

VU Learning HUB

BIO5105 Quiz File

Chapter-wise Solved MCQs

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Lesson 1: The Cell Theory and the Discovery of Cells

1. Who completed the cell theory in 1855 by proposing that all cells arise from pre-existing cells (omnis cellula e cellula)?

- A) Robert Hooke
- B) Antonie van Leeuwenhoek
- C) Matthias Schleiden
- D) Rudolf Virchow

2. What is the limit of resolution for a modern light microscope?

- A) 0.2 nanometres
- B) 0.2 micrometres
- C) 0.5 micrometres
- D) 2.0 micrometres

3. Which type of microscopy is specifically used to examine internal cellular ultrastructure at nanometre resolution?

- A) Scanning electron microscopy (SEM)
- B) Transmission electron microscopy (TEM)
- C) Simple light microscopy
- D) Fluorescence microscopy

4. Robert Hooke coined the term "cell" in 1665 after observing which material under a microscope?

- A) Living bacteria
- B) Protozoa in pond water
- C) Cork compartments
- D) Human sperm cells

Answer Key

1. D — Rudolf Virchow completed the cell theory in 1855 with the principle omnis cellula e cellula.
2. B — Modern light microscopy has a resolving power limit of about 0.2 micrometres.
3. B — Transmission electron microscopy (TEM) reveals internal ultrastructure, while SEM examines surfaces.
4. C — Robert Hooke named cells in 1665 after observing cork compartments.

Lesson 2: Prokaryotic versus Eukaryotic Cells

1. Where is the genetic material located in prokaryotic cells such as bacteria and archaea?

- A) Inside a membrane-bound nucleus
- B) In a nucleoid region
- C) Within the Golgi apparatus
- D) Inside a vacuole

2. What geometric constraint limits cell size as a cell grows larger?

- A) Surface area increases faster than volume
- B) Volume rises faster than surface area
- C) DNA content decreases rapidly
- D) Membrane thickness doubles

3. Which organism is identified in the handout as a model organism for studying prokaryotic genetics?

- A) Escherichia coli (E. coli)
- B) Yeast
- C) HeLa cells
- D) Drosophila

4. By which division mechanism do typical prokaryotic cells reproduce?

- A) Mitosis
- B) Meiosis
- C) Binary fission
- D) Budding

Answer Key

1. B — Prokaryotic cells lack a membrane-bound nucleus and hold their DNA in a nucleoid region.
2. B — As a cell grows, volume rises faster than surface area, limiting nutrient uptake and waste exchange.
3. A — Escherichia coli (E. coli) serves as the primary model organism for prokaryotic genetics.
4. C — Prokaryotic cells divide by binary fission, whereas eukaryotic cells divide via mitosis or meiosis.

Lesson 3: The Chemistry of Cells: Biomolecules

1. Which level of protein organization consists of alpha-helices and beta-sheets held together by hydrogen bonds?

- A) Primary structure
- B) Secondary structure
- C) Tertiary structure
- D) Quaternary structure

2. What interaction primarily drives the overall three-dimensional folding in tertiary protein structure?

- A) Hydrophobic interactions
- B) Peptide bonding
- C) Phosphodiester linkages
- D) Glycosidic bonds

3. What effect does denaturation caused by extreme heat or pH changes have on a protein?

- A) It alters the primary amino acid sequence
- B) It destroys protein function by unfolding its structure
- C) It converts the protein into nucleic acids
- D) It increases catalytic enzyme activity

4. How do enzymes function as biological catalysts during chemical reactions?

- A) By raising the activation energy
- B) By lowering the activation energy
- C) By altering the equilibrium constant of the reaction
- D) By permanently changing their own structure

Answer Key

1. B — Secondary structure includes alpha-helices and beta-pleated sheets stabilized by hydrogen bonds.

2. A — Tertiary structure features 3D folding driven primarily by hydrophobic interactions.
3. B — Denaturation caused by heat or pH destroys protein function by unfolding its structure.
4. B — Enzymes function as biological catalysts by lowering the activation energy of reactions.

Lesson 4: The Plasma Membrane and Transport

1. Who proposed the fluid mosaic model of membrane structure in 1972?

- A) Schleiden and Schwann
- B) Singer and Nicolson
- C) Watson and Crick
- D) Robert Hooke

2. What is the specific ion movement executed by the active transport sodium–potassium pump?

- A) 2 Na⁺ out and 3 K⁺ in
- B) 3 Na⁺ out and 2 K⁺ in
- C) 3 Na⁺ in and 2 K⁺ out
- D) 2 Na⁺ in and 3 K⁺ out

3. What happens to red blood cells placed in pure water (a hypotonic environment)?

- A) They undergo crenation and shrivel
- B) They undergo haemolysis and burst
- C) They remain completely unchanged
- D) They divide rapidly via binary fission

4. Which component of the plasma membrane forms the outer glycocalyx involved in cell recognition and immunity?

- A) Phospholipid tails
- B) Cholesterol molecules
- C) Surface carbohydrates (glycolipids and glycoproteins)
- D) Microtubules

Answer Key

1. B — Singer and Nicolson described the fluid mosaic model of membranes in 1972.
2. B — The sodium–potassium pump uses ATP to pump 3 Na⁺ out of the cell and 2 K⁺ into the cell.
3. B — In pure water, red blood cells take in water via osmosis and undergo haemolysis (bursting).
4. C — Surface carbohydrates attached to lipids and proteins form the glycocalyx for cell recognition.

Lesson 5: The Nucleus: Genome Storage and Control

1. What is the first level of chromosome packaging in which DNA wraps around histone proteins?

- A) 30-nm fibre
- B) Nucleosomes
- C) Euchromatin
- D) Heterochromatin

2. Which nuclear subdomain is responsible for synthesizing ribosomal RNA (rRNA) and assembling ribosomal subunits?

- A) Nuclear envelope
- B) Nuclear pore
- C) Nucleolus
- D) Centrosome

3. How does euchromatin differ from heterochromatin in terms of structure and functional activity?

- A) Euchromatin is densely packed and transcriptionally silent
- B) Euchromatin is loosely packed and transcriptionally active
- C) Euchromatin contains no histones
- D) Euchromatin is only found during mitosis

4. What structural feature on the double nuclear envelope regulates selective traffic such as mRNA export and protein import?

- A) Nucleosomes
- B) Nuclear pores
- C) Histone loops
- D) Microfilaments

Answer Key

1. B — Nucleosomes consist of DNA wrapped around histones, forming the first level of chromosome packaging.
2. C — The nucleolus is the nuclear subdomain where ribosomal RNA is synthesized and ribosomal subunits are assembled.
3. B — Euchromatin is loosely packed and transcriptionally active, whereas heterochromatin is dense and silent.
4. B — Nuclear pores perforate the double nuclear envelope to act as selective gates for mRNA export and protein import.

Lesson 6: The Endomembrane System: ER, Golgi and Lysosomes

1. Which organelle in the endomembrane system is studded with ribosomes and synthesizes secretory and membrane proteins?

- A) Smooth endoplasmic reticulum (SER)
- B) Rough endoplasmic reticulum (RER)
- C) Lysosome
- D) Central vacuole

2. What is the correct directional route followed by proteins along the secretory pathway?

- A) Golgi → transport vesicle → RER → secretory vesicle → plasma membrane
- B) RER → transport vesicle → Golgi → secretory vesicle → plasma membrane
- C) Plasma membrane → endosome → Golgi → RER
- D) Smooth ER → lysosome → Golgi → transport vesicle

3. Which process describes the lysosomal digestion and recycling of a cell's own worn-out organelles?

- A) Exocytosis

- B) Phagocytosis
- C) Autophagy
- D) Glycosylation

4. Which genetic disorder is cited in the handout as resulting specifically from a missing lysosomal enzyme?

- A) Cystic fibrosis
- B) Tay–Sachs disease
- C) Inclusion-cell disease
- D) Primary ciliary dyskinesia

Answer Key

1. B — The rough endoplasmic reticulum (RER) is studded with ribosomes and synthesizes secretory and membrane proteins.
2. B — The secretory pathway delivers proteins from the RER via transport vesicles to the Golgi, and then via secretory vesicles to the plasma membrane.
3. C — Autophagy is the lysosomal degradation and recycling of the cell's own damaged or worn-out organelles.
4. B — Tay–Sachs disease is a lysosomal storage disease resulting from a missing lysosomal enzyme.

Lesson 7: Mitochondria, Chloroplasts and Energy

1. Which theory proposes that mitochondria and chloroplasts originated as engulfed free-living bacteria?

- A) Cell theory
- B) Fluid mosaic theory
- C) Endosymbiotic theory
- D) Germ theory

2. Where in the cell does glycolysis take place during cellular respiration?

- A) Mitochondrial matrix
- B) Cytoplasm
- C) Inner mitochondrial membrane
- D) Intermembrane space

3. What mechanism drives ATP synthesis as protons flow back through ATP synthase during oxidative phosphorylation?

- A) Active transport
- B) Chemiosmosis
- C) Substrate-level phosphorylation
- D) Fermentation

4. Where do the light-dependent reactions of photosynthesis occur within chloroplasts?

- A) Stroma
- B) Outer membrane
- C) Thylakoid membranes
- D) Matrix

Answer Key

1. C — The endosymbiotic theory proposes that mitochondria and chloroplasts originated as engulfed free-living bacteria.
2. B — Glycolysis occurs in the cytoplasm, converting glucose into pyruvate with a net yield of 2 ATP.
3. B — Chemiosmosis describes ATP synthesis driven by proton flow through ATP synthase down an electrochemical gradient.
4. C — The light reactions of photosynthesis take place in the thylakoid membranes holding chlorophyll.

Lesson 8: Cytoskeleton, Cell Junctions and the Cell Surface

1. Which cytoskeletal components consist of hollow tubulin polymers and form the 9+2 structural core of cilia and flagella?

- A) Microfilaments
- B) Intermediate filaments
- C) Microtubules
- D) Actin filaments

2. Which type of cell junction provides direct channels connecting adjacent animal cells for ion and small-molecule exchange?

- A) Tight junctions
- B) Desmosomes
- C) Gap junctions
- D) Plasmodesmata

3. Which motor protein walks along microtubules to power the coordinated beating of cilia and flagella?

- A) Actin
- B) Dynein
- C) Keratin
- D) Myosin

4. Which transmembrane proteins link the extracellular matrix to the cell's internal cytoskeleton?

- A) Cadherins
- B) Integrins
- C) Selectins
- D) Connexins

Answer Key

1. C — Microtubules are hollow tubulin polymers that build transport tracks, the mitotic spindle, and the 9+2 core of cilia and flagella.
2. C — Gap junctions act as open channels directly connecting animal cells for sharing ions and small molecules.
3. B — Dynein motor proteins walk along microtubule doublets to drive the beating motion of cilia and flagella.
4. B — Integrins span the cell membrane to physically link the extracellular matrix with the internal cytoskeleton.

Lesson 9: The Cell Cycle and Mitosis

1. During which phase of interphase does DNA replication occur, duplicating each chromosome into sister chromatids?

- A) G1 phase
- B) S phase
- C) G2 phase
- D) M phase

2. What key structural event occurs during anaphase of mitosis?

- A) Chromosomes condense and the mitotic spindle forms
- B) Chromosomes align along the equator of the cell
- C) Sister chromatids separate and move toward opposite poles
- D) Nuclear envelopes re-form around divided sets of chromosomes

3. Which protein is known as the "guardian of the genome" for arresting or killing cells with damaged DNA?

- A) Cdk1
- B) Cyclin B
- C) p53
- D) Ras

4. Which regulatory molecules interact to drive transitions across the checkpoints of the cell cycle?

- A) Microfilaments and myosins
- B) Cyclins and cyclin-dependent kinases (Cdks)
- C) Integrins and cadherins
- D) Histones and nucleosomes

Answer Key

1. B — DNA replication occurs during the S phase of interphase.
2. C — Sister chromatids separate and move to opposite poles during anaphase.
3. C — The tumour suppressor p53 acts as the guardian of the genome by arresting or destroying cells with damaged DNA.
4. B — Cyclins and cyclin-dependent kinases (Cdks) drive cell-cycle progression through its checkpoints.

Lesson 10: Meiosis and Genetic Diversity

1. What critical event occurs during prophase I of meiosis that generates new combinations of alleles?

- A) Separation of sister chromatids
- B) Crossing over between paired homologous chromosomes
- C) Unequal division of cytoplasm
- D) Duplication of mitochondrial DNA

2. How do the division events of Meiosis I and Meiosis II differ?

- A) Meiosis I separates sister chromatids, whereas Meiosis II separates homologous chromosomes
- B) Meiosis I separates homologous chromosomes, whereas Meiosis II separates sister chromatids
- C) Meiosis I doubles chromosome number, whereas Meiosis II halves it
- D) Meiosis I occurs in somatic cells, whereas Meiosis II occurs in germ cells

3. What error in meiotic chromosome separation causes aneuploidy, such as Down syndrome (trisomy 21)?

- A) Autophagy
- B) Nondisjunction
- C) Denaturation
- D) Chemiosmosis

4. Unlike spermatogenesis which yields four functional sperm cells, what does human oogenesis yield from one meiotic division?

- A) Four functional ova
- B) Two diploid zygotes
- C) One ovum and polar bodies
- D) Four non-functional polar bodies

Answer Key

1. B — Homologous chromosomes pair (synapsis) and exchange segments during crossing over in prophase I.
2. B — Meiosis I separates homologous chromosomes to reduce chromosome number, while Meiosis II separates sister chromatids.
3. B — Nondisjunction is the failure of chromosomes to separate properly in meiosis, resulting in aneuploid conditions like trisomy 21.
4. C — Oogenesis undergoes unequal cytoplasmic division to form one functional ovum and polar bodies.

Lesson 11: Cell Signalling and Communication

1. Which mode of cell signalling involves hormones released into the bloodstream to travel to distant target cells?

- A) Paracrine signalling
- B) Autocrine signalling
- C) Endocrine signalling
- D) Synaptic signalling

2. Which intracellular relay molecules carry signals from cell-surface receptors to downstream cellular targets?

- A) Primary ligands
- B) Second messengers (e.g., cAMP, Ca²⁺)
- C) Histone proteins
- D) Caspases

3. Cholera toxin causes severe pathology by interfering with which crucial stage of signal transduction?

- A) Phosphorylation of receptor tyrosine kinases
- B) Blocking G-protein shutoff and preventing signal termination
- C) Binding directly to intracellular steroid receptors
- D) Degrading cyclic AMP in the cytoplasm

4. Which cell-surface receptors are targeted by many modern cancer drugs because uncontrolled growth-factor signalling drives tumour growth?

- A) G-protein-coupled receptors (GPCRs)

- B) Receptor tyrosine kinases (RTKs)
- C) Nuclear envelope pore complexes
- D) Voltage-gated ion channels

Answer Key

1. C — Endocrine signalling involves hormones travelling via the bloodstream to reach distant target cells.
2. B — Second messengers like cAMP and Ca²⁺ act as intracellular relay molecules in signal transduction.
3. B — Cholera toxin blocks G-protein shutoff, preventing signal termination and leading to disease.
4. B — Receptor tyrosine kinases (RTKs) mediate growth-factor signalling and are key targets for modern cancer therapies.

Lesson 12: Cell Death, Apoptosis and Cancer

1. How does apoptosis differ from accidental cell death by necrosis?

- A) Apoptosis causes cell swelling, rupture, and tissue inflammation
- B) Apoptosis is an orderly, energy-requiring, non-inflammatory process where the cell shrinks and DNA fragments
- C) Apoptosis occurs exclusively following direct mechanical injury
- D) Apoptosis releases toxic cellular contents into the surrounding extracellular space

2. Which family of proteases acts as the primary executioners of programmed cell death?

- A) Cyclin-dependent kinases (Cdks)
- B) Caspases
- C) Phosphodiesterases
- D) Integrins

3. What key molecule is released from mitochondria into the cytoplasm during the intrinsic pathway of apoptosis?

- A) Cytochrome c
- B) Acetyl-CoA
- C) Glucose
- D) Chlorophyll

4. Which hallmark enables cancer cells to achieve limitless replication?

- A) Cell shrinkage and chromatin fragmentation
- B) Activation of telomerase
- C) Failure of sodium–potassium ATPases
- D) Accumulation of intracellular glycogen

Answer Key

1. B — Apoptosis is orderly, programmed, energy-requiring, and non-inflammatory, whereas necrosis causes swelling and inflammation.
2. B — Caspases are protease executioners that mediate the orderly breakdown of the cell during apoptosis.
3. A — The intrinsic apoptotic pathway is triggered when mitochondria release cytochrome c into the cytoplasm.
4. B — Limitless replication in cancer cells is facilitated by mechanisms such as telomerase activation.

Lesson 13: Studying Cells: Fractionation, Microscopy and Culture

1. Which technique separates cellular organelles by spinning homogenates at increasing speeds, pelleting nuclei at low speed and ribosomes at ultra-high speed?

- A) Confocal microscopy
- B) Differential centrifugation
- C) Flow cytometry
- D) Gel electrophoresis

2. Which marker enzyme is specifically identified in the handout to confirm the purity of isolated lysosomes during cell fractionation?

- A) Cytochrome c
- B) DNA polymerase
- C) Acid phosphatase
- D) ATP synthase

3. Which advanced microscopy technique utilizes optical sectioning to create three-dimensional (3D) images of cellular structures?

- A) Transmission electron microscopy (TEM)
- B) Confocal microscopy
- C) Scanning electron microscopy (SEM)
- D) Simple light microscopy

4. How do primary cell cultures differ from immortalized cell lines, such as HeLa cells?

- A) Primary cultures divide indefinitely, whereas cell lines undergo immediate apoptosis
- B) Primary cultures have a limited number of divisions, whereas immortal cell lines proliferate indefinitely
- C) Primary cultures consist only of prokaryotic cells, whereas cell lines are plant cells
- D) Primary cultures grow without nutrients, whereas cell lines require solid agar

Answer Key

1. B — Differential centrifugation separates organelles by size and density using progressively higher centrifugation speeds.

2. C — Acid phosphatase serves as a specific marker enzyme to verify lysosomal fraction purity.

3. B — Confocal microscopy uses optical sectioning to construct three-dimensional (3D) visual images.

4. B — Primary cultures undergo a limited number of divisions, whereas immortal cell lines like HeLa divide continuously.

End of Quiz

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