

**ADVANCED LEVEL BIOLOGY NATIONAL EXAMINATION PAPER 2013
(BCG, MCB, PCB)**

SECTION A: Answer ALL questions /70 marks

01. a) A cell is defined as the structural and functional unit of any living organism. Explain this. 2 marks

b) Why are cells said to be units of life? 1 mark

Answer:

a) Cell is called structural unit because body of all the organisms is made up of cells. It is functional unit of life because all the functions of body (physiological, biochemical, genetic and other functions) are carried out by cells.

b) Cells make up the smallest level of a living organism such as yourself and other living things. The cellular level of an organism is where the metabolic processes occur that keep the organism alive. That is why the cell is called the fundamental unit of life.

02. a) Why would you expect to find abundant rough endoplasmic reticulum in the pancreas? 2 marks

b) Why do we stain biological sections when observing under a microscope? 2 marks

Answer:

a) Pancreatic secretory cells are making large amounts of enzymes, which are proteins, they would need a large number of ribosomes to translate tRNA to protein, lots of rough endoplasmic reticulum to fold the protein and many golgi to prepare and package the proteins for secretion. That is the logical conclusion as to why they have so many of these particular organelles.

b) Staining is an auxiliary technique used in microscopy to enhance contrast in the microscopic image. Stains and dyes are frequently used in biology and medicine to highlight structures in biological tissues for viewing, often with the aid of different microscopes. Stains may be used to define and examine bulk tissues (highlighting, for example, muscle fibers or connective tissue), cell populations (classifying different blood cells, for instance), or organelles within individual cells.

Cell staining is a technique that can be used to better visualize cells and cell components under a microscope. By using different stains, one can preferentially stain certain cell components, such as a nucleus or a cell wall, or the entire cell. The main purpose of staining a specimen on a microscope slide is so that it can be better viewed. The stain usually colors one part of the specimen, but not another part. By creating that color contrast it becomes easier to view parts of the subject. Sometimes a certain part of a specimen cannot be seen, even with a microscope, so it has to be stained a certain color so that it can be viewed and studied. Most stains may be used on non-living specimens, though only some stains will work on living specimens.

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03. Below is a classification of an earthworm.

Kingdom: Animal

Phylum: Annelida

Class: Oligochaeta

Order: Terricolae

Family: Lumbricidae

Genus: Lumbricus

Species: Terrestris.

Give the scientific name of the earthworm. **2 marks**

Answer:

Significance of scientific name:

- Avoids the confusion or ambiguity caused by local names
- Gives the same identity of a specimen to all the users regardless their origin or languages
- Enables later research by other scientists
- Allows identifying the background of the discovery of the specimen.

The scientific name of the earthworm is **Lumbricus terrestris**

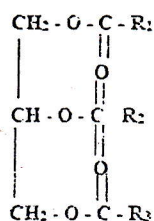
04. Give two main differences between diffusion and active transport. **2 marks**

Answer:

Differences

| Diffusion | Active transport |
|---|--|
| Ions and molecules move down concentration gradient | Ions and molecules move against concentration gradient |
| No energy (No ATP) required | Energy (ATP) is required |
| Movement through channel proteins | Movement through carrier proteins |

05. Look at the diagram of the triglyceride.



- a) Name the two different types of molecules that make up this triglyceride. **2 marks**
- b) Name the bond between these molecules. **1 mark**

Answer:

- a) Glycerol (alcohol) and fatty acid (carboxylic acid)
- b) The bond is covalent called ester bond.

06. a) Digestive glands secrete enzymes. What initiates these secretions? **3 marks**

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b) Digestion is either entirely extracellular or intracellular or both. Give examples of organisms which have:

- i) Extracellular;
- ii) Intracellular;
- iii) Both extracellular and intracellular. 3 marks

Answer:

a) The secretion of digestive enzymes is initiated by: hormones (e.g: secretin, pancreaticozym) and by expectations (e.g: imagination, thought, sight, smelling, taste, contact of food with digestive organs, reflex stimulation, dream.....)

b) Examples of organisms which have:

- i) Extracellular digestion: fungi, dog, human...
- ii) intracellular digestion: amoeba, paramecium....
- iii) Both extra and intracellular digestion; hydra, lancelet.....

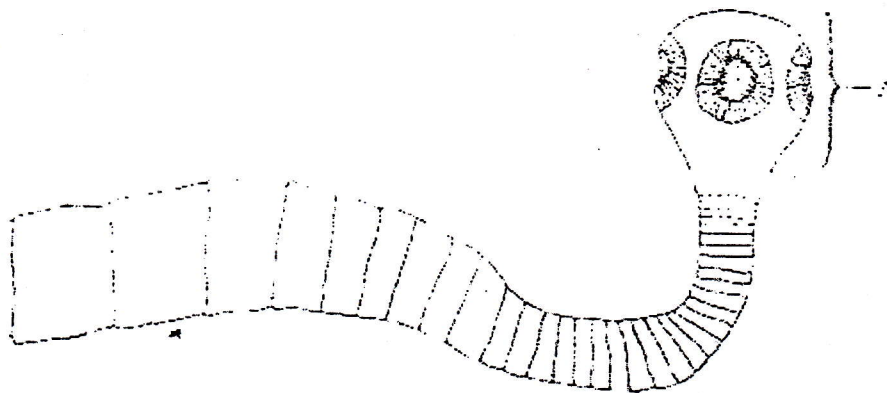
07. Explain each of the following statements.

- a) If you stand on your head it is possible to swallow food. 2 marks
- b) Secretion of gastric juice may start before the food reaches the stomach. 2 marks
- c) If the bile duct is blocked, digestion of fats is stopped. 2 marks

Answer:

- a) Because food (bolus) is pushed by wave contractions of oesophagus muscle (peristalsis)
- b) Because the secretion of gastric juice may be initiated by the sight, smell and food.
- c) Because the bile helps in the digestion of fat by emulsifying them into small droplets for easy digestion of lipase enzyme. So, when the bile duct is blocked, the bile will not reach the duodenum and therefore lipids will not be emulsified.

08. The diagram below shows a part of the beef tapeworm taenia saginata.



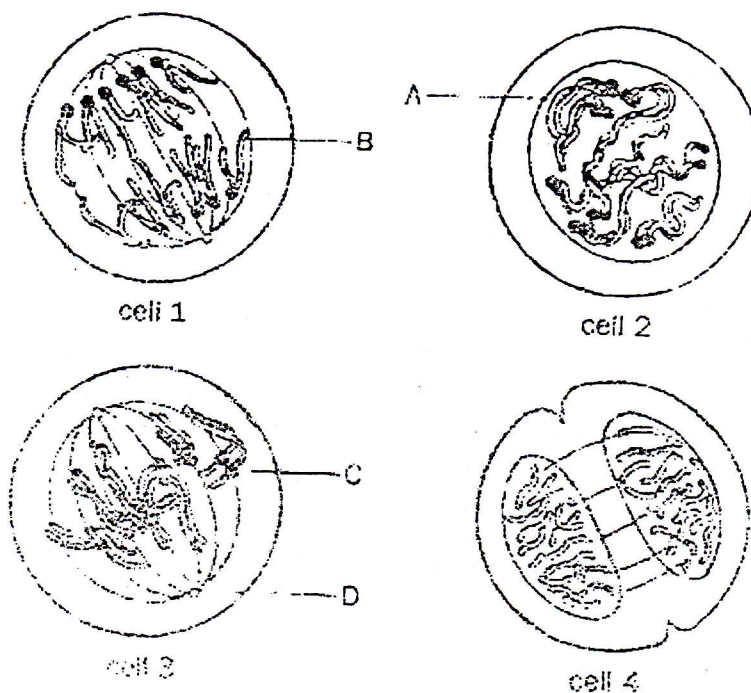
- a) Explain the importance of the part labeled A in the life of the tapeworm. 2 marks
- b) Describe how the tapeworm obtains its nutrients. 2 marks
- c) How does the nutrition of rhizopus differ from that of the tapeworm? 2 marks

Answer:

- The part A (scolex) attaches the tapeworm to gut wall of the host preventing its removal due to peristalsis.
- It is a parasite obtaining food from the living human host; food digested by the host is absorbed through the body wall.
- Differences between feeding in tapeworm and rhizopus

| Tapeworm | Rhizopus |
|-----------------------|------------------------------|
| Parasite | Saprobiont/ saprophyte |
| Feeds on living hosts | Feeds on dead organic matter |
| No digestion | Extracellular digestion |

09. The diagrams below show four animal cells at different stages of mitosis.



- Name the structures labeled A, B, C and D. 4 marks
- Name the stages of division shown by cells 1 and 3. 2 marks
 - Use the numbers of each cell to arrange the stages in the correct sequence of mitosis. 1 mark
- How does mitosis maintain genetic stability in an organism? 1 mark

Answer:

- A-nuclear membrane/ nucleus; B- Chromatid / daughter chromosome/ spindle, C- Centromere; D – Aster/ centriole/ centrosome
- Stage 1 – Anaphase; Stage 3 – metaphase
 - The correct order of the sequence in mitosis is 2 → 3 → 1 → 4
- Mitosis maintains genetic stability in an organism because:

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- Each chromosome makes a copy of itself by replication
- During the mitosis there is no crossing over
- Each member of homologous chromosome is fixed on its own spindle fibre
- There is independent assortment of chromosomes
- Number of chromosomes of daughter cells is equal to that in the mother cell.

10. a) What physiological events would you expect to follow the injection of a small quantity of glucose into the blood stream of a healthy mammal? **2 marks**
- b) What would be the result of injecting glucose into the blood stream of a man whose pancreas has been removed? **2 marks**
- c) Algae are not associated with disease like many fungi and bacteria. Explain. **2 marks**

Answer:

- a) After the injection of a small quantity of glucose in the bloodstream of a healthy mammal, the glucose will be an increase of blood glucose level. That rise of blood glucose level will be detected and therefore the beta cells of the pancreas will secrete the insulin in the bloodstream. The insulin will thereafter cause the conversion of glucose into glycogen by hepatic cells, the conversion of glucose into fats, the absorption of glucose by the body cells, the increase of the rate of cell respiratory (oxidation of glucose) in order to produce ATP.
- b) The result of injected glucose into the bloodstream of man whose pancreas has been removed is the hyperglycemia i.e: high blood glucose level that leads to diabetes and glucosuria i.e: presence of glucose in the urine.
- c) Algae, also called cyanobacteria or blue-green algae, are unicellular or multicellular eukaryotes that obtain nourishment by photosynthesis. They live in water, damp soil, and rocks and produce oxygen and carbohydrates used by other organisms. It is believed that cyanobacteria are the origins of green land plants.

11. Explain fully the following biological terms:

- a) Double circulation; **4 marks**
- b) Double fertilization. **4 marks**

Answer:

- a) A double circulatory system refers to a system in which blood pumps through the heart twice during each trip around the body. The blood is first pumped into the lungs, where it becomes oxygenated, and is then pumped back into the heart, before it is finally pumped into the rest of the body. While most types of vertebrates have double circulatory systems, some have the more primitive single circulatory system.

The majority of mammals (including humans) utilize a double circulatory system. This means that we have two loops in our body in which blood

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- circulates. One is oxygenated, meaning oxygen rich, and the other is deoxygenated, which means it has little to no oxygen, but a lot of carbon dioxide.
- b) Double fertilization is a complex fertilization mechanism of flowering plants (angiosperms). This process involves the joining of a female gametophyte (megagametophyte, also called the embryo sac) with two male gametes (sperm). It begins when a pollen grain adheres to the stigma of the carpel, the female reproductive structure of a flower. The pollen grain then takes in moisture and begins to germinate, forming a pollen tube that extends down toward the ovary through the style. The tip of the pollen tube then enters the ovary and penetrates through the micropyle opening in the ovule. The pollen tube proceeds to release the two sperm in the megagametophyte.

One sperm fertilizes the egg cell and the other sperm combines with the two polar nuclei of the large central cell of the megagametophyte. The haploid sperm and haploid egg combine to form a diploid zygote, while the other sperm and the two haploid polar nuclei of the large central cell of the megagametophyte form a triploid nucleus (triple fusion). Some plants may form polyploid nuclei. The large cell of the gametophyte will then develop into the endosperm, a nutrient-rich tissue which provides nourishment to the developing embryo. The ovary, surrounding the ovules, develops into the fruit, which protects the seeds and may function to disperse them. The two central cell maternal nuclei (polar nuclei) that contribute to the endosperm, arise by mitosis from the same single meiotic product that gave rise to the egg. The maternal contribution to the genetic constitution of the triploid endosperm is double that of the embryo.

12. Match each level of protein structure with the correct description. 4 marks

Protein structure

A. Primary structure

B. Secondary structure

C. Tertiary structure

D. Quaternary structure

Description

A. The twisting of the amino acid chain into helix held together with hydrogen bonds

B. The association of a number of polypeptide chain.

C. The sequence of amino acids in polypeptide chain.

D. The folding of the polypeptide into a complex three-dimensional shape

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Answer:

A – C

B – A

C – D

D – B

13. What are the advantages of supplying the pulmonary circulation with blood at a lower pressure than that of the systemic circulation? 5 marks

Answer:

Advantages of supplying the pulmonary circulation with blood at lower pressure:

- Increase of gaseous exchange rate
- Efficient removal of CO₂ and absorption of O₂ by diffusion
- Preventing the destruction (rupture) of pulmonary capillaries.

14. a) Define 'Locomotion'. 1 mark

- b) What is the basic reason for the fact that animals show locomotion whereas plants do not? 3 marks

Answer:

- a) Locomotion in biology pertains to the various movements of organisms (single-celled or multicellular organisms) to propel themselves from one place to another. In multicellular animals, these movements include walking, running, jumping, crawling, climbing, swimming, flying, galloping, slithering, and so on. The movements may vary depending on the habitat of the animal.

b)

Locomotion deals with the movement of an organism. Locomotion in humans and bipeds is accomplished through walking on legs. In other animals, it can be accomplished through walking on four limbs, flying, or swimming. In cells, cilia and flagella are used to move about. However, since plants are not capable of moving themselves, there is no locomotion of plant species.

Both plants and animals respond to external stimuli. They react to factors by showing a series of movements. The stimulus is sent from one part of the body, the receiving zone to another part of body, the reaction zone.

The resultant reaction in the movement of plants is different from that of animals. For example, in plants, it involves only the movement within the body or often movement of organs of the body such as flower and roots. The entire plant body does not move. In animals, the entire body

15. a) What are mutations? 1 mark

- b) What are causes of mutations? 2 marks

Answer:

- a) Mutation is a spontaneous change which is inherited from generation to generation/ Mutation is a change in genotype/ change in number and structure of chromosomes, gene, DNA and that brings new inheritance traits.

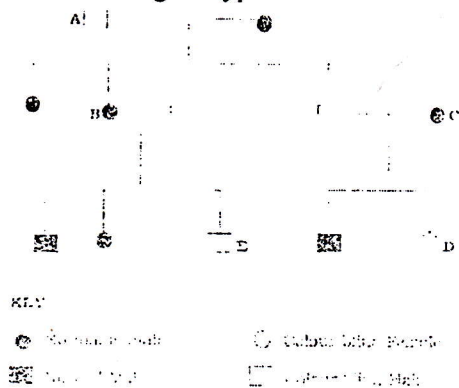
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- b) Causes of mutation: radiations (UV, X-rays, gamma-rays...) chemicals (phenols, tar of tobacco, formalin, benzene, colchicines, nitrous acid...), heavy metal, climatic changes (temperature).

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

16. a) What is meant by the term homologous chromosomes? 2 marks
 b) State three ways by which meiosis creates genetic variation. 3 marks
 c) Red-green colour blindness is a sex-linked recessive condition. The gene of colour blindness is carried on the X-chromosome. The figure below shows a family tree. Work out the genotype of individuals labeled A-E. 5 marks



Answer:

- a) Homologous chromosomes are two chromosomes, one from each parent; having the same length, centromere in the same position; same number of genes; genes in same order.
- b) Three ways by which meiosis creates genetic variations:
- Separation of homologous chromosomes
 - Crossing-over in prophase I
 - Independent assortment of chromosomes at metaphase I
- c) The genotypes of individuals A-E:
 A: X^cY ; B: X^CX^c or X^cX^c ; C: X^CX^C or X^cX^c ; D: X^CX^C ; E: X^cY
17. a) Define the following biological terms.
- i) Photosynthesis. 2 marks
 - ii) Tissue respiration. 2 marks
- b) State the differences and similarities between photosynthesis and tissue respiration. 6 marks

Answer:

a)

- i) Photosynthesis is the process by which green plants manufacture their own food. The process takes place in small structures within the plant's cells called chloroplasts.

Or

Photosynthesis is a chemical process through which plants, some bacteria and algae, produce glucose and oxygen from carbon dioxide and water, using only light as a source of energy.

ii)

The metabolic process by which living cells absorb oxygen and release carbon dioxide also called internal respiration.

The term tissue respiration *denotes the* exchange of respiratory gases within an aggregation of cells in the course of the biological oxidation of nutrients.

The oxygen received by the cells from the capillary blood is consumed in oxidative metabolism, and at the same time the metabolic end product carbon dioxide is released into the capillary blood

b) Differences

| Photosynthesis | Tissue respiration |
|--|---|
| - Anaerobic reaction | - Catabolic reaction |
| - Occurs within chloroplasts | - Occurs within mitochondrion |
| - Endothermic reaction | - Exothermic reaction |
| - Takes in CO ₂ and releases O ₂ | - Takes in O ₂ and releases CO ₂ |
| - Last electron acceptor is ATP | - Last electron acceptor is O ₂ |
| - $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$ | - $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O} + \text{E}$ |

Or

| PHOTOSYNTHESIS | RESPIRATION |
|--|---|
| It takes place in cells containing chlorophyll. | It takes place in all living cells. |
| It occurs in presence of sunlight. | It requires no light to occur. |
| Carbon dioxide and water are used to prepare food (glucose). | Food (glucose) is oxidized by atmospheric oxygen. |
| Energy is stored. | Energy is released. |
| Chloroplast plays the main role. | Mitochondria plays the main role. |
| Only plants and some algae perform photosynthesis. | All living organisms perform respiration. |

Similarities

- Both are enzyme controlled
- Both occur in steps
- Both require the transport of electrons
- Both produce ATP (both involve phosphorylation)
- Both intervene in gaseous exchange
- Both take place within cell (intracellular reactions)

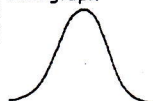
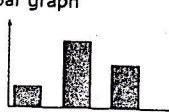
Or

| Respiration | Photosynthesis |
|--|--|
| Form of metabolism | Form of metabolism |
| Breakdown molecules to capture energy | Capture energy to build molecules |
| Uses energy stored in chemical bonds (sugar, fat, protein) | Uses light energy from the sun |
| Occurs inside the cell in specialized compartments called mitochondria | Occurs inside the cell in specialized compartments called chloroplasts |
| Happens in humans, animals, plants, and microorganisms | Happens in plants and microorganisms |
| Includes a metabolic pathway for breaking down sugar | Includes a metabolic pathway for building sugar |
| Uses an electron transport chain to make energy (ATP) | Uses an electron transport chain to make energy (ATP) |
| Gets rid of excess electrons by dumping them on oxygen | Steals electrons from water leaving behind waste oxygen |

18. a) What is variation? Give an example. 2 marks
 b) Give the two types of variation. 2 marks
 c) There are many ways in which humans can vary from each other. For each of these ways indicate whether you think the variation you have mentioned is due to genes or environmental influence or both. 6 marks

Answer:

- a) Variation, in biology, any difference between cells, individual organisms, or groups of organisms of any species caused either by genetic differences (genotypic variation) or by the effect of environmental factors on the expression of the genetic potentials (phenotypic variation). Variation may be shown in physical appearance, metabolism, fertility, mode of reproduction, behaviour, learning and mental ability, and other obvious or measurable characters.
 Example: our eye colour is inherited from our parents.
- b) There are two forms of variation: continuous and discontinuous variation. but also we can have genetic and environmental variation.

| | Continuous variation | Discontinuous variation |
|----------------|--|---|
| Properties | <ul style="list-style-type: none"> - No distinct categories - No limit on the value - Tends to be quantitative | <ul style="list-style-type: none"> - Distinct categories. - No in-between categories - Tends to be qualitative |
| Examples | <ul style="list-style-type: none"> • height • weight • heart rate • finger length • leaf length | <ul style="list-style-type: none"> • tongue rolling • finger prints • eye colour • blood groups |
| Representation | Line graph  | Bar graph  |
| Controlled by | A lot of Gene and environment → range of phenotypes between 2 extremes, e.g. height in humans. | A few genes → limited number of phenotypes with no intermediates e.g. A, B, AB and O blood groups in humans |

c)

| Variations | Genetic | environmental |
|-----------------|--------------------------|--------------------------|
| Eye colour | <input type="checkbox"/> | |
| Skin tone | <input type="checkbox"/> | |
| Shape (ex face) | <input type="checkbox"/> | <input type="checkbox"/> |
| Weight | <input type="checkbox"/> | <input type="checkbox"/> |
| Height | | <input type="checkbox"/> |
| Skin colour | <input type="checkbox"/> | <input type="checkbox"/> |
| Blood group | <input type="checkbox"/> | |
| Sex | <input type="checkbox"/> | |

19. Write short notes on the ecological aspects of the following: 10 marks

- Conservation.
- Deforestation.

Answer:

a) **Conservation:**

Conservation biology is the scientific study of nature and of Earth's biodiversity with the aim of protecting species, their habitats, and ecosystems from excessive rates of extinction and the erosion of biotic interactions.

b) **Deforestation:**

Deforestation is the permanent destruction of forests in order to make the land available for other uses.

Some other common reasons are:

- To make more land available for housing and urbanization
- To harvest timber to create commercial items such as paper, furniture and homes

- To create ingredients that are highly prized consumer items, such as the oil from palm trees
 - To create room for cattle ranching
20. a) Distinguish between Aerobic and Anaerobic respiration. 10 marks
- b) Outline the process of glycolysis.
- c) How is energy produced in glycolysis?

Answer:

- a) Difference between aerobic and anaerobic respiration

| | |
|-------------------------------|-----------------------------------|
| Aerobic respiration | Anaerobic respiration |
| Occurs in presence of oxygen | Occurs in absence of oxygen |
| Produces 38ATP (many) | Produces 2ATP (few) |
| Waste products have no energy | Waste products have enough energy |

b)

Glycolysis takes place in the cytoplasm: it produces 2 pyruvate molecules, 2 ATP, 2 NADH, and 1 H⁺ from every glucose molecule.

Glycolysis has 4 main stages

1. Phosphorylation (means phosphates are added)

Two phosphate groups are added to 1 glucose molecule to create 1 hexose biphosphate molecule. The phosphate groups are provided by 2 ATP molecules.

2. Lysis (means molecules are split)

The hexose biphosphate molecule is broken into 2 molecules of triose phosphate.

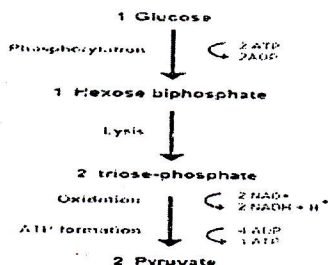
3. Oxidation (means hydrogens are lost)

Two atoms of hydrogen are removed from each triose phosphate molecule and added to 2 molecules of NAD⁺.

4. ATP formation (means ADP is phosphorylated)

Pyruvate is formed by transferring 2 phosphate groups from each triose-phosphate molecule to 4 molecules of ADP.

Or



GLYCOLYSIS

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Or again

It occurs in cytoplasm;

- hexose is phosphorylated using ATP;
 - hexose phosphate is split into two triose phosphates;
 - oxidation by removal of hydrogen; (do not accept hydrogen ions/protons)
 - conversion of NAD to NADH (+H⁺);
 - net gain of two ATP / two ATP used and four ATP produced;
 - pyruvate produced at the end of glycolysis;
- c) In the second half of glycolysis, energy is released in the form of 4 ATP molecules and 2 NADH molecules.
- The net energy release in glycolysis is a result of two molecules of glyceraldehyde-3-phosphate entering the second half of glycolysis where they are converted to pyruvic acid.
 - Substrate-level phosphorylation, where a substrate of glycolysis donates a phosphate to ADP, occurs in two steps of the second-half of glycolysis to produce ATP.
 - The availability of NAD⁺ is a limiting factor for the steps of glycolysis; when it is unavailable, the second half of glycolysis slows or shuts down.

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SECTION A: Answer ALL questions /70 marks

01. a) Give two advantages of the electron microscope over a light microscope. **2 marks**
b) What is the difference between magnification and resolution? **3 marks**

Answer:

- a) Two advantages of the electron microscope over a light microscope:

- The resolution is 0.1 nm(2000x more than in the light microscope)
- Electron microscope can be used to produce detailed images of the structures (organelles) inside cells.
- Sees greater details/ can see in 3D image
- Sees smaller organelles/objects/ structures
- Has greater magnification
- Has greater resolving power

- b) Magnification is the number of times greater an image is than the object while Resolution is the ability to distinguish two separate points as distinct from each other.

02. Give at least four differences between Eukaryotic and Prokaryotic cells. **4 marks**

Answer:

Differences between Eukaryotic and prokaryotic cells