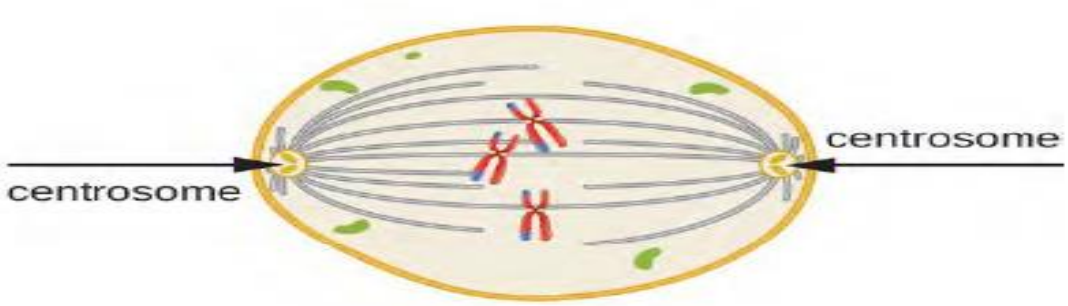
Introduction to Cell Structure and Function

Like a prokaryotic cell, a eukaryotic cell has a plasma membrane and cytoplasm. The cytoplasm is made of two parts: the cytosol and the cytoskeleton.

The cytoskeleton has three different types of protein elements. Microfilaments provide rigidity and help shape the cell. Intermediate filaments bear tension and anchor the nucleus and other organelles in place. Microtubules help the cell resist compression and serve as tracks for motor proteins that move vesicles through the cell. They are also the structural elements of centrosomes, flagella, and cilia.

centrosomes: specialized microtubules that pull chromosomes to their poles during cell division.



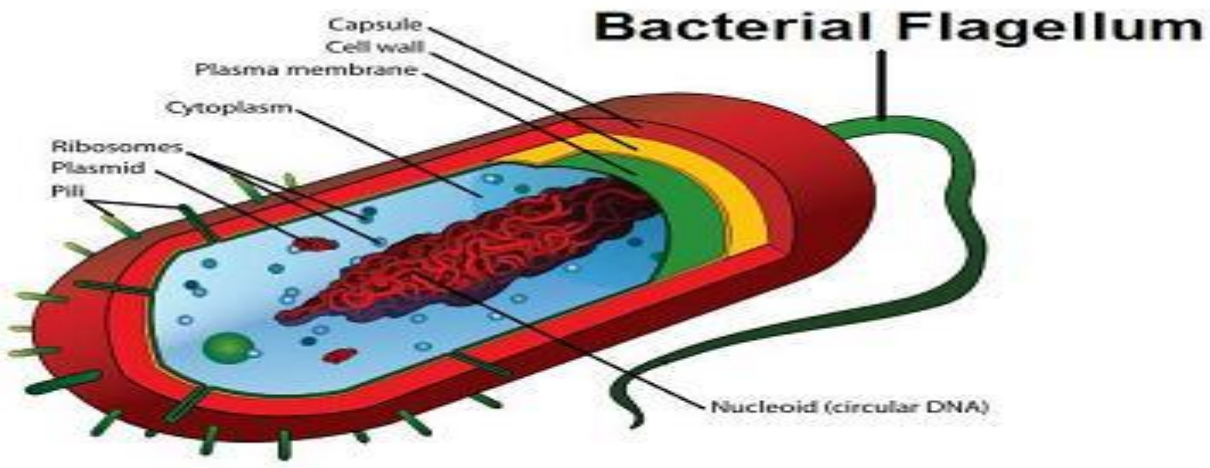
cilium: (plural: cilia) a short, hair-like structure that extends from the plasma membrane in large numbers and is used to move an entire cell or move substances along the outer surface of the cell.

cytoplasm: the entire region between the plasma membrane and the nuclear envelope, consisting of organelles suspended in the gel-like cytosol, the cytoskeleton, and various chemicals.

cytoskeleton: the network of protein fibers that collectively maintain the shape of the cell, secures some organelles in specific positions, allows cytoplasm and vesicles to move within the cell, and enables unicellular organisms to move

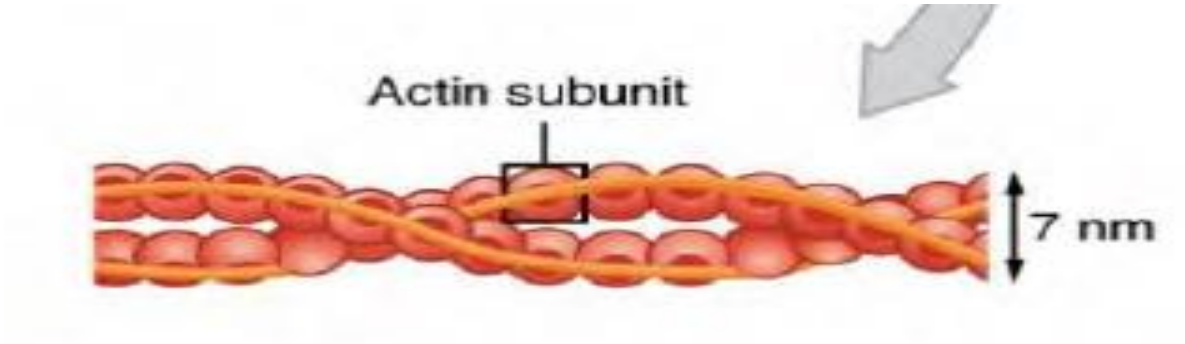
cytosol: the gel-like material of the cytoplasm in which cell structures are suspended

flagellum: (plural: flagella) the long, hair-like structure that extends from the plasma membrane and is used to move the cell.

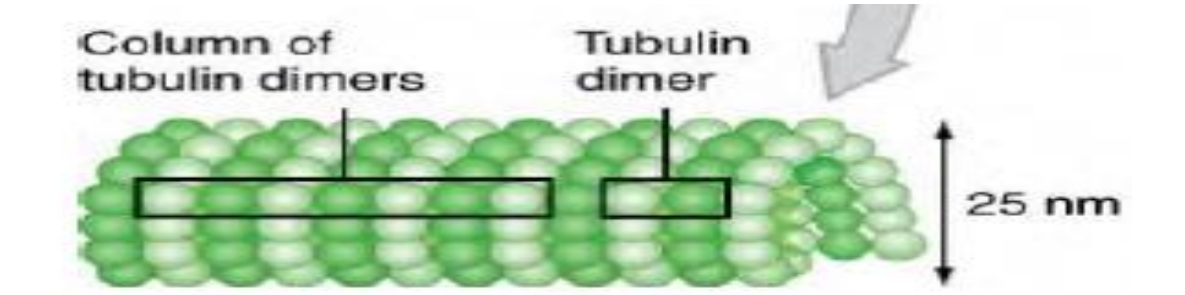


intermediate filaments: fibers of the cytoskeleton that are of intermediate diameter and have structural functions, such as maintaining the shape of the cell and anchoring organelles.

microfilaments: the thinnest of the cytoskeletal fibers and function in moving cellular components and maintaining cell structure.



microtubules: the thickest fibers that make up the cytoskeleton and can dissolve and reform quickly.



plasma membrane: a phospholipid bilayer with embedded (integral) or attached (peripheral) proteins that separates the internal contents of the cell from its surrounding environment.

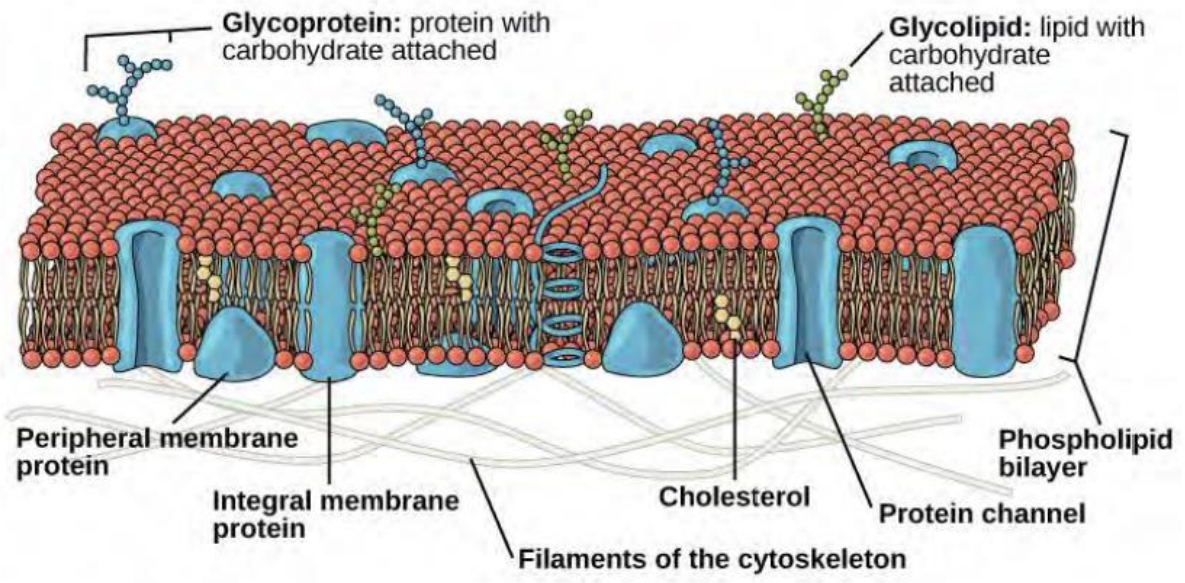


Figure : The plasma membrane

The cell membrane, also known as the plasma membrane, is a double layer of lipids and proteins that surrounds a cell and separates the cytoplasm (the contents of the cell) from its surrounding environment. It is selectively permeable, which means that it only lets certain molecules enter and exit. It can also control the amount of some substances that go into or out of the cell.

The functions of cell membranes include:

1. Mechanical Structure
    1. Defines/encloses the Cell
    2. Re. Cytoskeleton
    3. Extracellular Matrix
    4. Protection
2. Selective Permeability
3. Active Transport
4. **Bulk Transport**:
   Exocytosis and Endocytosis
5. Markers & Signalling
   (for communication with other cells & the external environment)
6. Metabolic Activities

More about each of these functions of the cell membrane follows below:

1. Mechanical Structure

Defines/encloses the Cell
A cell membrane encloses and defines the cell. There are different ways to express this, e.g.

The cell membrane maintains the physical integrity of the cell. It's most obvious in the cases of animal cells (because they don't have cell walls) that the cell membrane holds the cell together by enclosing the cytoplasm and organelles within it.
The cell membrane forms a barrier between the inside of the cell and the environment outside the cell - enclosing cytoplasm and any organelles within the cell, and enabling different chemical environments to exist on each side of the cell membrane.
The cell membrane physically separates the intracellular components (e.g. organelles in eukaryotic cells) from the extracellular environment.
The 3 points listed above say much the same thing.

Re. Cytoskeleton
In many cases the cell membrane also helps to hold the cytoskeleton (which is within the cell) in place. This is is achieved by some proteins in the cell membrane attaching to some cytoskeletal fibres and helps to define and maintain the shape of the cell.

Extracellular Matrix
In many cases (but not all, e.g. not in the case of single celled-organisms) the cell membrane interacts with the cell membrane of adjacent cells e.g. to form plant and animal tissues.

Protection
The cell membrane protects the cell from some harmful chemicals in its external environmemt.
It also protects the cell from loss of useful biological macromolecules held within the cell by its plasma membrane.

2. Selective Permeability

The cell membranes that enclose cells (inside the cell wall in the cases of plant cells and prokaryotic cells) are selectively permeable. That is, the structure of these membranes is such that they allow certain particles, incl. e.g. molecules, - but not others - to pass through the membrane, hence into or out of the cell.

(This cell membrane function is one of several functions that facilitate the transport of materials needed for survival of the cell, others include "active transport", "exocytosis" and "endocytosis".)

3. Active Transport

Cell membranes, also known as "plasma membranes", can allow active transport of specific molecules across the cell membrane in either direction, i.e. either into or out of the cell.

That is - cell membranes can allow some particular molecules to move against a concentration gradient e.g. from a lower concentration outside the cell to a higher concentration inside the cell, or vice-versa. Active transport (movement against the concentration gradient) requires, that is it uses, energy.

4. Bulk Transport: Exocytosis & Endocytosis

Exocytosis is the process by which a cell moves the contents of secretory vesicles out of the cell via the cell membrane.
Endocytosis is the opposite process by which the contents of secretory vesicles are moved into the cell via the cell membrane.

5. Markers & Signaling

Proteins called surface protein markers embedded in the cell membrane identify the cell, enabling nearby cells to communicate with each other.

Cell membranes often include receptor sites for interaction with specific biochemicals such as certain hormones, neurotransmitters and immune proteins. In this way the cell can recognize and process some signals received from the extracellular environment.

6. Metabolic Activities

Plasma membranes include as part of their structures certain proteins and enzymes that are involved in some of the metabolic processes of the cell

1. Which of the following is the main component of the plasma membrane?

a) Carbohydrates

b) Nucleic acids

c) Phospholipids

d) Amino acids

e) Glycoproteins

2. What part of the cytoskeleton helps the cell maintain its shape and resist compression?

a) Intermediate filaments

b) Microtubules

c) Microfilaments

d) Centrioles

e) Cilia

3. The cytoplasm includes all of the following EXCEPT:

a) Organelles

b) Nuclear envelope

c) Cytoskeleton

d) Cytosol

e) Various chemicals

4. Which structure is used by the cell for movement and is long and whip-like?

a) Cilia

b) Vesicles

c) Flagella

d) Intermediate filaments

e) Ribosomes

5. What is the function of microfilaments?

a) Bear tension

b) Serve as tracks for motor proteins

c) Anchor organelles

d) Maintain cell structure and movement

e) Resists compression

6. The function of centrosomes is to:

a) Move vesicles along microtubules

b) Pull chromosomes to their poles during cell division

c) Anchor the nucleus

d) Form the plasma membrane

e) Move the entire cell

7. Which of the following structures helps cells adhere to neighboring cells and the extracellular matrix?

a) Microfilaments

b) Microtubules

c) Plasma membrane

d) Cytosol

e) Centrioles

8. Cytosol can be best described as:

a) The network of protein fibers within the cell

b) Gel-like material where organelles are suspended

c) Fluid surrounding the nucleus

d) The outermost layer of the cell

e) The area where microtubules are formed

9. Which type of transport requires energy to move molecules against a concentration gradient?

a) Simple diffusion

b) Active transport

c) Facilitated diffusion

d) Osmosis

e) Exocytosis

10. What is the primary role of the cell membrane?

a) Define and enclose the cell

b) Produce proteins

c) Store nutrients

d) Synthesize DNA

e) Regulate pH balance

11. What structure helps maintain the shape of the cell by anchoring organelles in place?

a) Intermediate filaments

b) Flagella

c) Cilia

d) Cytosol

e) Endoplasmic reticulum

12. Which of the following is NOT a function of the plasma membrane?

a) Selective permeability

b) Communication with external environment

c) Synthesize proteins

d) Active transport

e) Mechanical structure

13. What process involves vesicles fusing with the plasma membrane to release contents outside the cell?

a) Exocytosis

b) Endocytosis

c) Osmosis

d) Active transport

e) Diffusion

14. Cilia are primarily involved in:

a) Anchoring organelles

b) Moving the cell or substances across the cell surface

c) Cellular communication

d) Producing proteins

e) DNA replication

15. Which is the thinnest component of the cytoskeleton?

a) Microfilaments

b) Intermediate filaments

c) Microtubules

d) Centrosomes

e) Centrioles

16. What structure allows the plasma membrane to interact with specific hormones and neurotransmitters?

a) Receptor proteins

b) Microtubules

c) Cytosol

d) Cilia

e) Vesicles

17. Which cytoskeletal element is known to be the most rapidly restructured?

a) Intermediate filaments

b) Microtubules

c) Flagella

d) Microfilaments

e) Plasma membrane

18. The cell membrane protects the cell from:

a) Osmosis

b) Active transport

c) Harmful chemicals in the environment

d) Cellular metabolism

e) Energy depletion

19. Bulk transport mechanisms include:

a) Simple diffusion and osmosis

b) Endocytosis and exocytosis

c) Active transport and diffusion

d) Osmosis and active transport

e) Protein synthesis

20. Which structure serves as the site for cellular respiration in eukaryotic cells?

a) Nucleus

b) Cytoplasm

c) Mitochondria

d) Golgi apparatus

e) Ribosomes

21. Which part of the cytoskeleton is essential for muscle contraction?

a) Intermediate filaments

b) Microfilaments

c) Microtubules

d) Centrosomes

e) Flagella

22. The plasma membrane consists mainly of:

a) Phospholipid bilayer

b) DNA and RNA

c) Carbohydrates

d) Ribosomes

e) Lysosomes

23. What process allows certain molecules to pass through the plasma membrane while preventing others?

a) Selective permeability

b) Endocytosis

c) Exocytosis

d) Simple diffusion

e) Osmosis

24. What is the primary function of intermediate filaments?

a) Facilitate movement

b) Provide tracks for motor proteins

c) Bear tension and anchor organelles

d) Aid in cell division

e) Form vesicles

25. Active transport of molecules across the plasma membrane:

a) Requires energy

b) Moves molecules with the concentration gradient

c) Happens passively

d) Involves osmosis

e) Relies on exocytosis

26. Which of the following is a metabolic activity of the plasma membrane?

a) Flagellar movement

b) Involvement in enzymatic reactions

c) Formation of ribosomes

d) Production of glucose

e) DNA replication

27. The cytoskeleton includes:

a) Ribosomes, vesicles, and the Golgi apparatus

b) Microtubules, microfilaments, and intermediate filaments

c) Lysosomes and centrioles

d) Mitochondria and flagella

e) Nucleus and cytosol

28. What is the gel-like substance within the cytoplasm where organelles are suspended?

a) Plasma membrane

b) Cytosol

c) Nucleus

d) Endoplasmic reticulum

e) Golgi apparatus

29. What is the major function of the cell membrane in terms of transport?

a) Selective permeability

b) Active transport

c) Osmosis

d) Protein synthesis

e) Glycolysis

30. Which of the following describes the function of the cytoskeleton?

a) Synthesizes lipids

b) Maintains the shape of the cell and aids in movement

c) Produces DNA

d) Stores nutrients

e) Regulates cell division

31. What is the function of motor proteins in the cytoskeleton?

a) Move vesicles along microtubules

b) Anchor the nucleus

c) Form flagella

d) Facilitate endocytosis

e) Replicate DNA

32. Which component of the cytoskeleton is most involved in cell division?

a) Microfilaments

b) Intermediate filaments

c) Microtubules

d) Flagella

e) Lysosomes

33. The plasma membrane controls the exchange of materials through:

a) Selective permeability

b) Mitochondria

c) Flagella

d) Golgi apparatus

e) Ribosomes

34. Which of the following enables the cell membrane to interact with the external environment?

a) Surface protein markers

b) Microtubules

c) Cytoskeleton

d) Lysosomes

e) Ribosomes

35. Intermediate filaments help:

a) Move vesicles

b) Maintain cell shape and anchor organelles

c) Facilitate cell division

d) Drive cell movement

e) Form the nucleus

36. What cellular structure provides the rigidity and shape to the cell?

a) Microfilaments

b) Mitochondria

c) Ribosomes

d) Plasma membrane

e) Lysosomes

37. Which of the following is responsible for bulk transport into and out of the cell?

a) Active transport

b) Exocytosis and endocytosis

c) Selective permeability

d) Diffusion

e) Osmosis

38. The plasma membrane is responsible for:

a) Communicating with other cells

b) Synthesizing proteins

c) Replicating DNA

d) Breaking down waste

e) Storing nutrients

39.

What is a key structural component of centrosomes?

a) Ribosomes

b) Microtubules

c) Microfilaments

d) Nucleus

e) Lysosomes

40. Which of the following is a function of the cytoskeleton?

a) Synthesizing proteins

b) Replicating DNA

c) Moving vesicles within the cell

d) Storing nutrients

e) Producing ATP