Chapter 1: Cellular Basis of Animal Physiology

Dr. Shubham Bhere,

M.V.Sc Scholar,

Veterinary Biotechnology,

IVRI

Refresher points:

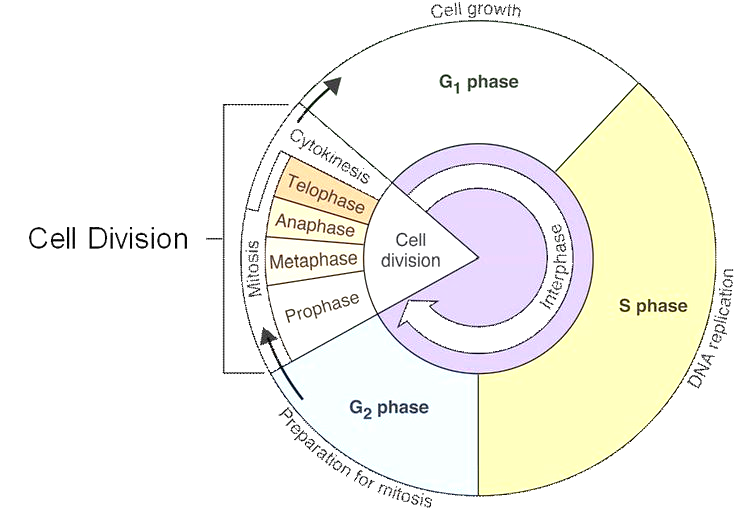
|  |  |
| --- | --- |
| Nucleus | * Houses the genetic material in the form of DNA. * Regulates and orchestrates cellular activities by directing the synthesis of RNA leading to protein synthesis. * Nuclear pore complexes regulate the transport of macromolecules. |
| Nucleolus | * Located within the nucleus. * Site of ribosomal RNA synthesis and ribosome assembly. |
| Rough Endoplasmic Reticulum (RER) | * Studded with ribosomes on its cytoplasmic surface, giving it a "rough" appearance. Involved in protein synthesis. * Proteins synthesized may be secreted, incorporated into the cell membrane, or sent to organelles like lysosomes. * Provides an environment for protein folding and post-translational modifications. |
| Smooth Endoplasmic Reticulum (SER) | * Lacks ribosomes, appearing smooth. * Involved in lipid synthesis, including phospholipids and steroids. * Important for cell membrane formation and hormone production. * Detoxifies drugs and poisons, stores calcium ions, and participates in carbohydrate metabolism |
| Golgi Apparatus | * Crucial for processing, modifying, and sorting cellular products. * Receives proteins and lipids from the ER (Cis-face), modifies them, and dispatches them (trans-face) to their destinations. * Forms transport vesicles for efficient distribution of cellular materials. * Involved in lysosome formation. |
| Lysosomes | * Cellular organelles containing enzymes for breaking down waste materials, cellular debris, and macromolecules. * Synthesize lysosomal enzymes in the rough ER, modify them in the Golgi apparatus, and package them into lysosomes. * Release enzymes during apoptosis to break down cellular components. * Degrade defunct intracellular organelles and substances taken in from outside the cell. * Require acidic pH for enzyme activity. |
| Peroxisomes | * Contribute to cellular homeostasis by participating in diverse metabolic pathways. * Contain enzymes like catalase and dismutase, breaking down hydrogen peroxide and protecting from reactive oxygen species. * Essential for lipid metabolism, detoxification, and maintaining cellular integrity. * Involved in synthesizing ether lipids important for cell membrane structure. |
| Plasma Membrane | * Selectively permeable membrane regulating substance passage in and out of the cell. Steroid hormone can pass freely * Contains receptors, playing a key role in cell signaling and communication. * Maintains an electrochemical gradient critical for cellular processes. * Allows endocytosis, pinocytosis(cell drinking) and exocytosis for substance uptake and cellular product secretion. * Endocytosed material must first pass through a series of organelles called endosomes before ending up in the lysosome |

Cell Cycle:

**G0**

G1 restriction point:

Cyclin E, CDK2



M/Spindle checkpoint:

Cyclin D, CDK4

G2 checkpoint:

Cyclin B, CDK1

S restriction point:

Cyclin A, CDK2

**Imp events in cell division:**

* Interphase: Before mitosis begins, during the interphase, organelles such as the nucleus, endoplasmic reticulum (ER), Golgi apparatus, mitochondria, and other cellular components duplicate to prepare for division.
* Prophase: The duplicated centrosomes move to opposite poles of the cell, and microtubules (spindle fibers) begin to form. The nuclear envelope starts to break down, and the duplicated chromosomes condense, becoming visible.
* Prometaphase: The nuclear envelope completely dissolves, allowing the spindle fibers to interact with the chromosomes. Each sister chromatid is attached to spindle fibers via the kinetochore.
* Metaphase: Chromosomes align at the metaphase plate in the center of the cell. The spindle fibers attach to the centromeres of each chromosome, ensuring proper alignment for separation.
* Anaphase: Centromeres split, separating sister chromatids into individual chromosomes. Spindle fibers shorten, pulling chromosomes to opposite poles.
* Telophase: Chromosomes reach the poles and begin to de-condense. A new nuclear envelope forms around each set of chromosomes.
* Cytokinesis: it involves the formation of a cleavage furrow, a contractile ring of actin and myosin filaments, which pinches the cell membrane at the center. As cytokinesis progresses, organelles such as the ER and mitochondria are distributed to each daughter cell. These organelles contain information that is required for their construction, and so they cannot be made de novo., ensuring that each cell has the necessary organelles for its functions.
* The mitogen-activated protein kinase (MAPK) cascade, consisting of Raf, MEK, and ERKs, forms a three-tiered kinase signaling pathway that plays a pivotal role in facilitating cellular division.
* Meiosis: Two rounds of cell division occur during Meiosis. Meiosis 1 leads to the formation of two haploid cells. During prophase 1 homologous chromosomes pair up in a process called synapsis and crossing over takes place. Meiosis 2 resembles mitosis leading to formation of 4 daughter cells with haploid set of chromosomes. In oogenesis meiosis1 occurs during fetal development and is paused until fertilization occurs in most species.

**Cell signalling:**

* Receptor Tyrosine Kinase (RTK) Pathway: Involves the activation of receptor tyrosine kinases, leading to the phosphorylation of tyrosine residues and the activation of downstream signaling cascades.
* G Protein-Coupled Receptor (GPCR) Pathway: GPCRs are a large family of cell surface receptors that activate intracellular signaling pathways through G proteins.
* Notch Signaling: Important in cell fate determination and tissue development. It involves the activation of Notch receptors and the release of intracellular domains that act as transcription factors.
* Wnt Signaling: Critical for embryonic development and tissue homeostasis. It regulates cell proliferation, differentiation, and migration

|  |  |  |  |
| --- | --- | --- | --- |
| **Secondary Messenger** | **Mechanism of Generation** | **Example** | **Effector** |
| cAMP | Adenylate cyclase converts ATP to cAMP | G protein-coupled receptors (GPCRs) | Protein kinase A (PKA), cAMP response element-binding protein (CREB) |
| cGMP | Guanylate cyclase converts GTP to cGMP | Nitric oxide signaling | Protein kinase G (PKG), cGMP-regulated ion channels |
| IP3(inositol triphosphate) | Phospholipase C cleaves phosphor inositol bisphosphate(PIP2) into IP3 | Receptor tyrosine kinase (RTK) signaling, GPCR | Inositol trisphosphate receptor (IP3R), activation of protein kinase C (PKC) |
| DAG (Diacylglycerol) | Phospholipase C cleaves PIP2 into DAG | GPCRs, RTKs | Protein kinase C (PKC) |
| Ca2+ | Released from intracellular stores (ER) or by channels | IP3 mediated release from ER, voltage/ligand gated channels | Calmodulin, protein kinase C (PKC), Ca2+/calmodulin-dependent protein kinase (CaMK) |

**Body fluid dynamics and membrane transport:**

* The basal daily water requirement of an animal depends on caloric expenditure that is directly proportional to the body surface area.
* Osmosis: Movement of water molecules across a selectively permeable membrane from an area of lower solute concentration to an area of higher solute concentration. Example: RBCs becoming flaccid in hypertonic solution.
* Simple Diffusion: Spontaneous movement of molecules from an area of higher concentration to an area of lower concentration, driven by the concentration gradient. Example: Oxygen molecules diffusing from the alveoli in the lungs into the bloodstream.
* Facilitated Diffusion: Passive transport of molecules across a membrane with the assistance of transport proteins, moving from higher to lower concentration. Example: Glucose transport facilitated by glucose transporters (GLUT proteins) in cell membranes.
* Active Transport: Energy-dependent process that pumps molecules against their concentration gradient, requiring ATP for the movement of solutes. Example: Sodium-potassium pump actively transporting sodium out of the cell and potassium into the cell.
* Co-Transport: Simultaneous transport of two substances across a membrane, where the movement of one substance is coupled with the movement of another. Example: Symport of sodium and glucose into intestinal cells during nutrient absorption.
* The movement of any inorganic ion across a membrane channel is dictated by the electrochemical gradient specific to that ion. This gradient results from the interplay of two factors: the voltage gradient and the concentration gradient of the ion across the membrane. When these two factors precisely counterbalance each other, the electrochemical gradient for the ion becomes zero, and there is no overall movement of the ion through the channel. The membrane potential (voltage gradient) at which this equilibrium occurs is referred to as the equilibrium potential for the ion, a concept described by the Nernst equation.
* The Donnan equilibrium refers to the state of ionic distribution across a semipermeable membrane when one side of the membrane contains impermeable solutes. In this equilibrium, ions that are permeable to the membrane distribute themselves according to their concentration gradients, while ions that cannot permeate the membrane result in an unequal distribution of permeable ions. The presence of impermeable solutes leads to an asymmetry in ion concentrations, generating an electrical potential across the membrane. Consequently, the osmotic pressure is higher on the side with impermeable ions.

**Questions**

1. Integral proteins are imbedded in cell membrane mainly through ………. interactions.- hydrophobic
2. Tight junctions are also known as ………. .- zonula occludens
3. Hormones regulate facilitated diffusion by changing the number of transporters available. TRUE
4. Nucleosides are made of ……. . -
   1. **Sugar & N-base**
   2. Sugar & phosphate
   3. Phosphate & N-base
   4. Neucleotide & phosphate
5. Phospholipids have ………. backbone.- Glycerol
6. Hyaluronic acid (a component of the intercellular substance):
   1. Maintains an optimal pH of the ISF
   2. Counteracts the effects of hyaluronidase
   3. **Is a highly hydrated gel that holds ISF in its interstices**
   4. None of the above
7. The resting membrane potential is established by diffusion potentials that result from concentration differences of …….. ions.
   1. **Permeant**
   2. Temporary
   3. Positive
   4. Negative
8. In which order do vesicles move through the Golgi stacks during the secretory pathway?
   1. Cis-Golgi → Trans-Golgi → Medial-Golgi
   2. Trans-Golgi → Cis-Golgi → Medial-Golgi
   3. Medial-Golgi → Cis-Golgi → Trans-Golgi
   4. **Cis-Golgi → Medial-Golgi → Trans-Golgi**
9. In which part of the mitochondrion does the citric acid cycle (Krebs cycle) occur?
   1. Outer membrane
   2. Intermembrane space
   3. Inner membrane
   4. **Matrix**
10. Which organelle is responsible for maintaining cell shape and providing structural support in animal cells?
    1. Nucleus
    2. ER
    3. **Cytoskeleton**
    4. Golgi apparatus
11. Which cellular organelle is involved in the glycosylation of proteins and lipids?
    1. Nucleus
    2. Ribosome
    3. Endoplasmic reticulum
    4. **Golgi apparatus**
12. What is the function of the Golgi apparatus in the secretory pathway?
    1. Synthesizing proteins
    2. **Sorting and directing proteins to their destinations**
    3. Producing energy
    4. Breaking down cellular waste
13. Which organelle contains digestive enzymes and is involved in breaking down cellular waste?
    1. Nucleus
    2. Endoplasmic reticulum
    3. Golgi apparatus
    4. **Lysosome**
14. In the scenario where distinct solutions are positioned on opposite sides of a selectively permeable membrane and water moves from side A to side B, the side experiencing the greater effective osmotic pressure is side …..
    1. Side A
    2. **Side B**
    3. Both have same osmotic pressure
    4. Insufficient information
15. Erythrocytes placed in a solution becomes turgid, then the solution is ……
    1. Hypertonic
    2. **Hypotonic**
    3. Isotonic
    4. Paratonic
16. The yield of metabolic water is the highest for ……….
    1. Carbohydrates
    2. **Fats**
    3. Proteins
    4. Nucleic acids
17. The pH of a buffer can be predicted by …………. equation. **Henderson-Hasselbalch**
18. How does the Henderson-Hasselbalch equation change if the pH of a solution is greater than the pKa of the weak acid?
    1. **[A-]/[HA] ratio decreases**
    2. [A-]/[HA] ratio increases
    3. pH decreases
    4. pKa increases
19. When the pH of a solution equals the pKa of a weak acid in the Henderson-Hasselbalch equation, what is the ratio of [A-] to [HA]?
    1. 0
    2. **1**
    3. < 1
    4. > 1
20. What does the Henderson-Hasselbalch equation describe?
    1. Enzyme kinetics
    2. **Acid-base balance in a buffer solution**
    3. Cell membrane permeability
    4. Redox reactions
21. The basal daily needs for water are directly related to:
    1. Body weight
    2. **Caloric expenditure and body surface area**
    3. Animal color
    4. Animal height
22. Hyperpolarization makes the membrane potential more negative, which means
    1. **the cell interior becomes more negative**
    2. the cell interior becomes more positive
    3. the cell interior becomes more permeable to all ions
    4. cell becomes impermeable to all ions
23. A greater amount of metabolic water is derived from the metabolism of 100g of fat compared to the metabolism of 100g of either protein or carbohydrate because:
    1. Animals drink more water when eating fat
    2. **A higher number of cofactors undergo reduction (and subsequently require reoxidation) during the metabolism of fat**
    3. A gram of fat is heavier than a gram of either protein or carbohydrate
    4. None of the above
24. Lipid molecules containing sugar called ……. . -**glycolipids**
25. Lipid rafts are rich in sphingomyelin.-**TRUE**
26. Gangliosides are complex glycolipids rich containing ……. . -a
    1. **Oligosaccharides with one-to-many sialic acid moieties.**
    2. Glucose only.
    3. Amino acids as part of the carbohydrate backbone.
    4. A phosphate bond as a part of the carbohydrate backbone.
27. Facilitated diffusion is responsible for transport up the electrochemical gradient.-**False** down the gradient
28. Membrane proteins cannot be amphiphilic. **False**, They are amphiphilic
29. Match the following –

1. Simple diffusion A. Energy expensive

2. Facilitated diffusion B. No carrier required

3. Cotransport C. Symport

4. Active transport D. No metabolic energy spent

1. **A4,B1,C3,D2**
2. A1,B2,C3,D4
3. A2,B3,C4,B1
4. A4,B2,C3,D1
5. -ATPase is an example of ……. . -c
   1. Diffusion
   2. Osmosis
   3. **Active transport**
   4. Cotransport
6. The ease of solute diffusion through a membrane is defined as its ……. . -d
   1. Adaptability
   2. Osmolarity
   3. Affinity
   4. **Permeability**
7. Saturation kinetics is NOT observed in:
   1. Carrier mediated transpport
   2. **Diffusion**
   3. Facilitated diffusion
   4. Active transport
8. In hepatocytes transcription occurs in the ……. . -c
   1. Nuclear membrane
   2. Golgi bodies
   3. **Nucleus**
   4. RER
9. The magnitude of Flux of diffusion is inversely proportional to : -c
   1. Permeability of the membrane.
   2. Area of diffusion.
   3. **Concentration gradient.**
   4. None of the above.
10. Carrier for Na+-Glucose cotransport is present in both proximal renal tubule cells and luminal membrane of interstitial mucosa. – **true**
11. Na+–K+–2Cl– cotransporter is present predominantly in……. . -a
    1. **Kidney**
    2. Heart
    3. Liver
    4. Epidermis
12. Magnitude of Permeability is directly proportional to ……. . -a
    1. **Flux.**
    2. Area of diffusion.
    3. Concentration gradient.
    4. None of the above.
13. Assertion- Glucose uptake by muscle and adipose cells is inhibited by galactose.

Reason – Galactose binds to glucose carrier due to structural similarity.

1. **Both assertion and reason are true, and the reason is the correct explanation of the assertion.**
2. Both assertion and reason are true, but the reason is not the correct explanation of the assertion.
3. Assertion is true, but the reason is false.
4. Assertion is false.
5. Assertion- Lymph and interstitial fluids have higher concentrations of inorganic cations.

Reason – Donnan membrane equilibrium causes movement of chloride ions towards plasma.

* 1. Both assertion and reason are true, and the reason is the correct explanation of the assertion.
  2. Both assertion and reason are true, but the reason is not the correct explanation of the assertion.
  3. Assertion is true, but the reason is false.
  4. **Assertion is false**

1. Urine, Feces, and other body secretions are ………. type of water loss
   1. Insensible
   2. Nonsensible
   3. Evaporative
   4. **Sensible**
2. Incase of head injuries swelling can be reduced by the infusion of ……… solution
   1. Hypotonic
   2. **Hypertonic**
   3. Isotonic
   4. Paratonic
3. Loss of cell cycle control is often associated with the development of:
   1. Antibodies
   2. **Tumors and cancer**
   3. Alzheimer’s
   4. Dementia
4. What is the role of caspases in apoptosis?
   1. Initiating cell cycle progression
   2. Promoting cell survival
   3. **Initiating programmed cell death**
   4. Repairing damaged DNA
5. Which organelle is often involved in initiating the intrinsic pathway of apoptosis?
   1. Golgi apparatus
   2. **Mitochondria**
   3. Endoplasmic reticulum
   4. Lysosome
6. What is the purpose of apoptosis in multicellular organisms?
   1. Promoting tumor growth
   2. **Eliminating damaged or unwanted cells**
   3. Enhancing cell division
   4. Inducing inflammation
7. What is the role of cyclins in the regulation of the cell cycle?
   1. Activation of apoptosis
   2. Promotion of DNA replication
   3. Inhibition of cyclin-dependent kinases (CDKs)
   4. **Activation of CDKs at specific checkpoints**
8. How many rounds of cell division occur in meiosis?
   1. One
   2. **Two**
   3. Three
   4. Four
9. Which of the following is a unique feature of meiosis I compared to meiosis II?
   1. Crossing over
   2. Synapsis
   3. **Reduction in chromosome number**
   4. Formation of haploid cells
10. During which stage of meiosis do homologous chromosomes separate?
    1. Prophase I
    2. Metaphase I
    3. **Anaphase I**
    4. Prophase II
11. Chiasmata formation occurs during which phase?
    1. **Diplotene**
    2. Pachytene
    3. Prophase 2
    4. G0
12. Crossing over of genetic material takes place during which phase?
    1. **Prophase 1**
    2. Cytokinesis 2
    3. Prophase 2
    4. G0
13. Which stage of meiosis involves the alignment of homologous chromosomes at the cell's equator?
    1. Prophase I
    2. **Metaphase I**
    3. Anaphase I
    4. Prophase II
14. Which secondary messenger is involved in the release of calcium ions from intracellular stores?
    1. cAMP
    2. cGMP
    3. **IP3 (Inositol trisphosphate)**
    4. DAG (Diacylglycerol)
15. Which secondary messenger is associated with the nitric oxide (NO) signaling pathway?
    1. cAMP
    2. **cGMP**
    3. IP3
    4. DAG
16. Which enzyme is responsible for the production of inositol trisphosphate (IP3) in the phospholipase C (PLC) pathway?
    1. Adenylyl cyclase
    2. Phosphodiesterase
    3. Protein kinase A (PKA)
    4. **PLC (phospholipase C)**
17. In the phosphoinositide signaling pathway, what does diacylglycerol (DAG) activate?
    1. Protein kinase A
    2. Adenylyl cyclase
    3. **Protein kinase C (PKC)**
    4. G protein
18. What is the result of meiosis II?
    1. **Four haploid cells**
    2. Two diploid cells
    3. Two haploid cells
    4. Four diploid cells
19. At the end of meiosis I, each resulting cell is:
    1. Diploid
    2. **Haploid**
    3. Tetraploid
    4. Triploid
20. How does calmodulin transmit signals within the cell?
    1. Through phosphorylation cascades
    2. By direct binding to DNA
    3. Via interaction with G proteins
    4. **Through calcium-dependent conformational changes**
21. How many calcium-binding sites does calmodulin have?
    1. 1
    2. **2**
    3. 3
    4. 4
22. Which of the following statements is true regarding calmodulin signaling?
    1. Calmodulin acts as a G protein
    2. Calmodulin activates adenylate cyclase
    3. Calmodulin is involved in the cAMP pathway
    4. **Calmodulin regulates the activity of various proteins, including kinases**
23. What type of proteins does calmodulin commonly interact with in the cell?
    1. G proteins
    2. DNA polymerases
    3. Receptor tyrosine kinases
    4. **kinases and phosphatases**
24. …….. proposed the fluid mosaic model in 1972. – Singer and Nicolson
25. The molecules that form a membrane have the simple physicochemical property of being amphiphilic—that is :
    1. **They have both hydrophobic and hydrophilic properties**
    2. The are zwitterions
    3. They are immiscible
    4. They have both positive and negative charge on same ion
26. …….. gene doesn’t have introns. -d
    1. Haemoglobin
    2. COX-1
    3. Adenylate cyclase 1
    4. **Histone**
27. Endosymbiotic theory suggests Mitochondria evolved from ……. . -a
    1. **Proteobacterium**
    2. Cyanobacterium
    3. Protists
    4. None of the above
28. Statement 1 – pH of RBC is slightly lower than plasma

Statement 2 – Hb of RBC is negatively charged, therefore causing accumulation oh positively charged H+ ions

* 1. **Both statements are true, and statement 2 is correct explanation of stat**ement 1
  2. Both statements are true, and statement 2 is NOT correct explanation of statement 1
  3. Statement 1 is true and 2 is False.
  4. Both statements are incorrect.

1. Solution A and Solution B are divided by a semipermeable membrane that allows the passage of K+ but not Cl–. Solution A contains 100 mM KCl, while Solution B contains 1 mM KCl. Which statement regarding Solution A and Solution B is correct?
   1. Potassium ions (K+) will move through the semipermeable membrane from solution A to solution B until the concentration of K+ in both solutions reaches 50.5 mM.
   2. Potassium ions (K+) will migrate from solution B to solution A until the concentration of K+ in both solutions equals 50.5 mM.
   3. Potassium chloride (KCl) will move from solution A to solution B until the concentration of KCl in both solutions is 50.5 mM.
   4. **Potassium ions (K+) will undergo diffusion from solution A to solution B until a membrane potential forms, with solution A becoming negatively charged in relation to solution B.**
2. Which of the following is a characteristic feature of housekeeping genes?
   1. Tissue-specific expression
   2. Variable expression under different conditions
   3. Regulation by inducers and repressors
   4. **Constant expression across various cell types and conditions**
3. Which type of genes are often used as reference genes in gene expression studies?
   1. **Housekeeping genes**
   2. Oncogenes
   3. Tumor suppressor genes
   4. Homeobox genes
4. Which cellular processes are often associated with housekeeping genes?
   1. Cell division and apoptosis
   2. DNA repair and recombination
   3. Synthesis of specialized proteins
   4. **Basic metabolic functions and maintenance of cell structure**
5. DNA synthesis occurs in……. phase. -a
   1. **S**
   2. G1
   3. G2
   4. M
6. Movement of water across aquaporins is na example of ……. . -c
   1. Facilitated diffusion
   2. Active transport
   3. **Simple diffusion**
   4. None of the above
7. Cholesterol reduces the fluidity of lipid membrane. -**True**
8. Cell drinking is called ……….-**Pinocytosis**
9. Lipid PIP2 plays important role in vesicle assembly. **true**
10. ………is necessary for pinching off of clatherin coated vesicles from cell membrane.
    1. **Dynamin**
    2. Actin
    3. Osmotic pressure
    4. None of the above
11. Which among the following is true for Gap junctions
    1. Mediate passage of organelles
    2. **mediate passage of small molecules and ions**
    3. mediate passage of large proteins molecules
    4. mediate passage of all metabolites
12. Gap junctions are preliminary composed of protein………..- **connexin.**
13. Thyroid hormones diffuse across plasma membrane. TRUE
14. G-protein coupled receptor are also called ……………. .- **Serpentine receptors, 7TM receptor**
15. Vertebrate Mitochondrial genes lack introns. **TRUE**
16. Exoplasmic leaflet with areas rich in cholesterol and sphingolipids, capable of dynamic movement are called……. . -c
    1. Lipid nucleus
    2. Cholesterol ship
    3. **Lipid Raft**
    4. Liposomes
17. Protein kinase C (PKC)c when activate din response to extracellular signal binds to ……. face of plasma membrane. -b
    1. both cytosolic and non-cytosolic
    2. **cytosolic**
    3. non-cytosolic
    4. periplasmic
18. ……., a saturated 14-carbon fatty acid, is added to the N-terminal amino group of the protein during its synthesis on a ribosome, …….-c
    1. Glucuronic acid, to make the protein sweet
    2. Linolenic acid, to make the protein lipophilic
    3. **myristic acid, to provide membrane-anchorage for the attached protein**
    4. ascorbic acid, to produce postaglangins
19. Cytoplasmic protein tyrosine kinases are myristoylated.- True
20. Porin proteins most likely have a ……. structure . -b
    1. Alpha helix
    2. **Beta barrel**
    3. Beta sheet
    4. disordered
21. …….. emphasizes the thick carbohydrate-rich layer surrounding the cell. -a
    1. **ruthenium red**
    2. phenol red
    3. silver impregnation
    4. bromophenol blue
22. Statement 1- Spectrin deficiency might cause anaemia.

Statement 2- Spectrin cytoskeleton is responsible to maintain concave shape of RBCs.

* 1. **Both statements are true, and statement 2 is correct explanation of statement 1**
  2. Both statements are true, and statement 2 is NOT correct explanation of statement 1
  3. Statement 1 is true and 2 is False.
  4. Both statements are incorrect.

1. Antiporters are also be called as …… .-d
   1. Symporters
   2. Cotransporters
   3. Unipoprters
   4. **exchangers**
2. p-type pumps are called p-type because ……. . -a
   1. **they phosphorylate themselves while pumping ions**
   2. they are named after
   3. they are always positively charged
   4. they maintain a positive gradient
3. Select options with TRUE statements
4. Nerst equation provides relationship between the voltage gradient and concentration gradient responsible for flow of inorganic ions.
5. Inorganic ions at equilibrium across a membrane can have different concentrations across the membrane
6. The flow inorganic ions depend on the voltage gradient and is independent of the concentration gradient.
7. All the statements are true.
8. Only statements II and III are true
9. Only statement III is true
10. **Only statements I and II are true**
11. Assertion- Hepatocytes have higher membrane surface area contributed by the endoplasmic reticulum than the plasma membrane.

Reason- Liver is the factory of many plasma proteins along with xenobioitic detoxification.

* 1. **Both assertion and reason are true, and the reason is the correct explanation of the assertion.**
  2. Both assertion and reason are true, but the reason is not the correct explanation of the assertion.
  3. Assertion is true, but the reason is false.
  4. Assertion is false

1. Which organelle is site for Xenobiotic Detoxifiction in hepatocytes – b
   1. Mitochondria
   2. **Smooth endoplasmic reticulum**
   3. Rough endoplasmic reticulum
   4. Golgi apparatus
2. Mitochondrial tRNAs are ……. . -a
   1. **Coded by mitochondrial genome**
   2. Imported in mitochondrion from cytosol
   3. Mitochondia don’t meed tRNAs
   4. Synthesized in the nucleus
3. Protiens lacking sorting signals are……. . -d
   1. Immediately exported
   2. Moved to the lysosomes
   3. Transported to the golgi
   4. **Stay in the cytosol**
4. Nuclear pore complex are selective for movement of……. . -d
   1. Polysaccharides
   2. Proteins with appropriate nuclear signal
   3. mRNA
   4. **Both b and c**
5. What is a characteristic of the initial transport of selected proteins into the ER lumen or mitochondria?
   1. Transported proteins remain fully folded
   2. Proteins are transported from the extracellular space
   3. **Proteins must unfold to pass through the translocator**
   4. Translocation occurs without the involvement of translocators
6. During vesicular transport, transport vesicles bud from one compartment and fuse with another topologically equivalent compartment. Which of the following statement is true?
   1. **Asymmetric orientation of membrane proteins is preserved**
   2. Random rearrangement of membrane proteins
   3. Inversion of protein domains
   4. Complete loss of membrane components
7. What is the pH environment typically found within lysosomes, and how does it contribute to their function?
   1. Neutral pH; it facilitates protein synthesis.
   2. **Acidic pH; it activates enzymes for digestion of cellular waste.**
   3. Alkaline pH; it protects cellular components from degradation.
   4. Basic pH; it promotes the formation of membrane-bound vesicles.
8. Which of the following is NOT a major class of biomolecules found in the extracellular matrix (ECM) surrounding mammalian cells?
   1. Collagen
   2. Elastin
   3. **selectins**
   4. Proteoglycans
9. What is the correct sequence import of protein into an organelle. -b
   1. Translocation> Maturation>Recognition
   2. **Recognition>Translocation> Maturation**
   3. Maturation>Recognition>Translocation
   4. Membrane binding> Recognition>Translocation
10. What is required for the threading of the protein through a membrane during the translocation stage?
    1. Targeting sequences
    2. Recognition by cytoplasmic chaperones
    3. **Energy and organellar chaperones on the trans side of the membrane**
    4. Oligosaccharides on the protein surface.
11. Why is it not possible to generate a new endoplasmic reticulum (ER) without an existing ER or a membrane containing the required translocators?
    1. Lack of suitable DNA sequences
    2. **Absence of ER specific protein translocators necessary for selective import of protein**s
    3. Inability to pass information to daughter cells
    4. Because ER replicates independently to its host cell
12. Nucleoporins have 8 fold rotational symmetry in vertebrates - **TRUE**
13. What is the correct order of phases in the cell cycle of animal cells?
    1. **G1 phase, S phase, G2 phase, mitosis**
    2. Mitosis, G1 phase, S phase, G2 phase
    3. G1 phase, G2 phase, S phase, mitosis
    4. S phase, G1 phase, G2 phase, mitosis
14. Which cyclin-dependent kinase (CDK) is associated with the G1 checkpoint?
    1. CDK1
    2. CDK2
    3. **CDK4**
    4. CDK6
15. What is the role of the M checkpoint in cell division?
    1. **Ensures proper spindle formation**
    2. Verifies the completion of cytokinesis
    3. Checks for DNA replication errors
    4. Monitors cell size before mitosis
16. If cyclin B/CDK1 complexes are inactivated in a cell which of the following would be true -
    1. **Cell division would stop arresting the cell in mitosis**
    2. Cell will divide uncontrolled
    3. Cell will be blocked from entering mitosis
    4. Cell will enter G0 phase.
17. Calcium ions acting as secondary messengers are released from. -d
    1. Mitochondria
    2. Golgi bodies
    3. Nuclear membrane
    4. **Endoplasmic reticulum**
18. Select options with TRUE statements
19. ATP is Converted to cAMP by the action of adenyl cyclase.
20. cAMP activates protein kinase A
21. one phosphate is released in conversion of ATP to cAMP
22. All the statements are true.
23. Only statements II and III are true
24. Only statement III is true
25. **Only statements I and II are true**
26. Select options with TRUE statements
    1. ATP is Converted to cAMP by the action of adenyl cyclase.
    2. cAMP activates protein kinase A
    3. one phosphate is released in conversion of ATP to cAMP
27. All the statements are true.
28. Only statements II and III are true
29. Only statement III is true
30. **Only statements I and II are true** -
31. Match the following:

|  |  |
| --- | --- |
| 1 IP3 | A Ca2+ |
| 2 DAG | B PKA |
| 3 cAMP | C PKC |

* 1. 1A,2B,3C
  2. 1B,2C,3A
  3. 1C,2B,3A
  4. **1A,2C,3B**

1. Statement 1- The extrinsic pathway of apoptosis is initiated either by an extracellular signal which activates a death receptor

Statement 2- Bax & Bak function by forming pores in outer mitochondrial membrane

1. Both statements are true, and statement 2 is correct explanation of statement 1
2. **Both statements are true, but statement 2 is NOT correct explanation of statement 1**
3. Statement 1 is true and 2 is False.
4. Both statements are incorrect.
5. Ran-GTP dissociates from nuclear transport receptor once in the …….. . –
   1. **cytosol**
   2. mitochondria
   3. nucleus
   4. ER
6. What effect does calcineurin have on NF-AT during T cell activation?
   1. Phosphorylates NF-AT
   2. **Blocks nuclear import signals**
   3. Exposes nuclear export signals
   4. Inhibits the transcription of genes
7. What is the term for the programmed destruction of cells that occurs during development or as part of normal tissue homeostasis?
   1. Necrosis
   2. **Apoptosis**
   3. Hypertrophy
   4. Hyperplasia
8. Which of the following is a key death ligand involved in extrinsic apoptosis?
   1. Interleukin-2
   2. **Tumor necrosis factor-alpha (TNF-α)**
   3. Insulin like death factor
   4. Epidermal death factor
9. Match the following:

|  |  |
| --- | --- |
| 1. G1 Phase 2. S Phase 3. G2 Phase 4. Mitosis 5. Cytokinesis | a. DNA is replicated during this phase. b. The cell undergoes normal growth and metabolic processes.  c. The cell prepares for cell division, and organelles replicate.  d. Division of the cytoplasm and other organelles occurs.  e. Nuclear division occurs, resulting in two daughter nuclei. |

–

* 1. **1b,2a,3c,4e,5d**
  2. 1c,2a,3d,4b,5e
  3. 1c,2b,3d,4a,5e
  4. 1e,2b,3a,4c,5d

1. Which of the following is a consequence of caspase activation in extrinsic apoptosis?
   1. Inhibition of death ligands
   2. Release of survival factors
   3. **Cleavage of cellular substrates leading to cell death**
   4. Induction of cell proliferation
2. The interaction between ……….. and Apaf-1 in the cytoplasmic compartment results in the cleavage of procaspase-9 and the assembly of the apoptosome complex–
   1. **Cytochrome C**
   2. Bax
   3. Bid
   4. Bcl
3. What is the role of caspases in apoptosis?
   1. Promoting cell survival
   2. Inhibiting DNA fragmentation
   3. **Initiating and executing apoptotic processes**
   4. Enhancing cell proliferation
4. Match the Following

|  |  |
| --- | --- |
| 1. Receptor Tyrosine Kinase (RTK) 2. G Protein-Coupled Receptor (GPCR) 3. Ion Channel Receptor 4. Nuclear Receptor | A. Activates intracellular signaling pathways through a series of phosphorylation events.  B. Utilizes a G protein to activate second messengers such as cAMP.  C. Acts as a ligand-gated channel, allowing ions to flow across the membrane.  D. Functions as a transcription factor regulating gene expression in response to ligand binding. |

* 1. 2A,3B,4C,1D
  2. 4A,2B,3C,1D
  3. **1A,2B,3C,4D**
  4. 4A,1B,3C,2D

1. When DNA is damaged, ………. is activated and triggers apoptosis to prevent the damaged cells from dividing and spreading.
   1. P52
   2. Hsp90
   3. Hsp70
   4. **P53**
2. Statement 1- Cancer cells divide uncontrollably

Statement 2- Inactive p53 cannot trigger apoptosis

* 1. **Both statements are true, and statement 2 is correct explanation of statement 1**
  2. Both statements are true, and statement 2 is NOT correct explanation of statement 1
  3. Statement 1 is true and 2 is False.
  4. Both statements are incorrect.

1. Which family of proteins regulates the intrinsic apoptotic pathway by controlling the permeability of the mitochondrial membrane?
   1. Ras proteins
   2. **Bcl-2 family proteins**
   3. G protein-coupled receptors
   4. Tyrosine kinase receptors
2. In the extrinsic apoptotic pathway, cell death is initiated by:
   1. Release of cytochrome c from mitochondria
   2. Activation of caspases
   3. **Binding of death ligands to death receptors on the cell surface**
   4. DNA fragmentation
3. Which of the following is a characteristic morphological change associated with apoptosis?
   1. Cell hypertrophy
   2. Cell hyperplasia
   3. **Cell shrinkage and membrane blebbing**
   4. Increase in organelle size
4. During apoptosis, what role do phagocytes play?
   1. Inhibiting the process of apoptosis
   2. **Clearing cellular debris and apoptotic bodies**
   3. Promoting uncontrolled cell division
   4. Suppressing caspase activity
5. What does JAK-STAT stand for in cell signaling?
   1. Juxtanuclear Activation Kinase - Signal Transduction and Transport
   2. **Janus Kinase - Signal Transduction and Transcription**
   3. Juxtaposed Activation Kinase - Systematic Transcription and Transport
   4. Junctional Kinase - Sequential Transduction and Transcription
6. Which component of the JAK-STAT pathway acts as a transcription factor when activated?
   1. JAK
   2. **STAT**
   3. Receptor Tyrosine Kinase (RTK)
   4. G Protein-Coupled Receptor (GPCR)
7. How are STAT proteins activated in the JAK-STAT pathway?
   1. **Phosphorylation by JAKs**
   2. Binding to G proteins
   3. Cleavage by JAKs
   4. Interaction with membrane receptors
8. Intravascular fluid is most often referred to as …….. .
   1. Blood volume
   2. Serum volume
   3. **Plasma volume**
   4. None of the above
9. Fluid in the rumen is ………. .
   1. **Transcellular compartment**
   2. Interstitial compartment
   3. Intravascular compartment
   4. None of the above
10. Which fluid compartment is crucial for maintaining the balance of electrolytes and nutrients between cells and the circulatory system?
    1. Intracellular fluid
    2. **Interstitial fluid**
    3. Plasma
    4. Cerebrospinal fluid
11. The thirst centre is located in which part of brain.
    1. Medulla
    2. Frontal cortex
    3. **Hypothalamus**
    4. Temporal lobe
12. Stimulus for thirst:
    1. Osmoconcentration of thirst cells in brain
    2. Angiotensin II release following hypovolemia
    3. Increased blood pressure
    4. **Both a and b**
13. For most animals ……… % dehydration is considered severe.
    1. 30%
    2. 20%
    3. **10%**
    4. 1%
14. A) Indian cattle breeds (Zebu and Brahman) are more tolerant of heat than European breeds

B) They have greater sweating greater sweating (and hence cooling)

C) They have special water conservation mechanism.

* 1. All statements are true
  2. None statements are true
  3. **Only statements A & B are true**
  4. Only statements A& C are true

1. Assertion: Camels can survive without water for longer than most ruminants.

Reason: Camel relies fat metabolism from hump to generate water.

1. Both assertion and reason are true, and the reason is the correct explanation of the assertion.
2. Both assertion and reason are true, but the reason is not the correct explanation of the assertion.
3. **Assertion is true, but the reason is false.**
4. Assertion is false.
5. What forms the meshwork of interconnected protein subunits known as the nuclear lamina, located on the nuclear side of the inner nuclear membrane?
   1. Nucleosomes
   2. Selectins
   3. Actins
   4. **Nuclear Lamins**
6. What triggers the dismantling of the nucleus during mitosis, leading to the disassembly of nuclear pore complexes (NPCs) and nuclear lamina
   1. **Activation of cyclin-dependent protein kinase (Cdk)**
   2. Inhibition of nuclear import receptors
   3. Phosphorylation of nucleoporins by mitotic kinase
   4. Binding of NPCs to nuclear envelope fragments
7. If a 50 kg buffalo calf needs 5 kg of daily water intake. How much water does a 500 kg badult buffalo need during its dry period.
   1. 50 kg
   2. 10kg
   3. 5kg
   4. **Insufficient information**
8. The basal daily water requirement of an animal depends on ……….
   1. Body weight
   2. Age
   3. **Caloric expenditure**
   4. Environment
9. Metabolic water is produced in ………..
   1. **Mitochondria**
   2. Nucleus
   3. Lysosome
   4. Endoplasmic reticulum
10. ………… are linked to vapor losses and consistently happen through the evaporation from the skin and the release of water vapor in exhaled air.
    1. Insensible water losses
    2. Missense water losses
    3. Unseen water losses
    4. Sense water losses
11. In cattle, about …… % body weight would be water
    1. 10%
    2. 20%
    3. 90%
    4. **70%**
12. A) Camels can drink water upto 25% body weight

B) Donkey, Sheep can drink water upto 25% body weight

* 1. **Both statements are true**
  2. Both statements are False
  3. Only statement A is true
  4. Only statement B is true

1. What is the primary function of the anaphase-promoting complex (APC/C) during mitosis?
   1. Activation of cyclins
   2. Initiation of DNA replication
   3. **Degradation of cyclins and other cell cycle proteins**
   4. Inhibition of CDKs
2. In which part of the cell does the assembly of the mitotic spindle occur during cell division?
   1. Nucleus
   2. Cytosol
   3. Endoplasmic reticulum
   4. **Centrosome**
3. What regulates the progression of the cell cycle and is often mutated in various cancers?
   1. **Tumor suppressor genes**
   2. Proto-oncogenes
   3. Cyclin genes
   4. Caspases
4. Which hormones directly affect transcription?
   1. Epinephrin
   2. Calcitonin
   3. **Calcitriol**
   4. None
5. Which of the following DOES NOT have a nuclear receptor
   1. Retinoic acid
   2. Thyroxine
   3. Estrogen
   4. **Melatonin**
6. Which of the following are NOT ligands of G protein coupled receptors
   1. Epinephrine
   2. Nor epinephrine
   3. Melatonin
   4. **Estrogen**