group of chromosomes; nucleolus reappears. Cytokinesis (division of cytoplasm) follows; two cells separate.

19. a) i) What does 'asexual reproduction' mean? 1 mark
 ii) Give two examples of asexual reproduction in animals 2 marks
 b) Why do animals generally produce more spermatozoa than eggs? 1 mark
 c) Describe i) Three differences and
 ii) Three similarities between the formation of male and female gametes in humans. 6 marks

Answer:

- a) i) Asexual reproduction is a reproduction in which there is no fusion of male and female sex cells gametes.
 ii) – Vegetative propagation or budding
 - Mitosis
 - Binary fission
 b) Animals generally produce more spermatozoa than eggs because:
 • Fewer resources are needed to produce a sperm than an egg cell
 • To ensure that at least one sperm makes way to the egg cell (particularly important in external fertilisation)
 c) i) Similarities:
 The formation includes a multiplication phase involving mitosis/ growth phase
 Formation includes a maturation phase involving meiosis
 Formation never complete before puberty.

ii) Differences:

Formation of male gametes	Formation of female gametes
Produced continuously after puberty	Starts before birth and complete development one per monthly cycle
4 males gametes produced from one primary spermatocyte	Only one female gamete produced from one primary oocyte
Male gametes complete formation in the testis	Female gamete only completes formation after fertilisation

20. a) Explain the following ecological terms:
 i) Ecological succession, 2 marks
 ii) Climax vegetation, 2 marks
 iii) Biodiversity. 2 marks
 b) Distinguish between the following pairs of terms as used in ecology
 i) Density dependent factors and 2 marks
 ii) Density independent factor
 Give an example of each. 2 marks

Answer:

- a) i) **Ecological succession:** is the gradual change in the composition of plant and animal communities in an area; after disturbance of the creation of a new substrate; through a number of stages or sere; increase in biomass/ species diversity; leading to a stable/ climax community.

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ii) Climax vegetation: is a stable community; often with highest biodiversity and in equilibrium with the climate.

iii) Biodiversity: is the range/ number of different plants and animals; sum of all different species.

b) Density-independent factors is a factor that affects a population in a manner that does not vary according to the density of the population, it is acting on its own, for example, fire and floods and other natural disasters.

Whereas, a density-dependent factor is a factor that affects a population based on its population, including, amount of resources (food, water, shelter), disease, etc. Density factors usually cause the population to either increase or decrease according to the positive or negative affect it has on an ecosystem.

Or

Density dependent environmental resistance factors

Density dependent factors include the environmental resources needed by the individuals of a population. Competition for food, water, shelter, etc., results as the population density increases. The survival, health, and reproduction of individuals will be affected if they cannot acquire the basic requirements of life.

Density dependent factors also include environmental factors, such as predators, infectious disease organisms, and parasites that do not necessarily result in competition for needed resources, but do affect the health, survival, and reproduction of individuals in the population as population density increases. Individuals that are diseased may have a reduced ability to reproduce. Dead individuals cannot reproduce.

Density dependent factors are referred to as Environmental Resistance Factors that determine the Carrying Capacity of the environment for a population.

Density Independent environmental resistance Factors

Density Independent factors are Resistance Factors that occur or have an effect on a population regardless of the density of the population.

Density independent factors include weather phenomena and natural disasters that affect the population, but the chance of their occurrence or level of severity is unrelated to the density of the population.

Density independent factors may affect the availability of resources that are required by the population (density

dependent factors), indirectly affecting the carrying capacity of the environment.

21. a) why do different enzymes have different optimum PH? 2 marks
 b) What is the difference between a reversible and an irreversible enzyme inhibitor? 4 marks
 c) Explain the term cofactor and give two examples of cofactors. 4 marks

Answer:

- a) The number of H^+ or OH^- ions in a solution affects the distribution of charges over the surface of the enzyme. The pH affects the ionization of side chain in amino acid residues and affects the hydrogen bonds and di-sulphur bridges which hold the enzyme in 3D shape. Extremes of pH denature the enzyme.

b)

Reversible enzyme inhibitor	Irreversible enzyme inhibitor
Binds loosely to the enzyme and reduces its activity	Binds permanently to enzyme
Can be removed without permanent damage	Once removed from the enzyme, it causes permanent change.
Inhibition can be reduced when the concentration of correct substrate is increased	Inhibition cannot be reduced by the increase of concentration of correct substrate.
e.g: malonate inhibits the enzyme succinate deshydrogenase (in krebs' cycle)	e.g: Arsenic and cyanide permanently damage respiratory enzymes.

- c) A cofactor is a non-protein chemical compound or metallic ion that is required for a protein's biological activity to happen. These proteins are commonly enzymes, and cofactors can be considered "helper molecules" that assist in biochemical transformations.
 Examples: NAD^+ (nicotinamide adenine dinucleotide) and FAD (flavin adenine dinucleotide)

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SECTION A: Answer ALL questions /70 marks

01. a) What is cell's protoplast? 1 mark
 b) List two processes carried out by the cell's protoplast? 3 marks

Answer:

- a) Cell's protoplast is a part of plant cell which lies within the cell wall and can be plasmolysed and which can be isolated by removing the cell wall by mechanical or enzymatic procedure.
 b) Some of these processes are:

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