MARKING GUIDE PAPER 2 SENIOR FIVE EOT ONE.

A scientist investigates the roles of organelles in the **synthesis** and **transport** of **polypeptides** through cells. The scientist:

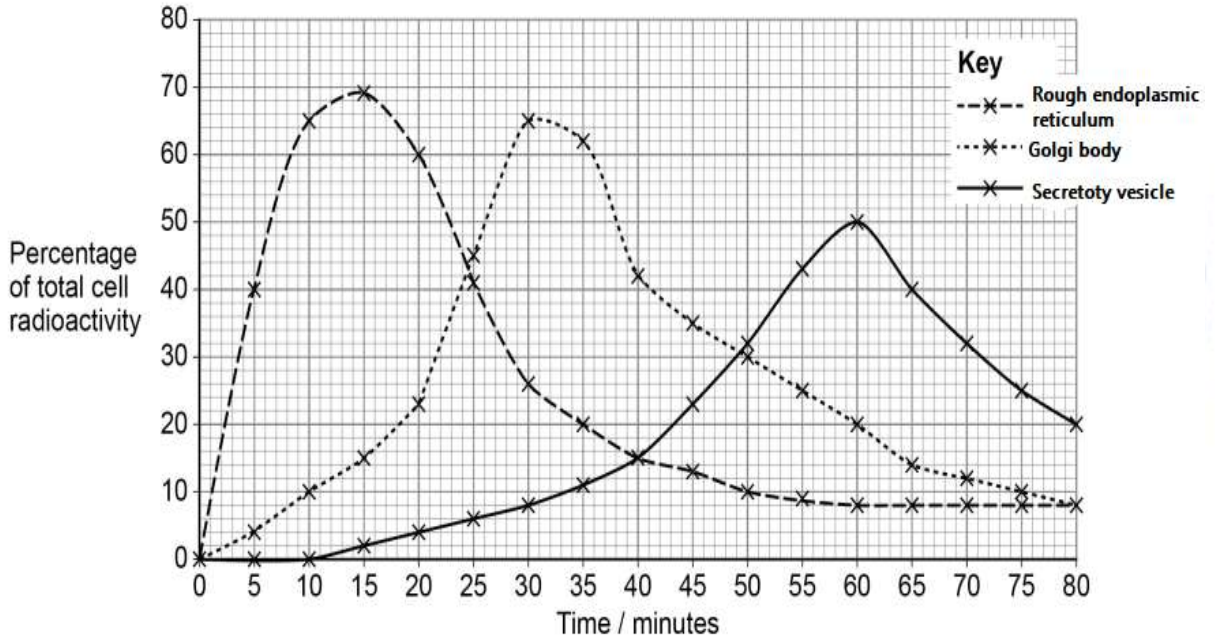
• Isolates cells and incubates them in a liquid containing **radioactively labelled amino acids**. Solution was **isotonic**, **buffered** and **nutrient rich**.

• Leaves the cells for 80 minutes so that they have time to absorb the radioactively labelled amino acids and **synthesise polypeptides**.

• Measures the radioactivity of 3 different types of organelle at 5-minute intervals.

• Calculates the percentage of the total cell radioactivity in each type of organelle.

Figure below shows the percentage of total cell radioactivity in the **Rough endoplasmic reticulum**, **Golgi body a**nd **Secretory vesicle.** Study it carefully and provide credible responses**.**



a) Compare the percentage of total cell radioactivity in the **Golgi body** and **secretory vesicle**. **(05 marks)**

Similarities

(In both) the Golgi body and Secretory vesicles, the percentage of total cell radioactivity.

Is equal/same/equivalent at 49.5 minutes;

Increases/rises;

Decreases/Falls;
Peaks/attain maximum percentage;
Curves show similar general shape;
Initially are low; **Any (02)**

Differences

Golgi body	Secretory vesicle.
Attain peak earlier	Attains peak later;
From 30 minutes to 60 minutes, percentage of total cell radioactivity decreases	Percentage of total cell radioactivity increases;
From 20 minutes to 30 minutes, percentage of total radioactivity increased rapidly	Percentage of total cell radioactivity increased gradually;
From 0 minute to 10 minutes, percentage of total cell radioactivity increased gradually	Percentage of total cell radioactivity was zero;
Below 49.5 minutes, percentage of total cell radioactivity was higher	Percentage of total cell radioactivity was lower;
Above/Beyond 49.5 minutes, percentage of total cell radioactivity was lower	Percentage of total cell radioactivity was higher;
Percentage of total cell radioactivity decreased gradually after the peak	Percentage of total cell radioactivity decreased rapidly after the peak;
Percentage of cell total radioactivity began at zero	Percentage of total cell radioactivity began at 10 minutes
Higher peak or maximum attained	Lower peak or maximum attained; Any (03)

b) Describe the **relationship** between the percentage total cell radio-activities in the following organelles.

(i) Rough endoplasmic reticulum and Golgi body. **(06 marks)**

Initially/At 0-minute, in both the Golgi body and rough endoplasmic reticulum the percentage of total cell radioactivity was zero; 01

From 0-minute to 15-minutes, percentage of the total cell radioactivity in both Golgi body and Rough endoplasmic reticulum (RER) increased; 01

From 15 minutes to 24.5 minutes, as the percentage of total cell radioactivity in RER decreased, that in Golgi body increased; 01

At 24.5 minutes, Percentage total cell radioactivity in both RER and Golgi body were equal/equivalent/same; 01

From 24.5 minutes to 30 minutes, Percentage of total cell radioactivity decreased in RER while increased to peak in Golgi body; 01

From 30 minutes to 60 minutes, Percentage of total cell radioactivity in both Golgi body and RER decreased; 01

From 60 minutes to 80 minutes, percentage of total cell radioactivity in RER remained constant while that of Golgi decreased; 01

(ii) Golgi body and secretory vesicle. **(06 marks)**

Initially/At 0-minute, in both the Golgi body and secretory vesicle the percentage of total cell radioactivity was zero; 01

From 0-minute to 10-minutes, as the percentage of total cell radioactivity in Golgi body increased, that in secretory vesicle was Zero; 01

From 10-minutes to 30-minutes, percentage of total cell radioactivity increased in both the Golgi body and secretory vesicle; 01

From 30 minutes to 49.5 minutes, as the percentage of total cell radioactivity decreased in Golgi body, that of the secretory vesicle increased; 01

At 49.5 minutes, in both the Golgi body and secretory vesicle, percentage of total cell radioactivity was equal/same/equivalent; 01

From 49.5 minutes to 60 minutes, as the percentage of total cell radioactivity decreased in Golgi body, that of the secretory vesicle increased to peak; 01

Beyond 60 minutes, in both the Golgi body and Secretory vesicle, percentage of total radioactivity decreased; 01

C) Explain the **relationship** between the total **radio-activities** in the following organelles.

(i) Rough endoplasmic reticulum and Golgi body**.** **(08 marks)**

Initially/At 0-minute, in both the Golgi body and rough endoplasmic reticulum the percentage of total cell radioactivity was zero because ribosomes are carrying out translation/synthesis of polypeptides; 01

From 0-minute to 15-minutes, percentage of the total cell radioactivity in both Golgi body and Rough endoplasmic reticulum (RER) increased because polypeptides enter the cisternae/cavities/lumen of RER for folding into tertiary structure;

Vesicles containing proteins bud/Pinch off from RER and fuse with the Cis Face of the Golgi body; 02

From 15 minutes to 24.5 minutes, as the percentage of total cell radioactivity in RER decreased, that in Golgi body increased because vesicles bud off from the RER and fuse with Golgi body; 01

At 24.5 minutes, Percentage total cell radioactivity in both RER and Golgi body were equal/equivalent/same because RER exports many proteins to Golgi body while the Golgi body starts to export few proteins by forming few secretory vesicles/granules; 01

From 24.5 minutes to 30 minutes, Percentage total cell radioactivity decreased in RER while increased to peak in Golgi body because vesicles bud off from RER and fuse with Golgi body; 01

From 30 minutes to 60 minutes, Percentage total cell radioactivity in both Golgi body and RER decreased because both compartments/organelles are exporting protein by vesicles; 01

From 60 minutes to 80 minutes, percentage of total cell radioactivity in RER remained constant while that of Golgi decreased because of depletion/exhaustion of protein in RER due to export to Golgi body; and the Golgi body forms secretory vesicles; 01

(ii) Golgi body and secretory vesicle. **(08 marks)**

Initially, in both the Golgi body and secretory vesicle the percentage of total cell radioactivity was zero because of no protein export; 01

From 0-minute to 10-minutes, as the percentage total cell radioactivity in Golgi body increased, that in secretory vesicle was Zero because proteins are exported to Golgi body by vesicles budded off from RER; and the Golgi body has not started to bud off forming secretory vesicles; 02

From 10-minutes to 30-minutes, percentage of total cell radioactivity increased in both the Golgi body and secretory vesicle because vesicles from RER fuse with the Golgi body; and Golgi body pinches off to form secretory vesicles; 02

From 30 minutes to 49.5 minutes, as the percentage total cell radioactivity decreased in Golgi body, that of the secretory vesicle increased because the Golgi body pinches off forming secretory vesicles; 01

At 49.5 minutes, in both the Golgi body and secretory vesicle, percentage total cell radioactivity was equal/same/equivalent because Golgi body pinches off forming secretory vesicles which are within the cytoplasm and have not carried out exocytosis; 01

From 49.5 minutes to 60 minutes, as the percentage of total cell radioactivity decreased in Golgi body, that of the secretory vesicle increased to peak because Golgi body bud off to form secretory vesicles; 01

Beyond 60 minutes, in both the Golgi body and Secretory vesicle, percentage of total radioactivity decreased because both organelles export the proteins; 01

d) With reasons, suggest explanations for the following observations.

(i) Using amino acid that was radioactively labelled. **(01 marks)**

To track the movement/make them detectable;

ii) Buffered, isotonic and nutrient rich solution. **(04 marks)**

Buffered to resist changes in P^H; which may cause <u>denaturation</u> of metabolic enzymes; Prevent disruption of cell membrane structure. Isotonic to prevent osmotic shocks/lysis; or crenation/shrinking; Nutrients are used by Mitochondria to provide energy (ATP) for protein or enzyme synthesis, Vesicular transport and exocytosis;

e) Calculate the **mean rate** of change in percentage radioactivity from 60 to 80 minutes for secretory vesicle. **(02 marks)**

$$\text{Rate} = \frac{50-20}{80-60}$$

$$= \frac{30}{20};$$

= <u>1.5</u> percentage per-minute;

<u>SECTION B (60 marks)</u>

<u>Choose three questions from this section.</u>

2a) Describe the **main components** of connective tissues. **(06 marks)**

Cells; Fibroblasts, Macrophages, Lymphocytes, adipocytes, Mast cells, Osteoblasts and Chondroblasts; Any one cell mentioned.

Matrix; Mucopolysaccharide where cells and fibres are embedded;

Fibres; Collagen, reticular and elastic/elastin fibres; Any one fibre mentioned.

b) Explain the **significances** of the main **mammalian** connective tissues. **(14 marks)**

Connective tissues	Function
Bone;	Forms skeleton, protects, supports the main body organs and anchors muscles; Any one mentioned.
Tendon;	Attaches muscles to bone;
Ligament;	Attaches bones to bones and provides support in joints;
Cartilage;	Smoothes surfaces of joints, prevents collapse of

	trachea and bronchi;
Adipose tissue;	**Stores fats and provides insulation;**
Blood;	**Transports substances around the body; AVP**
Areolar tissue;	**Protects organs, blood vessels and nerves, gives strength to epithelial tissue, general packing tissues;**

3a) Describe the **structure** of the following protein levels.

(i) Primary structure. **(03 marks)**

Linear sequence of amino-acids; in the polypeptide chain(s); held by peptide bonds;

(ii) Secondary structure. **(07 marks)**

Polypeptides fold; into alpha; and Beta sheets; sustained by hydrogen bonds;

Alpha helix - one polypeptide; coiled/folded; into cylindrical/spiral shape;

Beta sheet- two or more polypeptides; lie parallel; or anti-parallel; giving rise to flat sheets;

(iii) Tertiary structure. **(05 marks)**

Three dimensional shape; produced when sequence of amino-acids which produces alpha helix and Beta pleated sheets bend at particular places along the chain; giving rise to attractive forces stabilizing the structure like disulphide bridges, ionic, hydrogen bonds; hydrophilic amino acids point outwards; and hydrophobic amino acids or side chains point inwards sustained by hydrophobic interactions;

b) Explain the reasons behind the **existence of a variety** of carbohydrates. **(06 marks)**

Form 1,4 and 1,6-glycosodic linkages;
Pentoses and hexoses form polysaccharides;
Straight/linear and branched types;
Alpha and beta isomers;
Ketoses and aldoses exist;
Reactivity of monosaccharides to form polymers;

4a) Describe the **chemical composition** of **chromosomes**. **(06 marks)**

Proteins; Histone, Scaffold and Polymerases;

Deoxyribonucleic acid; double helix with genes;

Ribonucleic acids; single stranded;

b) Explain how the following mechanisms cause **genetic variation** in populations.

(i) Crossing over. (03 marks)

Crossing over; blocks of genes are swapped between non-sister chromatids at chiasmata; bringing some genes together and separating others/creating new genetic combinations;

(ii) Independent segregation and assortment. (05 marks)

Homologous chromosomes arrange themselves randomly; at the equator of the cell during metaphase I of meiosis; each pair determines same general feature but differ in details of the features; Random segregation of chromosomes into gametes; several sorts of combinations results in the gametes;

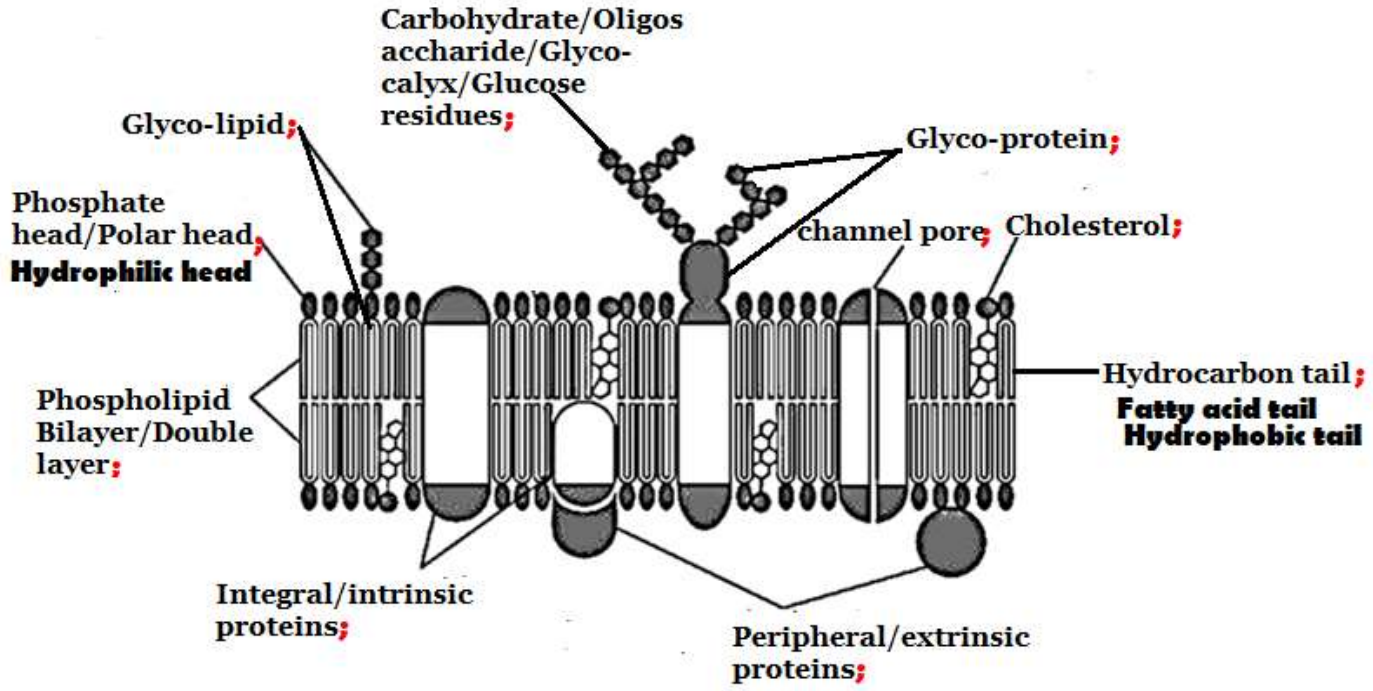
c) Differentiate between **cell division** and **nuclear division** in a life cycle of a cell. **(05 marks)**

Cell division	Nuclear division
Final step;	Initial step;
Different in plants and animals	Similar in plants and animals;
Involves duplication of cell organelles	Involves duplication of chromosomes;
Daughter cells are always similar	Daughter nuclei may or may not be similar;
No spindle formation	Spindle formation occurs;
Always preceded by nuclear division	Often, but not always followed by cell division;
Cytoplasm divides into two	Nucleus divides into two or four;
Equal distribution of cytoplasm and its contents	Equal distribution of genetic materials;
Less time taken	More time taken;

5a) Describe the structure of the **cell membrane** in accordance to the **fluid mosaic** model. **(10 marks)**

Bimolecular layer of phospholipids; with inwardly directed hydrophobic tails; and outwardly directed hydrophilic heads; protein molecules with irregular/scattered arrangement; some proteins occur on the surface of the phospholipid layer/peripheral/extrinsic; while some extend partly into it/integral/intrinsic; some extend completely across/trans-membrane proteins; present between phospholipids is cholesterol; glycoproteins and glycolipids; which are antennae like structures at the surface;

Mark a well labelled drawing with 10 key parts labelled.



b) Explain how the **cell membrane shows selectivity** of transport of materials. **(10 marks)**

Lipid double/Bi-layer; allows passage of water and small non-polar molecules; Channel proteins; allows passage of specific molecules of appropriate charge and size; through the hydrophilic pores; Gated proteins; open in presence of solutes to transport or change in potential difference; Carrier proteins; with binding/receptor sites

where specific molecules bind for transport along concentration gradient; Biological or Metabolic pumps; use ATP to transport molecules against their concentration gradients; like Na-K-ATPase pump;

Too big or large molecules are stopped from entering the cell membrane;

6a) Describe the following key stages in protein synthesis.

(i) Amino-acid synthesis. **(05 marks)**

In plants, Nitrates are reduced to amino group or ammonia; combination of amino group with a carbon skeleton /Alpha-ketogluterate; transamination forms the 20 amino acids which make protein structures;

In animals, essential amino-acids are supplied in the diet; and non-essential amino acids are made by the liver;

(ii) Amino acid activation. **(05 marks)**

Amino acid forms an intermediate/reacts with ATP; intermediate combines with transfer RNA; at the amino acid attachment site/acceptor arm; forming amino acid-tRNA complex; catalyzed/controlled by amino-acyl tRNA synthetase;

b) (i) What is meant by **a genetic code**? **(03 marks)**

Sequence of nucleotides on the DNA coding for amino acids making up protein structures; Stored in the molecular structure of DNA; Copied into molecular structure of mRNA during transcription;

(ii) Describe the different **properties** of **a genetic code.(07 marks)**

A few amino acids have only a single triplet code eg tryptophan;

Code is Polar; read in 5' to 3' direction;

Code degenerate; amino acids have more than one triplet code;

Some codons are start codons ie codon AUG;

Three codons UAA, UGA and UAG; are no sense/stop codons/don't code for amino acids;

Non overlapping; each base in a sequence is read only once;

Universal; same in all organisms;

Triplet codon; corresponding to one amino acid;

Code is commaless; after coding for one amino acid, next amino acid is automatically coded;
Non-ambiguous; particular codon will always code for same amino acid;

……END……

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EXTENSION FOR READING

Conventional symbols as used in the guide.

A Semicolon (;) –separates each point. **An oblique stroke** (/)- separates alternative within the a mark point. **Underlining of a word or phrase-** means the term must be used by candidate. **Brackets**- used to indicate contexts for which a mark point is valid. **Accept or reject**- shows answers which should be allowed or not allowed.
Owtte- Other words to the effect.

The trajectory must be similar to the combination of simple molecules into Complex ones and their evolution via Coecervates to probionts!

Comprehensive Biology Transformation Initiative (CBTI).

Kampala –Uganda.

Contributions made by MUGWE MARTIN.