Dr.Ahmad Al-Qawasmi

Biology

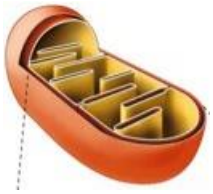
Chapter 7

Tour of the cell

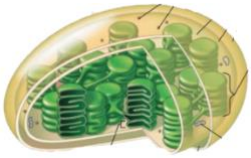
Med learn

❖ 7.5: [Mitochondria and chloroplasts change energy from one form to another]

- In eukaryotic cells, mitochondria and chloroplasts are the organelles that convert energy to forms that cells can use for work

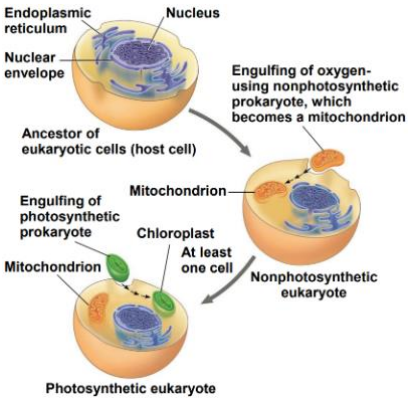


- **Mitochondria:** It is the site of cellular respiration, where Oxygen is used to generate ATP by extracting energy from sugars, fats & other fuels
  - ➢ Mitochondria present in **all eukaryotes**
- **Chloroplasts:** It is the site of photosynthesis, which uses solar energy to produce chemical energy in form of organic compounds, such as sugars (from carbon dioxide and water)
  - ➢ Chloroplasts present in **plants and algae**



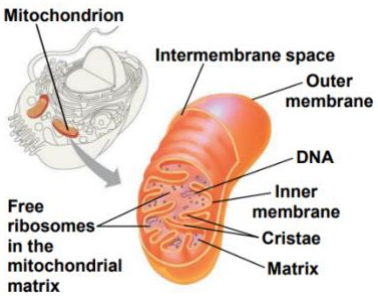
▪ The Evolutionary Origins of Mitochondria and Chloroplasts

- Mitochondria and chloroplasts have similarities with **bacteria**:
  - ✓ Enveloped by a double membrane
  - ✓ Contain free ribosomes and circular DNA molecules
  - ✓ Grow and reproduce somewhat independently in cells
- These similarities led to the **endosymbiont theory** which suggests that:
  - ➢ The early ancestor of eukaryotes **engulfed** an oxygen-using non-photosynthetic prokaryotic cell
  - ➢ The engulfed cell formed a relationship with the host cell, becoming an endosymbiont
  - ➢ The endosymbionts evolved into mitochondria
  - ➢ At least one of these cells may have then taken up a photosynthetic prokaryote, which evolved into a chloroplast



▪ Mitochondria: Chemical Energy Conversion

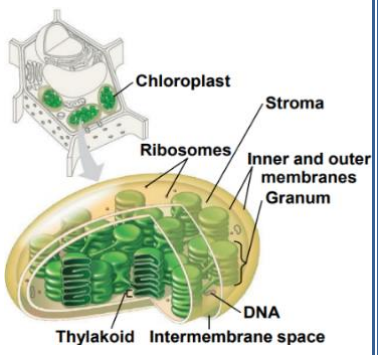
- Mitochondria are generally in the range of 1–10 µm long
- Mitochondria are **dynamic** structure they changing their shapes, and fusing or dividing in two
  - ➢ Cells can have a single large mitochondrion or multiple (hundreds or even thousands) mitochondria ➔ the number correlates with the cell's **level of metabolic activity**



- The mitochondrion is enclosed by double membrane:
  - ✓ The **outer** membrane which is **smooth**
  - ✓ The **inner** membrane **folded** into **cristae**
- The inner membrane divides the mitochondrion into **two** internal compartments:
  - **The intermembrane space** ➔ the narrow region between the inner and outer membranes
  - **The mitochondrial matrix** ➔ enclosed by the inner membrane, contains **different enzymes** (catalyze some of the steps of cellular respiration), the **mitochondrial DNA** and **ribosomes**
    - ➢ Other proteins that function in respiration, including the enzyme that makes ATP, are built into the inner membrane
- The **cristae** give the inner mitochondrial membrane a **large surface area**, thus **enhancing** the productivity of cellular respiration (structure fitting function)

▪ Chloroplasts: Capture of Light Energy

- Chlorophyll about 3–6 µm in length, are found in leaves and other green organs of plants and algae
- Chloroplasts contain the **green lens-shaped pigment** called **chlorophyll**
- Chloroplast are enclosed by an envelope consisting of **two membranes** separated by a very narrow intermembrane space



- **Inside** the chloroplast is another membranous system:
  - ✓ **Thylakoids** which are flattened, interconnected sacs (each **stack/group** of thylakoids called **granum**)
  - ✓ **Stroma** which is the fluid outside the thylakoids, which contains **the chloroplast DNA** and **ribosomes** as well as many **enzymes**

- The membranes of the chloroplast divide the chloroplast space into **three** compartments: the **intermembrane space**, **stroma**, and **thylakoid space**, this compartmental organization enables the chloroplast to convert light energy to chemical energy during photosynthesis (enhances function)
- The chloroplasts are **dynamic** structure, their shape is changeable, grow and pinch in two, reproducing themselves, and move around the cell along tracks of the cytoskeleton
- The chloroplast is a specialized member of a family of closely related plant organelles called **plastids**
- Other types of plastid:
  - ✓ **Amyloplast** which is a colorless organelle **stores starch** (amylose), particularly in roots & tubers
  - ✓ **Chromoplast** which has **pigments** that give fruits and flowers their **orange** and **yellow** hues

▪ Peroxisomes: Oxidation

- The peroxisome is a specialized **metabolic** compartment bounded by a **single membrane**
  - They contain enzymes that **remove hydrogen** atoms from various substrates and transfer them to oxygen (O_2) → producing **hydrogen peroxide (H_2O_2)** as a by-product

- **The functions of these reactions**
  - Some peroxisomes use oxygen **to break fatty acids down** into smaller molecules that are transported to mitochondria and used as fuel for cellular respiration
  - Peroxisomes in the liver **detoxify alcohol and other harmful compounds** by transferring hydrogen from the poisonous compounds to oxygen

- Although, H_2O_2 formed by peroxisomes is toxic → but the organelle also contains an enzyme that **converts H_2O_2 to water**
- How peroxisomes are related to other organelles is still unknown

- **Glyoxysomes** is a special type of **peroxisomes** found in the **fat-storing tissues of plant seeds**
  - ➢ They contain enzymes that initiate the conversion of fatty acids to sugar, which the emerging seedling uses as a source of energy and carbon until it can produce its own sugar by photosynthesis

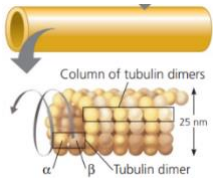
❖ 7.6: [The cytoskeleton is a network of fibers that organizes structures & activities in the cell]

- The **cytoskeleton** is a network of fibers extending throughout the cytoplasm
- **Roles of the Cytoskeleton ➔ Support and Motility**
  - ➢ The cytoskeleton helps to support the cell and maintain its shape
  - ➢ The term cell motility includes both changes in cell location and movements of cell parts
  - o It interacts with motor proteins to produce cell motility
  - o Inside the cell, vesicles can travel along tracks provided by the cytoskeleton

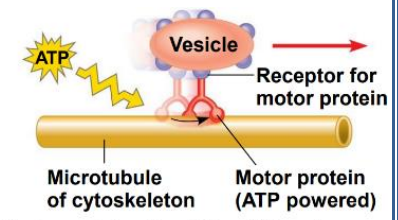
▪ Components of the Cytoskeleton

- The eukaryotic cytoskeleton plays a major role in **organizing the structures and activities** of the cell, is composed of three types of molecular structures:

1. Microtubules



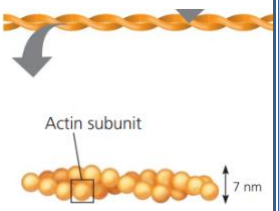
- They are the **thickest** of the three components of the cytoskeleton (25 nm in diameter)
- They are hollow tubes (15nm lumen) made of a globular proteins called **tubulins**
  - ➢ Each tubulin protein is a **dimer**, a molecule made up of two different subunits (polypeptides), **α-tubulin** and **β-tubulin**
  - ➢ A microtubule has 2 slightly different ends : "**plus end**" can accumulate or release tubulin dimers at a much higher rate than the other end "**minus end**"



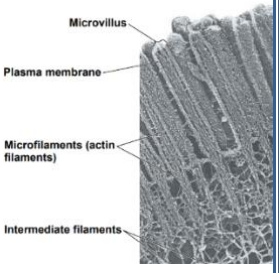
Motor proteins "walk" vesicles along cytoskeletal fibers.

- Microtubules shape and support the cell (compression-resisting) and serve as tracks for motor proteins which carry & move organelles
- Contribute in cell motility as in cilia and flagella & chromosomes movement in cell division

2. Microfilaments (Actin filaments)



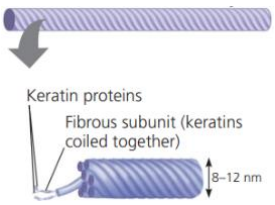
- Are the **thinnest** components of the cytoskeleton (7 nm in diameter)
- A microfilament is a twisted (interwined) **double chain** of **actin** subunits (globular protein)
- Microfilaments seem to be present in **all eukaryotic cells**
- A network of microfilaments helps support the cell's shape (tension-bearing elements)
  - ➢ They form a cortex just inside the plasma membrane to help support the cell's shape
- Contribute in changing the shape of the cell when needed
- Bundles of microfilaments make up the core of microvilli of intestinal cells that increase the cell's surface area
- Microfilaments also function in cellular motility
  - ➢ Cells crawl along a surface by extending **pseudopodia** (cellular extensions)



- Muscle contractions involve **myosin** & **actin** proteins
- Cytoplasmic streaming in plant cells (which is a circular flow of cytoplasm within cells, driven by **actin-myosin** interactions)
- Function in cell division of animal cells

3. Intermediate Filaments

- They are fibers with diameters in a **middle** range (8-12nm in diameter) → larger than microfilaments, smaller than microtubules
- Intermediate filaments are found in the cells of **some animals only** (including **vertebrates**)
- Intermediate filaments are more permanent cytoskeleton fixtures than the other two classes
  - ➢ They support cell shape and fix organelles in place
  - ➢ The anchor the nucleus (components of nuclear lamina)



- Each type of intermediate filaments is constructed from a particular fibrous subunit belonging to **keratins** family which are coiled into cables

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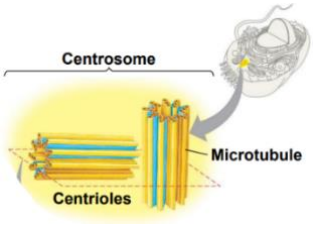
▪ Centrosomes and Centrioles

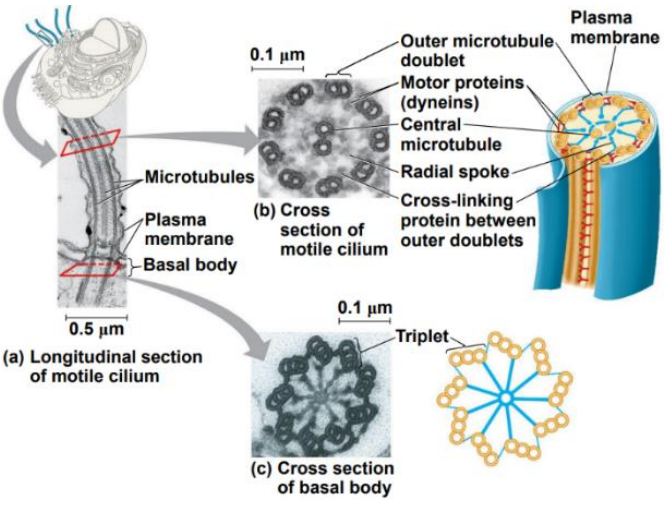


- **Centrosomes:** A region that is often located **near the nucleus in animal cells** where **microtubules grow out from it**
- A centrosome has a pair of **centrioles**
  - ➢ **Centrioles:** Nine triplets of microtubules arranged in a **ring**
- Centrosomes with centrioles may help organize microtubule assembly in animal cells

▪ Cilia and Flagella

- They are microtubule-containing extensions that **project** from some cells
  - ➢ Microtubules control the beating of flagella and cilia
  - ➢ Many unicellular eukaryotes are propelled through water by cilia or flagella
- Cilia or flagella extending from cells that are held in place as part of a tissue layer can move fluid over the surface of the tissue. For example:
  - The **ciliated lining of the trachea** (windpipe) sweeps mucus containing trapped debris out of the lungs
  - In a **woman's reproductive tract**, the cilia lining the oviducts help move an egg toward the uterus
- Motile cilia usually occur in large numbers on the cell surface, but flagella are usually limited to just one or a few per cell, and flagella are longer than cilia
- The microtubule assembly of a cilium or flagellum is anchored in the cell by a **basal body**, which is structurally very similar to a centriole

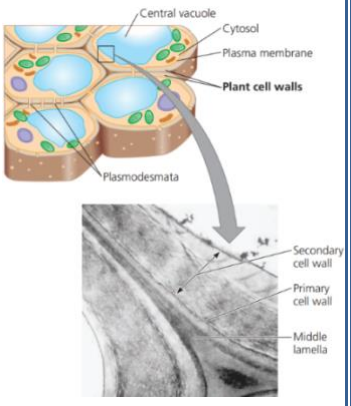
- The difference between the structure of centrioles, basal body, cilia & flagella:
  - ➢ **Celia and flagella** ➔ consist of a ring of 9 **doublets** with **2 central microtubules** (9 + 2)
  - ➢ **Basal body & centrioles** ➔ consist of a ring 9 **triplets** (9 + 0)



❖ 7.7: [Extracellular components & connections between cells help coordinate cellular activities]

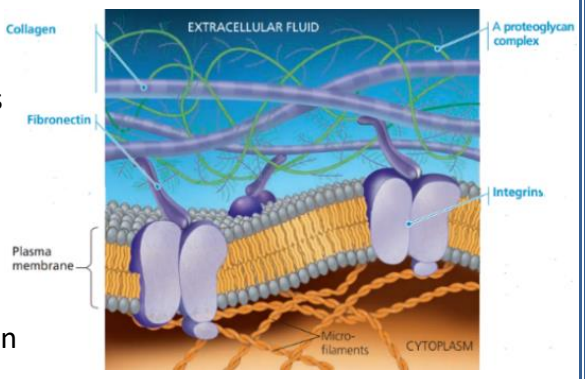
▪ The cell wall of plants

- **Cell wall:** is an **extracellular structure** that present in plant cells, prokaryotes, fungi, and some unicellular eukaryotes (**Notttt in animals**)
- The cell wall function in plants:
  - **Protects** the plant cell & **Maintains** its shape
  - **Prevents excessive** uptake of water
  - **Hold** the plant up against the force of gravity
- Plant cell walls are **much thicker than the plasma membrane** (ranging from 0.1 µm to several µms)
- The chemical composition of cell walls is **Microfibrils** made of the **polysaccharide cellulose** are synthesized by an enzyme called cellulose synthase and secreted to the extracellular space
- **Steps of forming cell walls:**
  - Firstly, a young plant cell secretes a thin and flexible wall called the **primary cell wall**
  - Between primary walls of adjacent cells is the **middle lamella**, a thin layer rich in sticky polysaccharides **pectins**
  - When the cell matures and stops growing, it strengthens its wall by secreting hardening substances between the plasma membrane and the primary wall add a **secondary cell wall**

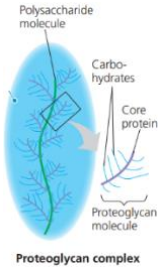


- The secondary wall often consist of several laminated layers, has a strong and durable matrix that affords the cell protection and support
- **Wood**, for example, consists mainly of secondary walls

▪ The Extracellular Matrix (ECM) of Animal Cells



- The main components of the ECM are **Glycoproteins** (such as **collagen**, **fibronectin** and **proteoglycan**)
  - ✓ **collagen** is the most abundant glycoprotein in the ECM of most animal
  - ➢ Collagen forms **strong fibers** outside the cells
  - ➢ Collagen accounts for about 40% of the total protein in the human body
  - ➢ The collagen fibers are embedded in a web of **proteoglycans complex** secreted by cells
    - ✓ **Proteoglycan** is a molecule consists of a small core protein with many carbohydrate chains covalently attached (up to 95% carbohydrate)
  - ➢ Large **proteoglycan complexes** can form when hundreds of proteoglycan molecules become **non-covalently** attached to a single long polysaccharide molecule
    - ✓ **Fibronectin** and other ECM proteins bind to cell-surface receptor proteins called **integrins** that are built into the plasma membrane



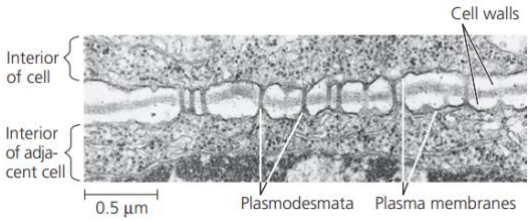
- **Integrins** are membrane proteins with **two subunits**, bind to the ECM on the outside and to associated proteins attached to microfilaments on the inside, this linkage can **transmit signals** between the cell's external environment and its interior and can result in changes in cell behavior

▪ Cell Junctions

- Neighboring cells often **adhere**, **interact**, and **communicate** via sites of direct physical contact, such as:

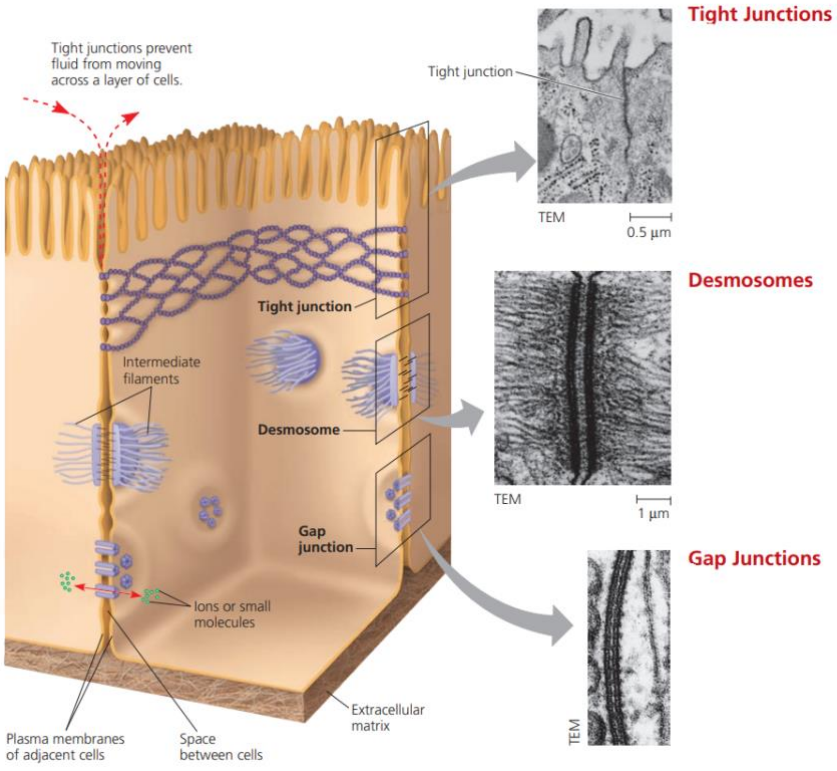
1. Plasmodesmata in Plant Cells

- They are channels that connect and join the internal chemical environments of adjacent cells
  - The plasma membranes of adjacent cells line the channel of each plasmodesma & thus are continuous
  - Water and small solutes can pass freely from cell to cell (certain proteins and RNA molecules can do this as well)



2. Tight Junctions, Desmosomes, and Gap Junctions in Animal Cells

- All three types of cell junctions are especially common in epithelial tissue
  - ➢ Epithelial tissue is a tissue that lines the external and internal surfaces of the body
  - **Tight junctions:** Cells are bound together by specific proteins, forming continuous seals around the cells, that establish a barrier that **prevents leakage of extracellular fluid** across a layer of epithelial cells
    - ➢ For example, tight junctions between skin cells make us **watertight**
  - **Desmosomes** (one type of anchoring junction)**:** Bind cells together into **strong sheets**
    - ➢ Intermediate filaments anchor desmosomes in the cytoplasm
    - ➢ For example, Desmosomes attach **muscle cells** to each other in a muscle
  - **Gap junctions (communicating junctions):** they work as cytoplasmic channels from one cell to an adjacent cell → they consist of membrane proteins that surround pores through which ions, sugars, amino acids and other small **molecules may pass**
    - ➢ for example, communication between cells in **heart muscle**, and in **animal embryos**



Past papers

1. Which of the following pairs would be separated by different configurations?

A. Ribosomes, Mitochondria
B. Na+ , K+
C. Cl- , H2PO4-
D. Amino Acids, glucose
E. None of the above

Answer: A

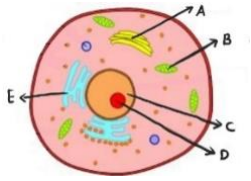
2. Viruses can be seen by

A. Compound microscope
B. Dissecting microscope
C. Electron microscope
D. Unaided eye
E. A,B and C

Answer: C

3. Which part of the cell, indicated by letters, produces rRNA?

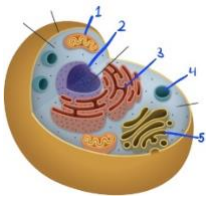
A. A
B. B
C. C
D. D
E. E



Answer: D

4. Which organelle is responsible for the production of membrane proteins?

A. 1
B. 2
C. 3
D. 4
E. 5



Answer: C

5. Structure A in the picture functions in all of the following except

A. Carbohydrate metabolism
B. Steroids synthesis
C. Calcium storage
D. Drugs detoxification
E. Proteins sorting and packaging

Answer: E

6. The middle lamella that joins plant cells together is

A. produced by the endoplasmic reticulum
B. produced by the Golgi apparatus
C. rich in sticky polysaccharides called pectin
D. made of cellulose
E. B & C are correct

Answer: B

7. **Which of the following organelles are interconnected and made of membranous sacs called cisternae?**

A. Golgi apparatus
B. Smooth endoplasmic reticulum
C. Rough endoplasmic reticulum
D. B&C
E. All of the above

Answer: E

8. **Which of the following contain the 9 + 2 arrangement of microtubules?**

A. Cilia
B. Centrioles
C. Flagella
D. A and C only
E. A, B, and C

Answer: D

9. **Which of the following possesses a micro tubular structure similar to a basal body?**

A. Centrioles
B. Lysosome
C. Nucleolus
D. Peroxisomes
E. Ribosome

Answer: A

10. **Which statement correctly characterizes bound ribosomes?**

A. Bound ribosomes are enclosed in their own membrane
B. Bound and free ribosomes are structurally different
C. Bound ribosomes generally synthesis membrane proteins and secretory proteins
D. The most common location for bound ribosomes is the cytoplasmic surface of the plasma membrane
E. All of the above

Answer: C

11. **Tay-Sachs disease is a human genetic abnormality that results in cells accumulating and becoming clogged with very large and complex lipids. Which cellular organelle must be involved in this condition**

A. The endoplasmic reticulum
B. The Golgi apparatus
C. Lysosomes
D. Mitochondria
E. membrane-bound ribosomes

Answer: C

12. **Which of the following organelles directly involved Intracellular digestion of macromolecules?**

A. contractile vacuole
B. Lysosomes
C. Central vacuole
D. food vacuole

Answer: C

13. Which is one of the main energy transformers of cells?

A. Lysosome
B. Vacuole
C. Mitochondrion
D. Golgi apparatus
E. Peroxisomes

Answer: C

14. Which of the following contains its own DNA and ribosomes?

A. Lysosome
B. Vacuole
C. Mitochondrion
D. Golgi apparatus
E. Peroxisomes

Answer: C

15. Which plant cell organelle contains its own DNA and ribosomes?

A. mitochondrion
B. glyoxysome
C. peroxisome
D. vacuole
E. Golgi apparatus

Answer: A

16. A cell has the following molecules and structures: enzymes, DNA, ribosomes, plasma membrane, and mitochondrion, it could be a cell from

A. A bacterium
B. An animal, but not a plant
C. A plant, but not an animal
D. A plant or an animal
E. any kind of organism

Answer: D

17. Cyanide binds with at least one molecule involved in producing ATP. If a cell is exposed to cyanide, most of the cyanide would be found within the

A. mitochondria
B. Ribosomes
C. Peroxisomes
D. Lysosomes
E. Endoplasmic reticulum

Answer: A

18. The liver is involved detoxification of many poisons and drugs. Which of the following structures is primarily involved in this process and therefore abundant in liver cells?

A. Rough ER
B. Smooth ER
C. Golgi apparatus
D. Nuclear envelope
E. Transport vesicles

Answer: B

19. Which of the following produces and modifies polysaccharides that will be secreted?

A. Lysosome
B. Vacuole
C. Mitochondrion
D. Golgi apparatus
E. Peroxisomes

Answer: D

20. Which of the following is true about free ribosomes?

A. It is attached to the nuclear envelope
B. It is attached to the ER
C. They produce the proteins that must be secreted out the cell
D. Producing cytoplasmic proteins
E. None of the above

Answer: D

21. _____ is a framework of protein fibers extending throughout the nuclear interior

A. Nuclear lamina
B. Nuclear matrix
C. Middle lamella
D. Pore complex
E. None of the above

Answer: B

22. For studying Phagocytosis (Lysosome function) , the best cells used to study it:

A. Liver cells
B. Red blood cells
C. Macrophages
D. Skin cell
E. None of the above

Answer: C

23. Which of the following organelles is absent in plant cells?

A. Plasma membrane
B. Cell wall
C. Chloroplast
D. Central vacuole
E. Centrosome

Answer: E

24. All of the following is found in prokaryotic cells except

A. DNA
B. Chromosomes
C. Ribosomes
D. Cytosol
E. Nuclear envelope

Answer: E

25. Large number of ribosomes can be found in cells that produce:

A. Proteins
B. Carbohydrate
C. Lipids
D. DNA
E. RNA

Answer: A

26. Which type of junctions establishes a barrier that prevents leakage of extracellular fluid across a layer of epithelial cells?

A. Tight Junction
B. Gap junction
C. Desmosomes
D. Plasmodesmata
E. None of the above

Answer: A

27. Under which of the following conditions would you expect to find a cell with a predominance of free ribosomal?

A. A cell that is secreting proteins
B. A cell that is producing cytoplasmic enzymes
C. A cell that is constructing its call wall or extracellular matrix
D. A cell that is digesting food particles
E. A cell that is enlarging its vacuole

Answer: B

28. Materials from one animal cell can enter adjacent cell by :

A. Tight Junction
B. Gap Junction
C. Desmosome
D. Microfilament
E. Intermediate filament

Answer: B

29. Microtubules are not involved in?

A. Cilia
B. Flagella
C. Movement of organelles
D. Cell division
E. Amoeboid movement

Answer: E

30. The plant cell's central vacuole:

A. Play a major role in growth
B. Store nutrient
C. Reservoir of Inorganic ions
D. Occupied large space of the cell
E. All of the above

Answer: E

31. The nuclear envelope is directly connect to:

A. Endoplasmic reticulum
B. Golgi apparatus
C. Lysosomes
D. Peroxisomes
E. Food vacuole

Answer: A

32. Which of the following found in both bacteria and plant cells:

A. Chloroplasts
B. Cell wall
C. Nucleus
D. Mitochondria
E. None of the above

Answer: B

33. The organelle that can carry out (Autophagy process) Is:

A. Golgi
B. ER
C. Nucleus
D. Mitochondria
E. Lysosomes

Answer: E

34. The correct pathway of secretory proteins:

A. Rough ER - Lysosome - Golgi - Plasma membrane
B. Smooth ER - Golgi - Transport vesicles - Plasma membrane
C. Rough ER - Golgi - Transport vesicle - Plasma membrane
D. Golgi - Lysosome - Plasma membrane
E. None of the above

Answer: C

35. The type of junction that can be seen between heart (Cardiac muscles) is

A. Tight junction
B. Gap junction
C. Desmosomes
D. Plasmodesmata
E. None of the above

Answer: B

36. Which of the following IS FALSE about lysosomes:

A. Can digest food and damage organelles
B. They are membranous
C. Contain hydrolytic enzymes
D. Has basic environment
E. All of the above is true

Answer: D

37. Chloroplasts and mitochondria have in common a :

A. Both of them bounded by double membrane
B. Both of them contain DNA
C. Both of them involved in energy conversion
D. Both of them involved in digestion of food
E. All of them true except of (D)

Answer: E

38. Microtubules control the beating of cilia and flagella which aid in cell motility in some unicellular organisms. Select one:

A. False
B. True

Answer: B

39. A plant cell was grown in a test tube with radioactive nucleotides, the part from which DNA is built. The radioactivity will be concentrated in the Rough ER

A. False
B. True

Answer: B

40. Cytochalasin D is a drug that prevents actin polymerization. A cell treated with cytochalasin D will still be able to contract muscle fibers, Select one:

A. False
B. True

Answer: B

41. What types of proteins are not synthesized in the rough ER? Select one:

A. endoplasmic reticulum proteins
B. plasma membrane proteins
C. mitochondrial proteins
D. extracellular matrix proteins
E. secretion proteins

Answer: C

42. Movement of vesicles within the cell depends on what cellular structures?

A. actin filaments and ribosomes
B. microtubules and motor proteins
C. actin filaments and intermediate filaments
D. actin filaments and microtubules
E. Centrioles and motor proteins

Answer: B

43. Motor proteins provide for molecular motion in cells by interacting with what typos of cellular structures?

A. A ribosomes
B. cytoskeletal structure
C. membrane proteins
D. cellulose fibers in the cell wall
E. sites of energy production in cellular respiration

Answer: B

44. if an individual has abnormal microtubules, then his sperm and skeletal muscles will be affected

A. false
B. true

Answer: B

45. phagocytic white blood cells ate the best tor studying lysosomes.

A. False
B. True

Answer: B

46. The electron microscope has been particularly useful in studying bacteria because

A. Bacteria have few organelles
B. Electrons can pass through bacterial cell wall
C. Bacteria move so quickly
D. their organelles are small and packed together
E. bacteria are so small

Answer: B

47. Intermediate filaments are involved in:

A. Pseudopodia
B. Spindle fibers
C. Anchorage of the nucleus
D. Nuclear lamina in animal cells
E. C and D are correct

Answer: E

48. Which is common for both mitochondria and chloroplast:

A. Both are surrounded by two membranes
B. Both have DNA and ribosomes
C. Both transform energy
D. ATP is produced
E. All of the options are correct

Answer: E

49. Microtubules are not involved in which of the following:

A. Cilia
B. Flagella
C. Spindle fiber
D. Basal body
E. Pseudopodia

Answer: C

50. The most likely pathway taken by a newly synthesized protein that will be secreted by a cell is.

ER → Golgi → vesicles that fuse with plasma membrane

A. False
B. True

Answer: B

51. The maximum magnification in the light microscope is 1000 times:

A. False
B. True

Answer: B