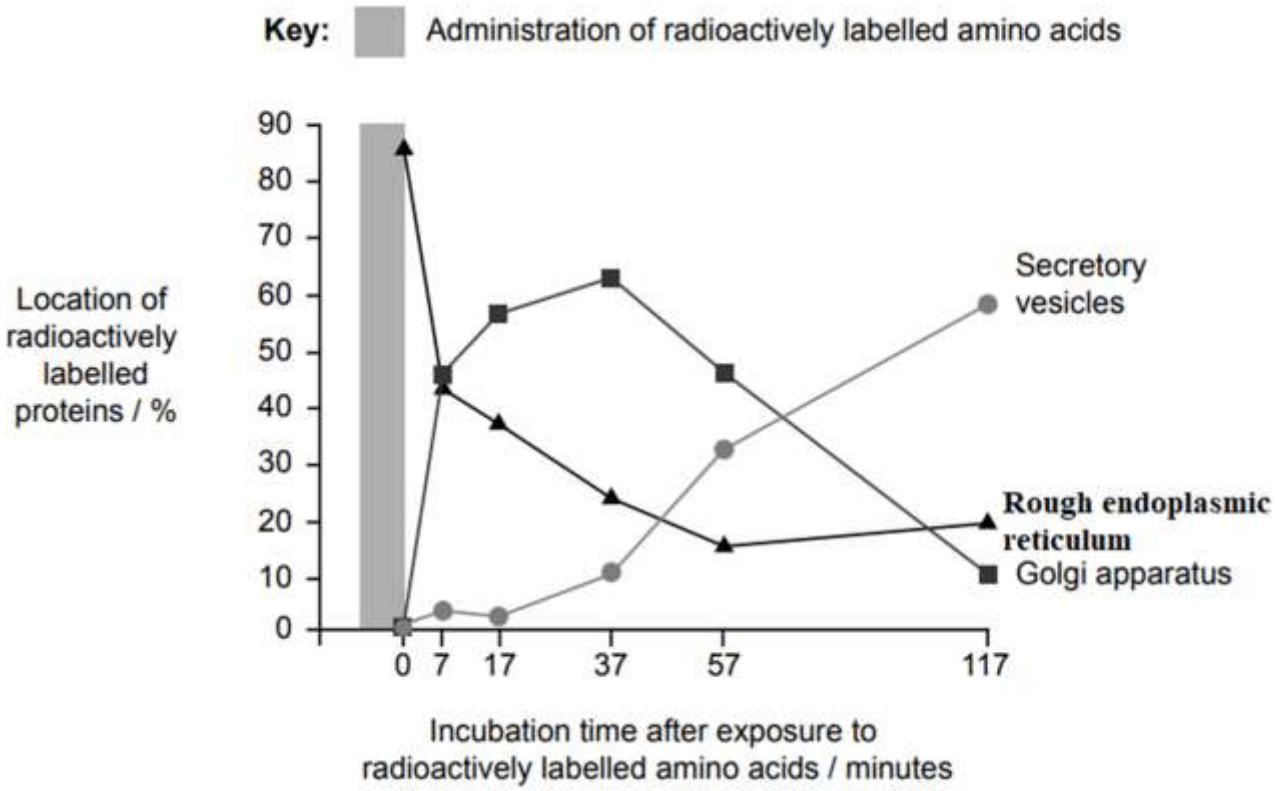
MARKING GUIDE S.5 PAPER 2 EOT-ONE

1.In an experiment investigating the secretion of proteins by gland cells, researchers supplied radioactively labelled amino acids to a sample of pancreas cells that secrete digestive enzymes. The graph shows the relative abundance of radioactively labelled proteins in three different organelles during the period after the cells were exposed to the radioactively labelled amino acids.



a) Compare the percentage location of the radioactively labelled proteins in the **Golgi body** and **Rough endoplasmic reticulum.** **(05 marks)**

Similarities.

(In Both) the percentage location of radioactively labelled proteins

Increases/rises;

Decreases/falls; **(02)**

Equal/same/equivalent at 7 minutes and 115 minutes;

Differences

Golgi body	Rough endoplasmic reticulum
From 0 minute to 7 minutes, percentage of radioactively proteins increased rapidly;	Percentage of radioactively proteins decreased rapidly;
From 7 minutes to 37 minutes, percentage of radioactively labelled proteins increased gradually;	Percentage of radioactively proteins decreased gradually;
From 57 minutes to 117 minutes, percentage of radioactively labelled proteins decreased gradually;	Percentage of radioactively labelled proteins increased gradually/slightly;
Initially/at O minute, percentage of radioactively labelled proteins was Zero/lower;	Percentage of radioactively labelled proteins was higher;
Between 7 minutes to 115 minutes, percentage of radioactively proteins was higher;	Percentage of radioactively proteins was lower;
Below 7 minutes, percentage of radioactively labelled proteins was lower;	Percentage of radioactively labelled proteins was higher;
Beyond 155 minutes, percentage of radioactively labelled proteins was lower;	Percentage of radioactively labelled proteins was higher;

Any (03) differences.

b) Describe the changes in the percentage location of the radioactively labelled protein in the following **Organelles.**

(i) **Golgi body** **(03 marks)**

From 0 minute to 7 minutes, percentage of radioactively labelled proteins increased rapidly; 01

From 7 minutes to 37 minutes, percentage of radioactively labelled proteins increased gradually to peak; 01

From 37 minutes to 117 minutes, percentage of radioactively labelled proteins decreased gradually; 01

(ii) **Rough endoplasmic reticulum.** **(03 marks)**

From 0 minute to 7 minutes, percentage of radioactively labelled proteins decreased rapidly; 01

From 7 minutes to 57 minutes, percentage of radioactively labelled proteins decreased gradually; 01

From 57 minutes to 117 minutes, percentage of radioactively labelled proteins increased slightly or gradually; 01

(iii) **Secretory vesicle.** **(04 marks)**

From 0 minute to 17 minutes, percentage of radioactively labelled proteins remained almost constant; 01

From 17 minutes to 37 minutes, percentage of radioactively labelled proteins increased gradually; 01

From 37 minutes to 57 minutes, percentage of radioactively labelled proteins increased rapidly; 01

From 57 minutes to 117 minutes, percentage of radioactively labelled proteins increased gradually; 01

c) Account for the changes above in (b) **(15 marks)**

<u>Golgi body</u>

Golgi body modifies proteins by adding Carbohydrates (Glycosylation) or Lipids (protein lipidation), phosphates, functional groups, packages and transports proteins or enzymes; 01

From 0 minute to 7 minutes, percentage of radioactively labelled proteins increased rapidly because (Many) Vesicles bud/pinch off from RER and Fuse with the (Cis Face of) Golgi body; 01

From 7 minutes to 37 minutes, percentage of radioactively labelled proteins increased gradually to peak because (few) vesicles carrying

remaining few proteins bud off from RER and fuse with the Golgi body/secretory vesicles start to bud off from Golgi body; 01

From 37 minutes to 117 minutes, percentage of radioactively labelled proteins decreased gradually because Secretory granules/Golgi vesicles bud off from Golgi body and fuse with plasma membrane for exocytosis of proteins; 01

<u>Rough endoplasmic reticulum</u>

Radioactively labelled amino acids are actively taken up by cells and carried to ribosomes coated on the RER by tRNA; ribosomes are sites for formation of polypeptides/translation; polypeptides enter into cisternae/cavities/lumen where they fold into tertiary structure of enzymes; 02

From 0 minute to 7 minutes, percentage of radioactively labelled proteins decreased rapidly because very (many) vesicles bud/pinch off from RER and fuse with Golgi body; 01

From 7 minutes to 57 minutes, percentage of radioactively labelled proteins decreased gradually because few vesicles carrying the remaining proteins bud off from RER and fuse with Golgi body; 01

From 57 minutes to 117 minutes, percentage of radioactively labelled proteins increased slightly because ribosomes make few polypeptides that enter cavities of RER for folding and packaging; 01

<u>Secretory Vesicles</u>

Secretory Vesicles transport the proteins/enzymes/zymogens/pro-enzymes to cell membrane for exocytosis or to other parts of the cell; 01

From 0 minute to 17 minutes, percentage of radioactively labelled proteins remained almost/fairly constant because secretory vesicles containing enzymes have not budded off from Golgi body/Golgi body

are still modifying proteins/sorting/ packaging or transporting proteins through their cavities/cisternae/lumen; 01

From 17 minutes to 37 minutes, percentage of radioactively labelled proteins increased gradually because (few) secretory vesicles budded off from the Golgi body; 01

From 37 minutes to 57 minutes, percentage of radioactively labelled proteins increased rapidly because of (many) secretory vesicles bud off from Golgi body; 01

From 57 minutes to 117 minutes, percentage of radioactively labelled protein increased gradually because few Secretory vesicles bud off from Golgi body carrying away the few remaining proteins; 01

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

(i) Using amino acids that were radioactively labelled.

(01 marks)

To track the movement/make them detectable; 01

(ii) Gland cells that secrete large volumes of fluid typically have many aquaporins in their plasma membranes. **(02 marks)**

Allow water movement into cells and fluid secretion by the cell; rate of water transport by aquaporins is not very high hence many needed; 02

e (i) After synthesis, globular proteins assume their final tertiary structure. Explain the relationship between the sequence of amino acids and the tertiary structure of globular proteins

(05 marks)

Sequence of amino acids determines the tertiary structure of a protein; tertiary structure formed due to the folding of a polypeptide chain(s);

R groups of amino acids can be polar or non-polar;

Protein folds with Polar groups outside and non-polar groups inside;

Folding forms bonds sustaining the structure example Hydrogen/covalent/ionic bond/disulphide bridges; 05

(ii) Using the graph above, point out the significances of **compartmentalization** in cells. **(02 marks)**

Division of Labour/specialization by organelles leading to efficiency;

Creation of specific micro-environments for opposing reactions;

Harmful reactants and enzymes are isolated from rest of cell to avoid damage;

Increasing surface area to volume ratio for reactions;

02

SECTION B (60 MARKS)

Choose three questions from this section.

2 a) Outline the **structure** of **DNA**. **(07 marks)**

Very long and large; two polynucleotide chains; anti-parallel; double helix; with nucleotides; containing Phosphate group, sugar, deoxyribose and nitrogenous bases; sugar phosphate backbone with 3'5'-phosphodiester linkages; Strands held by weak hydrogen bonds between complementary bases;

Accept Annotated drawing of DNA. 07

b) Explain why **proteins** show **infinity** variety. **(07 marks)**

Protein variety depends on the sequence of amino acids in each protein; 20 amino acids form protein structures; each with its own code of nucleotide bases on the DNA; four organic bases exists A (adenine) G (Guanine), C (Cytosine) and T (thymine); and triplet code forms an amino acid; triplet of organic bases produces 64 codes more than enough to satisfy requirements of 20 amino-acids; Also post-translational modifications; and splicing; 07

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c) Describe the process of **transcription** in eukaryotes. **(06 marks)**

RNA polymerase; binds to promoter/initiation region and unwinds/unzips the cistron/segment of DNA/gene;
RNA polymerase moves along the template strand; ribonucleotides are taken from nucleoplasm and matched up in precise way/adding complementary nucleotides forming mRNA;
RNA polymerase reaches end of the gene/termination sequence/Stop code; releases fully made mRNA/mRNA detaches;
Accept -Helicase enzyme unwinding cistron or gene.

3 a)(i) Explain how **enzyme activities are controlled** in humans.
(05 marks)

Activators; increase enzyme activity; 01
Inhibitors; reduce enzyme activities; 01
Compartmentalization; enzymes are stored in membranes to prevent damage of cells; 01
Feed-back inhibition; enzymes are inhibited by end products when they accumulate beyond norm/set-point; 01
Enzyme secreted in inactive forms/Zymogens; preventing activity in wrong places; 01
Genetic information contained in DNA; controls enzymes to be synthesized and level of metabolism; 01
Specificity of enzymes; catalyzing specific reaction; 01
Precursor activation; accumulation of the substrates causes the reaction to start by substrates binding with allosteric sites; 01

Award halves. Any 05 points.

(ii) Compare **competitive** and **non-competitive inhibition** of enzymes.
(07 marks)

Similarities

Both are reversible reactions/mechanisms;
Both reduce enzyme reaction when bind to enzymes; 02
Both regulate enzyme activity;
Both affect the rate of reaction;
Both interfere with the functioning of enzyme active site;

Differences.

Competitive inhibition	Non-competitive inhibition.
Inhibitor has same shape as the substrate	Inhibitor and substrate have different shapes;
Inhibitor binds to active site	Inhibitor binds to other site other than active sites;
Can be overcome by increasing substrate concentration	Cannot be overcome by increasing substrate concentration;
Substrate compete for active sites with Inhibitor	No competition of substrate with inhibitor for allosteric site;
Doesnot alter shape of active sites;	Alters the shape of active sites;
Enzyme binds with either substrate or inhibitor	Enzyme binds with both substrate and inhibitor;
	Any (05) points.

b) Explain **properties of water** which makes it a good transport medium in organisms. **(08 marks)**

Universal solvent; due to polar nature dissolves most substances;
High cohesion; water molecules stick together/form hydrogen bonds which allows water to form continuous column in the xylem;
High adhesion; attaches to the walls of the xylem/polar surfaces for upward water movement;
High specific heat capacity; prevent change in temperature of materials transported/maintain stable internal body temperature;
Liquid at room temperature; allows flow through tubes/vessels easily;
High surface tension; form small droplets that easily pass through aquaporins/water channels;
Neutral; doesnot react with materials transported;
High latent heat of fusion; prevents materials transported freezing due to fall in temperature; **Any Four points.**
High tensile strength; water column doesn't break/collapse in the xylem;
Low viscosity; allows rapid flow of water through tubes/vessels;

4a) Describe the structure of the following specialized tissues.

(i) **Xylem tissue.** **(05 marks)**

Tracheids; elongated; spindle shaped cells; arranged in rows; (end to end) thin or slender; tapered sloping end walls overlap; walls thickened with lignin; side walls perforated by pits; hollow/empty lumen/cavity; **Accept Polygonal in cross section.**

Accept well Annotated drawings.

Vessel cells; elongated; cylindrical shape; thickened; with lignin deposited; hollow/cavities/ empty lumen; broken end walls; with cells joined end to end; with pits in side walls; **10 points**

Accept Tracheid and vessel cells as specialized cells. Ignore other cells.

(ii) **Phloem tissue.** **(05 marks)**

Sieve tubes; elongated; with sieve tube elements joined end to end; cylindrical shape; thin layer of cytoplasm, mitochondria, trans-cellular strands, endoplasmic reticulum; hollow/ lumen/cavity; end wall perforated sieve plates;

Companion cells; dense cytoplasm with many mitochondria and large nucleus; thin cell wall; plasmodesmata linking to sieve tube elements; **10 points**

Accept the companion cells and sieve tubes. Ignore other cells.

b) Describe the classification of **covering epithelia** based on

(i) **Cell arrangement.** **(05 marks)**

Simple epithelia; one cell thick;

Pseudo-stratified epithelia; appear more than one cell thick but all cells rest on the same basement membrane;

Stratified epithelia; many cells thick/multiple layers of cells;

(ii) **Cell shapes.** **(05 marks)**

Squamous epithelia; flattened cells and thin;

Cuboidal epithelia; as wide as it is tall;

Columnar epithelia; taller than their width;

5a) Explain the significance of the **changes in the nucleus** during cell division. **(10 marks)**

Formation of spindle fibres; for chromosome movement to opposite poles/alignment of chromosomes in Metaphase at equatorial plate/separation of chromatids during anaphase; 02

Chiasmata; for crossing over leading to variability; physically link homologous chromosomes together which ensures each gamete receives balanced and diverse set of chromosomes; 02

Synapsis; proper/accurate pairing/alignment of homologous chromosomes which ensures accurate segregation of chromosomes; and allows crossing over; 02

Bivalents; ensures proper segregation of chromosomes during meiosis; allows crossing over; 02

Movement of chromosomes; ensures accurate distribution of genetic materials to daughter cells; 02

Condensation of chromosomes; allows movement of chromosomes without being entangled; 02

Centromere and chromosome division; allow accurate distribution of genetic materials to daughter cells; 02

Any (05) points well explained. Strictly changes during M-Phase.

b) Describe the role of the following in **creating variants** in populations.

(i) Independent assortment and segregation of chromosomes. **(05 marks)**

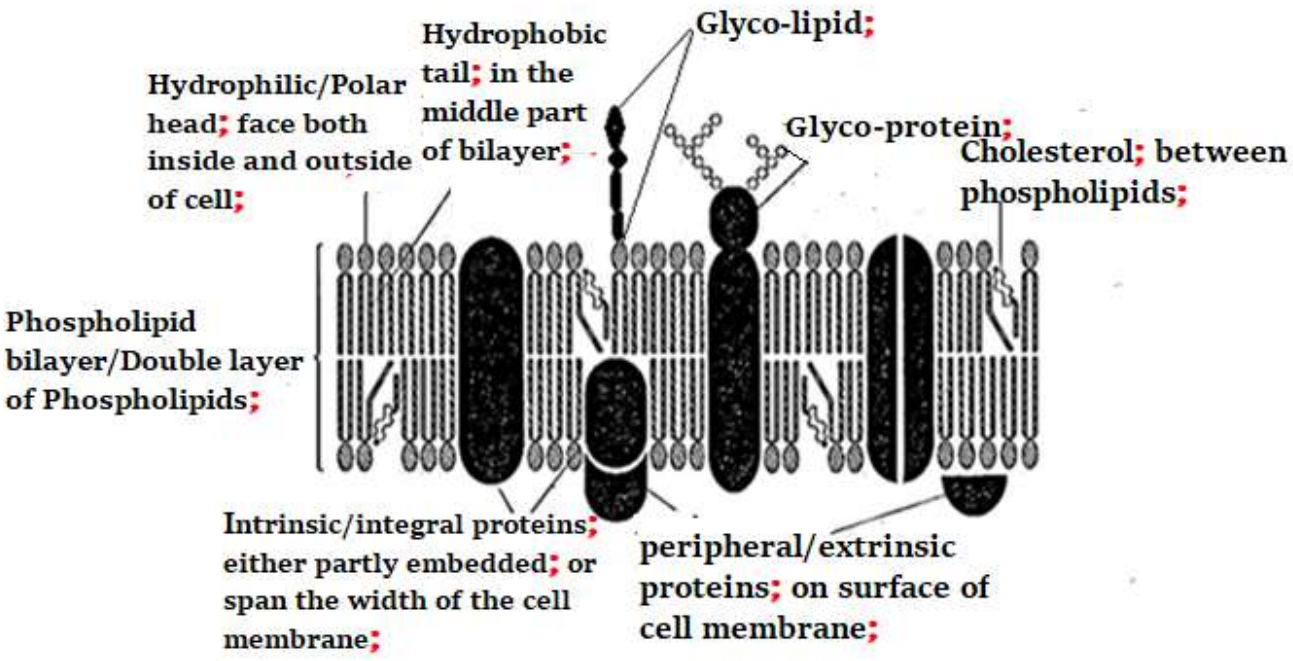
Homologous chromosomes arrange themselves randomly; at the equator of the cell during metaphase I of meiosis; each pair determines same general feature but differ in details of the features; Random segregation of chromosomes into gametes; several sorts of combinations results in the gametes; **05 marks**

(ii) Crossing over. **(05 marks)**

Non sister chromatids twist/wrap around; touching at Chiasmata; equivalent portions/sections of non-sister chromatids are exchanged/swapped; separating linked genes; creating new genetic combinations; 05

6a) Using **annotated** drawing, describe the **cell membrane structure.**

(07 marks)



Don't mark an essay. Strictly mark the annotated drawing. 14 points.

b) Explain the effect of the following on the cell membrane permeability.

(i) **Cholesterol.** **(05 marks)**

Cholesterol is positioned between phospholipids; regulate membrane fluidity; by preventing the cell membrane from solidifying and crystallizing at low temperature; prevents membrane becoming more fluid at high temperature by pulling hydrophobic tails together; reduces permeability to small water soluble molecules;

(ii) **Temperature.** **(05 marks)**

Increase in temperature increases kinetic energy of phospholipids and proteins which move faster with more energy; creating gaps for molecules to move across the membrane; at transitional/critical temperature phospholipids melt; Channel and carrier proteins denature creating big gaps; Low temperature reduces permeability due to rigid fatty acids/fatty acids closely packed;

(iii) **Organic solvents.** **(03 marks)**

Organic solvents dissolve the hydrophobic/hydrocarbon/fatty acid tails/lipids; disruption of the cell membrane structure/integrity occurs; membrane becomes more fluid and more permeable;

Accept- organic solvents denaturing proteins in cell membrane.

END

The Trajectory must be similar to the combination of simple molecules into complex ones and their evolution via coecervates to probionts!

CC- Comprehensive Biology Transformation Initiative..

Contributions made by MUGWE MARTIN.