1. The process of cellular respiration occurs in:

Options:
a) Nucleus
✓ **b) Mitochondria**
c) Ribosomes
d) Golgi apparatus

Explanation:
Cellular respiration, which produces energy (ATP), takes place in the **mitochondria**, also called the "powerhouse of the cell."

---

2. The smooth endoplasmic reticulum (SER) is primarily involved in the synthesis of:

Options:
a) Proteins
✓ **b) Lipids**
c) Carbohydrates
d) Nucleic acids

Explanation:
The **smooth ER** is responsible for **lipid synthesis** and detoxification, while the **rough ER** (with ribosomes) synthesizes proteins.

---

3. Ribosomes are composed of:

Options:
✓ **a) RNA and protein**
b) Lipids and protein
c) Carbohydrates and lipids
d) DNA and carbohydrates

Explanation:
Ribosomes are made up of **ribosomal RNA (rRNA)** and proteins. They are involved in protein synthesis.

---

4. What is the primary function of ribosomes?

Options:
a) Energy production
b) Lipid synthesis
✓ **c) Protein synthesis**
d) DNA synthesis

Explanation:
Ribosomes are the **site of protein synthesis** where amino acids are linked to form proteins.

---

5. Which cell organelle is involved in packaging and modifying proteins?

Options:
a) Nucleus
b) Mitochondria
✓ **c) Golgi apparatus**
d) Endoplasmic reticulum

Explanation:
The **Golgi apparatus** modifies, sorts, and packages proteins and lipids for secretion or use within the cell.

---

6. Which cell organelle is responsible for breaking down waste materials?

Options:
a) Golgi apparatus
b) Nucleus
c) Mitochondria
✓ **d) Lysosome**

Explanation:
Lysosomes contain digestive enzymes that break down waste, old cell parts, and invading pathogens.

---

7. Which of the following cell structures is involved in maintaining cell shape?

Options:
a) Nucleus
✓ **b) Centrioles**

c) Nucleolus
d) Lysosome

Explanation:
Centrioles are involved in **cell structure, shape, and cell division**. Microtubules in centrioles support the cytoskeleton.

---

8. Which specialized region of the nucleus is responsible for ribosome assembly?

Options:
a) Nucleoplasm
✓ **b) Nucleolus**
c) Chromatin
d) Nuclear envelope

Explanation:
The **nucleolus** is the dense region within the nucleus where **ribosomal RNA is produced** and **ribosome assembly** begins.

---

9. What is the main function of the nuclear pores?

Options:
a) Regulation of cell division
b) Control of pH of the cell
c) Protein synthesis
✓ **d) Control of transport of molecules**

Explanation:
Nuclear pores control the movement of molecules (like RNA and proteins) between the **nucleus and the cytoplasm**.

10. Which of the following cellular structures is found in animal cells and helps in cell division?

Options:
a) Cell membrane
✓ **b) Centriole**
c) Plasmodesma
d) Vacuole

Explanation:
Centrioles help in organizing the spindle fibers during **cell division** in animal cells. Plant cells usually lack centrioles.

---

11. Which sub-cellular organelle plays a crucial role in energy production within the cell?

Options:
a) Endoplasmic reticulum
b) Golgi apparatus
✓ **c) Mitochondria**
d) Lysosomes

Explanation:
Mitochondria are known as the **powerhouses of the cell** because they produce energy (ATP) through cellular respiration.

---

12. In a multicellular plant, which cell type is responsible for the production of glucose?

Options:
a) Xylem
b) Phloem
c) Epidermal
✓ **d) Mesophyll**

Explanation:
Mesophyll cells in plant leaves contain **chloroplasts** and perform **photosynthesis**, producing glucose.

---

13. Which organelle can double its number by self-replication?

Options:
a) Ribosomes
b) Lysosomes
✓ **c) Mitochondria**
d) Golgi apparatus

Explanation:
Mitochondria contain their own DNA and can replicate **independently**, similar to bacteria.

---

14. Which of these are present on the surface of rough endoplasmic reticulum?

Options:
✓ **a) Ribosomes**
b) Lysosomes
c) Mitochondria
d) Vacuoles

Explanation:
The **rough endoplasmic reticulum** is called "rough" because it is studded with **ribosomes**, which synthesize proteins.

B. Write Short Answers:

---

1. What are the main functions of the cell membrane?

Answer:

- Regulates entry and exit of substances.
- Provides protection and support.
- Maintains cell’s internal environment.

---

2. What key role does the Golgi apparatus play in eukaryotic cells?

Answer:
It modifies, sorts, and packages proteins and lipids for storage or transport outside the cell.

---

3. How do ribosomes contribute to the cell's functioning?

Answer:
Ribosomes synthesize proteins, which are essential for growth, repair, and enzyme production.

---

4. Which organelle detoxifies harmful substances and breaks down lipids?

Answer:
The **smooth endoplasmic reticulum (SER)** detoxifies drugs and toxins, and also synthesizes and breaks down lipids.

---

5. What is the smooth endoplasmic reticulum responsible for?

Answer:

- Lipid and steroid hormone synthesis
- Detoxification of harmful substances
- Metabolism of carbohydrates

---

6. How do the vacuoles in plant cells differ from vacuoles in animal cells?

Answer:

- Plant vacuoles are **large and central**, storing water and maintaining turgor pressure.
- Animal vacuoles are **smaller and more numerous**, mainly for waste storage.

---

7. What could happen if lysosomal enzymes stop working properly?

Answer:
Damaged or unneeded materials won't be broken down, leading to **waste accumulation**, which can cause **cell damage or death**.

---

8. Why are the cristae important for cellular respiration?

Answer:
Cristae are folds in the inner membrane of mitochondria that **increase surface area** for energy (ATP) production.

---

9. How are chromatin and chromosomes related?

Answer:
Chromatin is the uncoiled form of DNA. During cell division, it **condenses into chromosomes** to ensure proper DNA distribution.

---

10. Which type of cell is responsible for sending nerve signals?

Answer:
Neuron (nerve cell) — it transmits electrical and chemical signals in the nervous system.

11. What do mesophyll cells do in plant leaves?

Answer:
Mesophyll cells contain chloroplasts and carry out **photosynthesis**, converting sunlight, water, and CO_2 into glucose and oxygen.

---

12. How would you define a stem cell?

Answer:
A **stem cell** is an undifferentiated cell capable of dividing and developing into various types of specialized cells in the body.

---

13. Name the chemical compounds that make up:

- **a. Cell membrane:**
  → Phospholipids and proteins
- **b. Fungal cell wall:**
  → Chitin
- **c. Plant cell wall:**
  → Cellulose
- **d. Bacterial cell wall:**
  → Peptidoglycan
- **e. Ribosomes:**
  → rRNA and proteins
- **f. Chromosomes:**
  → DNA and proteins (histones)

C. Write Answers in Detail (Extended Format):

---

1. Explain the fluid mosaic model of the cell membrane.

Answer:
The **Fluid Mosaic Model**, proposed by **Singer and Nicolson in 1972**, explains the structure of the **plasma membrane** in eukaryotic cells. It is called *fluid* because the components are flexible and *mosaic* due to the pattern of proteins embedded in the lipid bilayer.

- The membrane consists of a **phospholipid bilayer** where **hydrophilic (water-loving) heads** face outward and **hydrophobic (water-repelling) tails** face inward.
- **Proteins** are scattered throughout the membrane like a mosaic:
  - **Integral proteins** span the entire bilayer.
  - **Peripheral proteins** are attached to either surface.
- **Cholesterol molecules** are also embedded, providing **stability** and maintaining **fluidity** of the membrane.
- This model explains how the membrane is **selectively permeable**, allowing some substances to pass while blocking others.

---

2. Describe the structure and functions of the cell wall.

Answer:
The **cell wall** is a rigid, **non-living structure** found in **plant cells**, **fungi**, and **bacteria**. It is **absent in animal cells**.

- **Composition**:
  - Plants: Made of **cellulose**.
  - Fungi: Made of **chitin**.
  - Bacteria: Made of **peptidoglycan**.

Functions:

- Provides **mechanical support** and **protection**.
- Maintains **cell shape**.
- Prevents the cell from **bursting due to excess water**.
- Allows free movement of water and solutes due to its **porous nature**.

---

3. Discuss the components of the nucleus.

Answer:
The **nucleus** is the **control center** of the cell, containing the genetic material (DNA). Its components include:

- **Nuclear Envelope**: A **double membrane** with **pores** that regulate material exchange between the nucleus and cytoplasm.
- **Nucleoplasm**: A jelly-like fluid that **suspends the contents** of the nucleus.
- **Nucleolus**: A dense region that **produces ribosomal RNA (rRNA)** and assembles **ribosomes**.
- **Chromatin**: A thread-like structure of **DNA and proteins (histones)**, which condenses into **chromosomes** during cell division.

---

4. Describe the structure and function of lysosome and endoplasmic reticulum.

Answer:
Lysosome:

- Membrane-bound vesicles containing **digestive enzymes**.
- Functions:
  - Break down **worn-out organelles**, **food particles**, and **foreign invaders**.
  - Involved in **autolysis** (self-destruction of cells).

Endoplasmic Reticulum (ER):

- **Rough ER**: Has **ribosomes** on its surface; responsible for **protein synthesis and transport**.
- **Smooth ER**: Lacks ribosomes; involved in **lipid synthesis**, **detoxification**, and **calcium ion storage**.

---

5. Describe the structure and function of the Golgi complex.

Answer:
The **Golgi complex** (or **Golgi apparatus**) is a stack of flattened, membrane-bound sacs called **cisternae**.

Functions:

- **Modifies, sorts, and packages** proteins and lipids received from the ER.
- Forms **lysosomes** and **transport vesicles**.
- Involved in **secretion** of materials outside the cell.

---

6. Describe the structure and functions of the chloroplast.

Answer:
Chloroplasts are **green, double-membraned organelles** found in **plant cells** and some **algae**.

- Contain **thylakoids**, which are disc-like structures stacked into **grana**.
- The fluid part surrounding the grana is called **stroma**.
- Contain **chlorophyll**, the pigment that **absorbs sunlight**.

Functions:

- Site of **photosynthesis**, where **sunlight** is converted into **chemical energy** (glucose).
- Release **oxygen** as a by-product.

---

7. How does turgor pressure develop in a plant cell?

Answer:
Turgor pressure is the pressure exerted by the **central vacuole** against the **cell wall** in plant cells.

- When a plant cell absorbs water via **osmosis**, the vacuole fills and swells.
- This causes the **plasma membrane** and **cytoplasm** to push against the rigid **cell wall**.
- The resulting pressure, called **turgor pressure**, helps maintain the **rigidity and structure** of the plant.
- It keeps plants **upright** and supports **growth**.

---

8. Write a note on differences between a plant cell and an animal cell.

Feature	Plant Cell	Animal Cell
Cell Wall	Present (made of cellulose)	Absent
Vacuole	Large, central vacuole	Small or absent
Chloroplast	Present (for photosynthesis)	Absent

Feature	Plant Cell	Animal Cell
Shape	Regular, rectangular	Irregular or round
Centrioles	Usually absent	Present (important for division)

---

9. Describe the concept of division of labour and how it applies in multicellular organisms.

Answer:
In **multicellular organisms**, cells are **specialized** to perform specific functions — this is called **division of labour**.

- It improves **efficiency** and **survival**.
- Instead of all cells doing all tasks, **specific cells or tissues** take up dedicated roles.

Examples:

- **Red blood cells** transport oxygen.
- **Muscle cells** contract to enable movement.
- **Nerve cells (neurons)** conduct impulses for communication.

This allows organisms to **function smoothly**, grow larger, and adapt better to complex environments.

---

10. Write a note on cell specialization.

Answer:
Cell specialization (also called **differentiation**) is the process by which **unspecialized cells (like stem cells)** become **specialized** in structure and function.

- Specialized cells perform **unique roles** in the body.
- This is necessary for the **complex functioning** of multicellular organisms.

Examples:

- **Root hair cells** absorb water and minerals in plants.
- **Mesophyll cells** in leaves perform photosynthesis.
- **Sperm and egg cells** are specialized for reproduction.

Specialization helps organisms work **efficiently**, repair themselves, and respond to changing environments.

D. Inquisitive Questions (Detailed Answers):

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1. What impact might mitochondrial dysfunction or absence have on other organelles' ability to operate in a cell?

Detailed Answer:
Mitochondria are often called the **"powerhouses of the cell"** because they produce **adenosine triphosphate (ATP)**, which is the **primary source of energy** for all cellular activities. Every organelle in the cell relies on ATP to carry out its specific functions. If mitochondria are absent or not functioning properly, it has serious consequences for the entire cell.

Effects on other organelles:

- **Golgi Apparatus:**
  Without ATP, the Golgi cannot **modify, sort, or package proteins and lipids**, which are vital for secretion and internal use. Protein trafficking and hormone release would be disrupted.
- **Ribosomes:**
  Ribosomes need energy to **assemble amino acids into proteins**. Without ATP, **protein synthesis slows down or stops**, affecting growth and repair.
- **Endoplasmic Reticulum (ER):**
  The ER depends on energy for **transporting proteins and lipids**, especially in secretory cells. Energy shortage results in **accumulated unfolded proteins** and **ER stress**.
- **Lysosomes:**
  Digestive enzymes in lysosomes require energy to be synthesized and transported. Without it, **waste and damaged organelles accumulate**, leading to **cellular toxicity**.
- **Overall Cell Survival:**
  Mitochondrial failure causes:
  - **Low energy availability**.
  - **Oxidative stress** due to reactive oxygen species.
  - **Cell death (apoptosis)** in extreme cases.

Conclusion:
Mitochondria are central to the functioning of every cell. Their dysfunction **directly**

disrupts the operation of other organelles, making them **essential for cell health and survival**.

---

2. What may happen if the coordination between the ribosomes and the nucleus were to fail, and why is it so important?

Detailed Answer:
In a healthy cell, the **nucleus** controls all cellular activities by sending **genetic instructions (mRNA)** to **ribosomes**, which then use this information to **synthesize proteins**. This coordination is **critical for life**.

If coordination fails:

- **Disrupted mRNA transmission:**
  If the nucleus cannot send proper mRNA to ribosomes, the ribosomes will not receive the correct instructions to build proteins.
- **Protein Synthesis Stops or Malfunctions:**
  Proteins are essential for:
  - **Enzyme production**
  - **Hormone signaling**
  - **Cell repair and growth**
  - **Defense mechanisms (antibodies)**
    Without proper coordination, these proteins are either **not made**, or **made incorrectly**, leading to cellular malfunction.
- **Loss of Gene Expression Control:**
  Gene expression is how a cell "reads" and "executes" its DNA code. Miscommunication between the nucleus and ribosomes leads to **failed gene expression**, making the cell **non-functional**.
- **Effect on Other Organelles:**
  Many organelles depend on specific proteins for their structure and function. If those proteins aren't made properly:
  - **ER** can't process proteins.
  - **Golgi** can't package them.
  - **Cell membrane** won't receive transport proteins.
- **Consequences:**
  - **Slowed cell growth**
  - **Cell aging or death**
  - **Developmental defects in multicellular organisms**
  - **Increased chance of disease (e.g., cancer, genetic disorders)**

Conclusion:
The **coordination between the nucleus and ribosomes** is like the relationship between a **software programmer and a computer**. Without proper instructions, the

computer (ribosome) can't function correctly. This harmony is **essential for life, repair, defense, and reproduction** at the cellular level.