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Biology — Class 11

Chapter(s): Cell: The Unit of Life

Maximum Marks: 39

Time Allowed: 1 Hour 10 Minutes

Section A — MCQ & Assertion-Reason (1 mark each)

Q1. A pancreatic acinar cell is experimentally induced to massively increase secretion of protein enzymes. Which immediate cellular change is most consistent with NCERT structure-function links for this cell type? [1 mark]

- A) Marked increase in SER with loss of ribosomes
- B) Marked increase in RER cisternae continuous with the outer nuclear membrane
- C) Marked increase in chromatophores containing pigments
- D) Marked increase in tonoplast activity to pump ions into vacuole

Q2. In a bacterium, a mutation eliminates the ability to form mesosomes. Which cellular function is most directly expected to be affected first? [1 mark]

- A) Intracellular movement using 9 + 2 axoneme
- B) Increase in respiratory surface area and enzyme content of plasma membrane
- C) Packaging of secretory proteins into cis-trans vesicles
- D) Osmoregulation via tonoplast-driven ion pumping

Q3. A spherical plant cell has diameter 20 μm . Its central vacuole occupies 90% of the cell volume. Approximate vacuole volume is: (Use $\pi = 3.14$; volume of sphere = $(4/3)\pi r^3$) [1 mark]

- A) $1.88 \times 10^3 \mu\text{m}^3$
- B) $3.77 \times 10^3 \mu\text{m}^3$
- C) $1.88 \times 10^4 \mu\text{m}^3$
- D) $3.77 \times 10^4 \mu\text{m}^3$

Q4. A eukaryotic flagellum shows a typical 9 + 2 axonemal pattern. How many microtubules (counting each tubule, not doublets) are present in one transverse section of the axoneme? [1 mark]

- A) 11
- B) 18
- C) 20
- D) 22

Q5. A student compares ribosomes from (i) cytosol of a typical animal cell, (ii) mitochondrion of the same cell, and (iii) a bacterium. Which option correctly matches their sedimentation types? [1 mark]

- A) (i) 70S, (ii) 80S, (iii) 80S
- B) (i) 80S, (ii) 70S, (iii) 70S
- C) (i) 60S, (ii) 50S, (iii) 40S
- D) (i) 80S, (ii) 80S, (iii) 70S

Q6. Assertion (A): Mitochondria and chloroplasts are not included in the endomembrane system.

Reason (R): The endomembrane system includes only those organelles whose functions are coordinated with ER, Golgi, lysosomes and vacuoles. [1 mark]

- A) Both A and R are true and R is the correct explanation of A.
- B) Both A and R are true but R is not the correct explanation of A.
- C) A is true but R is false.
- D) A is false but R is true.

Q7. Assertion (A): Middle lamella helps neighbouring plant cells adhere to each other.

Reason (R): Middle lamella is mainly composed of calcium pectate that acts as a cementing material between adjacent cell walls. [1 mark]

- A) Both A and R are true and R is the correct explanation of A.
- B) Both A and R are true but R is not the correct explanation of A.
- C) A is true but R is false.
- D) A is false but R is true.

Q8. Assertion (A): The plasma membrane is selectively permeable.

Reason (R): Nonpolar solutes can diffuse through the lipid bilayer down their concentration gradient without ATP, whereas many polar molecules require carrier proteins for facilitated transport. [1 mark]

- A) Both A and R are true and R is the correct explanation of A.
- B) Both A and R are true but R is not the correct explanation of A.
- C) A is true but R is false.
- D) A is false but R is true.

Q9. Assertion (A): Lysosomal hydrolytic enzymes can digest proteins, lipids, carbohydrates and nucleic acids.

Reason (R): Lysosomes are rich in hydrolases that are optimally active at acidic pH. [1 mark]

- A) Both A and R are true and R is the correct explanation of A.
- B) Both A and R are true but R is not the correct explanation of A.
- C) A is true but R is false.
- D) A is false but R is true.

Q10. Assertion (A): Plasmids can provide antibiotic resistance to bacteria.

Reason (R): Plasmids are small circular DNA molecules present outside the genomic DNA in many bacteria and can carry genes that confer unique phenotypic characters.

[1 mark]

- A) Both A and R are true and R is the correct explanation of A.
- B) Both A and R are true but R is not the correct explanation of A.
- C) A is true but R is false.
- D) A is false but R is true.

Section B — Very Short Answer (2 marks each)

Q11. A lab report lists sizes of isolated mitochondria as '0.5 mm diameter, 2 mm length'. Using NCERT values, identify the unit error and rewrite the values in correct SI units (metre). Answer in exactly 2 sentences. [2 marks]

Q12. A cell biologist wants to selectively extract proteins loosely attached to the membrane surface without disrupting the phospholipid bilayer. Which class of membrane proteins should predominantly be removed, and why? Answer in exactly 2 sentences. [2 marks]

Q13. An experiment blocks plasmodesmata in a young leaf tissue while leaving cell walls intact. Predict one direct physiological consequence for neighbouring plant cells and justify it. Answer in exactly 2 sentences. [2 marks]

Section C — Short Answer (3 marks each)

Q14. A researcher adds a nonpolar dye to one side of a cell membrane and a charged dye of similar size to the other side. In exactly 3 numbered points with headings, predict the relative rates of movement across the membrane and explain the mechanism using NCERT transport concepts (passive transport, carriers, active transport). [3 marks]

Q15. You are given a chloroplast with 25 grana. Each granum has 12 thylakoid discs. In exactly 3 numbered points with headings, calculate (i) total number of thylakoid discs in grana, and then relate this to (ii) where chlorophyll pigments are located and (iii) why grana architecture is functionally useful. (Use SI-free counting; no units needed for counts.) [3 marks]

Q16. A cell shows abundant Golgi cisternae but very few lysosomes. In exactly 3 numbered points with headings, explain a plausible mechanistic chain (from Golgi to enzyme packaging to consequences) that could account for reduced intracellular digestion of macromolecules. [3 marks]

Section D — Long Answer (5 marks each)

Q17. A new antibiotic is found to inhibit a bacterial membrane protein that normally expels toxic molecules (an efflux pump). In a lab, a student compares (a) a typical Gram-positive bacterium, (b) a Gram-negative bacterium, and (c) Mycoplasma, all exposed to the same antibiotic concentration. Answer in the following format:

Introduction (1 sentence) + 5 numbered headed points (2 sentences each) + Conclusion (1 sentence). In your answer, analyse how differences in the prokaryotic cell envelope and surface structures can change (i) antibiotic entry/retention, (ii) Gram-staining outcome, and (iii) survival chances of each organism. Include at least one correct structure-function link each for glycocalyx, cell wall, plasma membrane/mesosome, and plasmids. [5 marks]

Q18. A cell biologist isolates three fractions from a eukaryotic tissue by differential centrifugation and microscopy:

- Fraction X: membrane cisternae continuous with the outer nuclear membrane; many dense particles on the surface.**
- Fraction Y: stacks of flattened sacs with a clear convex and concave side; numerous small vesicles nearby.**
- Fraction Z: single-membrane vesicles rich in hydrolytic enzymes optimally active at acidic pH. Answer in the following format: Introduction (1 sentence) + 5 numbered headed points (2 sentences each) + Conclusion (1 sentence). (i) Identify X, Y and Z. (ii) Explain, using coordinated functions, how a secreted glycoprotein would move through these fractions from synthesis to release. (iii) Add one reason why mitochondria are excluded from this endomembrane pathway based on chapter logic. [5 marks]**

Section E — Case Study (4 marks each)
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Q19. Read the following passage and answer the questions that follow: [4 marks]

A pathology lab examines a biopsy from a glandular tissue that shows unusually high secretory activity. Electron microscopy notes: (1) extensive membrane cisternae with ribosomes on the outer surface, continuous with the nuclear envelope; (2) nearby stacks of flattened sacs with a clear polarity-one side appears convex and receives many small vesicles, the opposite side is concave and buds off vesicles; (3) numerous membrane-bound vesicles with hydrolytic enzymes that work best at acidic pH; and (4)

many sausage-shaped organelles with inner membrane infoldings.

A trainee claims that all four observed structures belong to the endomembrane system because they are membrane-bound. The senior scientist disagrees and asks the trainee to justify, using correct coordination of functions, which structures truly form the endomembrane system and which do not. The senior also asks for a quantitative check: the inner-membrane-folded organelles measured have an average diameter of $0.5\text{ }\mu\text{m}$, while the flattened sacs have diameter about $1.0\text{ }\mu\text{m}$.

- (i) Identify the four observed structures (1)-(4) using standard organelle names. (1 mark)
- (ii) State which of the four are part of the endomembrane system and give one coordination-based reason (not just 'membrane-bound'). (1 mark)
- (iii) Compute the ratio of diameters: [Golgi cisterna diameter] / [mitochondrion diameter]. Show steps and unit handling. (2 marks)

Biology — Class 11
Chapter(s): Cell: The Unit of Life

Section A — MCQ & Assertion-Reason (1 mark each)

A1.

Answer:

Correct option: (B)

Marked increase in RER cisternae continuous with the outer nuclear membrane

Explanation:

Rough ER bears ribosomes and is abundant in cells actively synthesising and secreting proteins; it is also continuous with the outer nuclear membrane. A surge in secreted protein enzymes therefore correlates with expansion of RER cisternae. Hence, option (B) is correct.

A2.

Answer:

Correct option: (B)

Increase in respiratory surface area and enzyme content of plasma membrane

Explanation:

Mesosomes are infoldings of the prokaryotic plasma membrane that increase membrane surface area and enzymatic content and aid processes including respiration. Loss of mesosomes most directly reduces these membrane-associated functions. Hence, option (B) is correct.

A3.

Answer:

Correct option: (B)

$3.77 \times 10^3 \mu\text{m}^3$

Explanation:

Cell radius $r = 10 \mu\text{m}$, so cell volume $= (4/3) \times 3.14 \times 10^3 \approx 4186.7 \mu\text{m}^3$; 90% of this is $0.9 \times 4186.7 \approx 3768 \mu\text{m}^3$, which is $3.77 \times 10^3 \mu\text{m}^3$ -wait, re-check: $(4/3)\pi r^3 = 4.186 \times 10^3 \mu\text{m}^3$; 90% $= 3.77 \times 10^3 \mu\text{m}^3$. Hence, option (B) is correct.

A4.

Answer:

Correct option: (C)

20

Explanation:

The axoneme has nine peripheral doublets ($9 \times 2 = 18$ microtubules) plus a central pair (2), giving $18 + 2 = 20$ microtubules; however, each peripheral doublet contains two microtubules, so total is 18, plus 2 central =

20. Hence, option (C) is correct.

A5.

Answer:

Correct option: (B)

(i) 80S, (ii) 70S, (iii) 70S

Explanation:

NCERT states cytoplasmic ribosomes of eukaryotes are 80S, while prokaryotic ribosomes are 70S; mitochondria also contain 70S ribosomes. Therefore the matching is (i) 80S, (ii) 70S, (iii) 70S. Hence, option (B) is correct.

A6.

Answer:

Correct option: (A)

Both A and R are true and R is the correct explanation of A.

Explanation:

NCERT defines the endomembrane system as ER, Golgi, lysosomes and vacuoles because their functions are coordinated. It explicitly excludes mitochondria and chloroplasts as their functions are not coordinated with these components, so R correctly explains A.

A7.

Answer:

Correct option: (A)

Both A and R are true and R is the correct explanation of A.

Explanation:

NCERT states the middle lamella is chiefly calcium pectate and 'glues' neighbouring cells, so its composition directly explains its adhesive role. Hence both A and R are true

and R explains A.

A8.

Answer:

Correct option: (A)

Both A and R are true and R is the correct explanation of A.

Explanation:

Selective permeability arises because the nonpolar lipid bilayer permits easier passage of certain molecules by diffusion, while polar molecules/ions generally need membrane proteins. This differential transport basis is exactly what R states, so it explains A.

A9.

Answer:

Correct option: (A)

Both A and R are true and R is the correct explanation of A.

Explanation:

NCERT states lysosomes contain hydrolytic enzymes (lipases, proteases, carbohydrases etc.) that act best at acidic pH, enabling digestion of major macromolecules including nucleic acids. Therefore R correctly explains how A is possible.

A10.

Answer:

Correct option: (A)

Both A and R are true and R is the correct explanation of A.

Explanation:

NCERT describes plasmids as extra-chromosomal circular DNA that confers unique phenotypic traits, explicitly including antibiotic resistance. Thus R provides the genetic basis that explains A.

Section B — Very Short Answer (2 marks each)

A11.

Answer:

The unit error is that mitochondria are micrometre-scale, not millimetre-scale; typical diameter is about 0.2-1.0 μm (average 0.5 μm) and length about 1.0-4.1 μm . Converting: 0.5 $\mu\text{m} = 5.0 \times 10^{-7} \text{ m}$ and 2 $\mu\text{m} = 2.0 \times 10^{-6} \text{ m}$ (using 1 $\mu\text{m} = 10^{-6} \text{ m}$).

NCERT gives mitochondrial dimensions in μm , so mm would imply an organelle visible to

the naked eye, contradicting microscopy-based observation. The verification step is the conversion $1\text{ }\mu\text{m} = 10^6\text{ m}$, yielding values in metres consistent with organelle scale.

A12.

Answer:

Peripheral membrane proteins should predominantly be removed because they lie on the surface of the membrane rather than being buried in the lipid bilayer. This follows the NCERT classification based on ease of extraction: peripheral proteins are more easily detached than integral proteins that are partially/totally embedded.

A13.

Answer:

Intercellular exchange/communication between neighbouring cells will decrease because their cytoplasms are no longer connected. Plasmodesmata traverse the cell wall and middle lamella to connect cytoplasm, so blocking them directly reduces symplastic transport.

Section C — Short Answer (3 marks each)
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A14.

Answer:

1) Prediction (Relative Rates): The nonpolar dye will cross the membrane faster by simple diffusion, while the charged dye will show very slow/near-zero direct passage across the lipid bilayer.; The lipid core is nonpolar, so nonpolar solutes move down their concentration gradient without ATP.

2) Mechanism (Selective Permeability): The charged dye is polar/ionic and cannot efficiently pass through the nonpolar phospholipid bilayer.; It would require specific carrier proteins/channels for facilitated transport; without a suitable carrier, transport is strongly restricted.

3) Energy Link (Active vs Passive): If a transporter exists and the dye must move against its gradient, ATP-dependent active transport would be required.; This follows NCERT's distinction: passive transport occurs down the gradient, whereas active transport uses ATP (e.g., Na/K pump principle).

A15.

Answer:

1)

Calculation: (Total Thylakoid Discs): Total discs in grana = number of grana × discs per granum = $25 \times 12 = 300$.; So, there are 300 thylakoid discs organised into grana.

2) Location Link (Pigments): Chlorophyll pigments are present in the thylakoid

membranes.; Therefore, the 300 stacked thylakoid discs represent extensive pigment-bearing membrane area.

3) Functional Inference (Why Stacks Help): Stacking into grana increases total thylakoid membrane surface area per chloroplast volume.; More membrane area means more sites to hold chlorophyll and associated light-reaction machinery, improving light-energy trapping efficiency as per NCERT structure-function logic.

A16.

Answer:

1) Source Step (Golgi Packaging): Lysosomes are membrane-bound vesicles formed by packaging processes in the Golgi apparatus.; If Golgi packaging/biogenesis is impaired for lysosomal vesicles, fewer lysosomes will be produced even if Golgi stacks are present.

2) Enzyme Step (Hydrolases Targeting): Lysosomes are rich in hydrolytic enzymes (lipases, proteases, carbohydrases) that are optimally active at acidic pH.; Failure to correctly package/target these hydrolases into vesicles reduces the cell's compartment for controlled macromolecule digestion.

3) Outcome Step (Functional Consequence): With fewer functional lysosomes, digestion of proteins, lipids, carbohydrates and nucleic acids inside the cell decreases.; As a result, undigested materials may accumulate in the cytoplasm or in vesicles, lowering cellular turnover and recycling efficiency.

Section D — Long Answer (5 marks each)

A17.

Answer:

Cells differ in their envelope architecture, and these differences directly affect how an antibiotic enters, is retained, and whether the cell can survive.

1) Glycocalyx (slime layer/capsule) and exposure to antibiotic: A capsule or thick glycocalyx can act as a physical barrier that slows diffusion of the antibiotic toward the plasma membrane, so apparent entry rate may be reduced. It can also help attachment to host tissues/surfaces, indirectly aiding survival by maintaining favourable microenvironments even when drug is present.

2) Cell wall and Gram response linked to envelope: Gram-positive bacteria have an envelope that takes up the Gram stain (Gram-positive), reflecting a wall/envelope organisation that retains the stain; Gram-negative bacteria do not retain the Gram stain (Gram-negative) due to a different envelope organisation. Because the cell wall provides strong structural support preventing bursting/collapsing, damage or stress caused after efflux inhibition will be better tolerated when the wall remains intact.

- 3) Plasma membrane and mesosome as functional sites: The plasma membrane is selectively permeable and is the interface for transport proteins; inhibiting an efflux pump increases intracellular antibiotic retention, raising effective dose inside the cytoplasm. Mesosomes are infoldings of the plasma membrane that help in respiration, secretion, cell wall formation, and DNA replication/distribution, so membrane-targeted disruption can have amplified downstream effects on growth and division.
- 4) Mycoplasma exception and predicted survival: Mycoplasma lacks a cell wall, so it lacks the wall-based mechanical protection that normally prevents bursting or collapse. Therefore, when toxic molecules accumulate due to efflux inhibition, Mycoplasma is expected to be comparatively more vulnerable because only the plasma membrane must maintain integrity under stress.
- 5) Plasmids and antibiotic resistance outcome: Many bacteria carry plasmids that confer unique phenotypic characters such as antibiotic resistance, so a plasmid-encoded alternative pump or resistance mechanism could partially compensate for the inhibited efflux protein. Thus, survival is not determined only by envelope layers; the presence/absence of resistance plasmids can shift outcomes between otherwise similar cells.

Conclusion: Overall, Gram-positive, Gram-negative, and Mycoplasma differ in glycocalyx, wall, and membrane organisation, and these differences-together with plasmid-borne resistance-determine antibiotic entry/retention and survival when efflux is blocked.

A18.

Answer:

Eukaryotic cells show compartmentalisation, and the endomembrane system coordinates synthesis, modification, packaging, and intracellular trafficking.

- 1) Identification of fractions from structural clues: Fraction X is rough endoplasmic reticulum (RER) because it forms membrane cisternae/tubules continuous with the outer nuclear membrane and bears ribosomes as dense particles. Fraction Y is the Golgi apparatus because it is a stack of flattened cisternae with distinct cis (forming) and trans (maturing) faces and associated vesicles.
- 2) Identification of lysosomal fraction: Fraction Z is lysosomes because they are single membrane-bound vesicles containing hydrolytic enzymes (lipases, proteases, carbohydrases) that act optimally at acidic pH. Their origin is by packaging in the Golgi apparatus, matching the fraction description.
- 3) Synthesis step for a secreted glycoprotein (entry into pathway): The protein part of the glycoprotein is synthesised by ribosomes attached to RER (Fraction X), which is

characteristic of cells actively involved in protein synthesis and secretion. The newly made protein enters/associates with the ER lumen/ER-derived vesicles, beginning the endomembrane route.

4) Modification and packaging in Golgi (directionality cis→trans): Vesicles carrying the product bud from ER and fuse with the cis face of the Golgi (Fraction Y), explaining the close association between ER and Golgi. In the Golgi cisternae, proteins are modified and glycoproteins/glycolipids are formed, then packed into vesicles that leave from the trans face for secretion.

5) Lysosomes and why mitochondria are excluded: Some Golgi-derived vesicles become lysosomes (Fraction Z) to deliver hydrolases for intracellular digestion, showing a second coordinated destination besides secretion. Mitochondria are excluded from the endomembrane system because their functions are not coordinated with ER-Golgi-lysosome/vacuole trafficking as per the chapter's definition of the endomembrane system.

Conclusion: Thus X = RER, Y = Golgi, Z = lysosome, and a secreted glycoprotein follows an ER→Golgi→trans-vesicle route, while mitochondria remain outside this coordinated pathway.

Section E — Case Study (4 marks each)
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A19.

(i) Identify the four observed structures (1)-(4) using standard organelle names.

Answer:

- (1) Rough endoplasmic reticulum (RER)
- (2) Golgi apparatus
- (3) Lysosomes
- (4) Mitochondria (with cristae).

(ii) State which of the four are part of the endomembrane system and give one coordination-based reason (not just 'membrane-bound').

Answer:

Endomembrane system includes

- (1) RER,
- (2) Golgi apparatus and
- (3) lysosomes (also vacuoles), because their functions are coordinated via vesicle trafficking (ER products fuse to cis-Golgi, are modified/packaged, and Golgi packaging forms lysosomes). Mitochondria
- (4) are excluded because their functions are not coordinated with

ER-Golgi-lysosome/vacuole pathway in this definition.

(iii) Compute the ratio of diameters: [Golgi cisterna diameter] / [mitochondrion diameter]. Show steps and unit handling.

Answer:

Given: Golgi cisterna diameter = $1.0\ \mu\text{m}$; mitochondrion diameter = $0.5\ \mu\text{m}$.

Formula: Ratio = $[1.0\ \mu\text{m}] / [0.5\ \mu\text{m}]$;

Substitution: /Calculation: Ratio = $1.0/0.5 =$

2.

The Golgi cisterna diameter is 2 (dimensionless) times the mitochondrion diameter.