General Zoology Lecture 1

Intercellular Junctions (connection) between cells and cytoskeleton

Types of intercellular junctions

- Cells in animals or plants are organised into tissues, organs, and organ systems.
- Cells adhere, interact, and communicate through direct physical contact.
- In animals, three main types of intercellular junctions:
  - Tight Junctions
  - Desmosomes
  - Gap Junctions.
- These types are found in epithelial tissue, which lines the external and internal surfaces of the body.

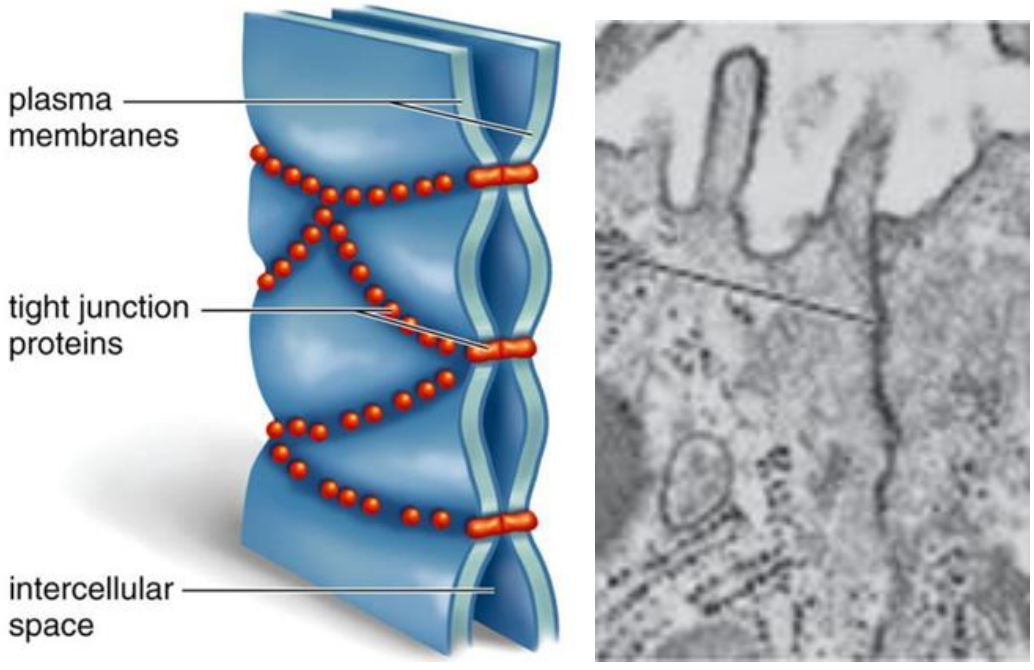
Tight Junctions

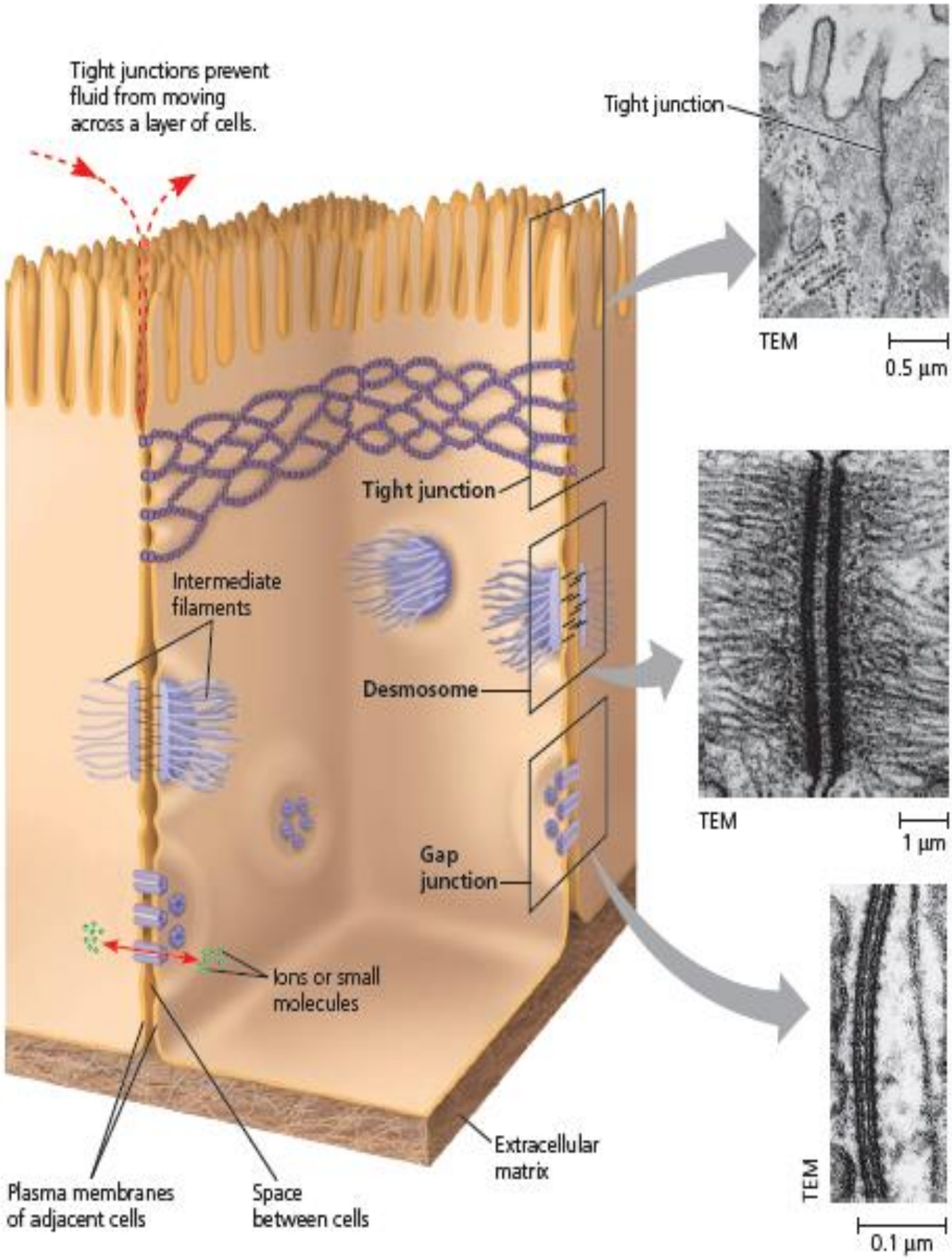
- Plasma membranes of neighbouring cells are very tightly pressed against each other.
- Bound together by a raw of specific proteins forming continuous seals around the cells.

Function:

- Prevent leakage of extracellular fluid (molecules and ions) across a layer between epithelial cells.

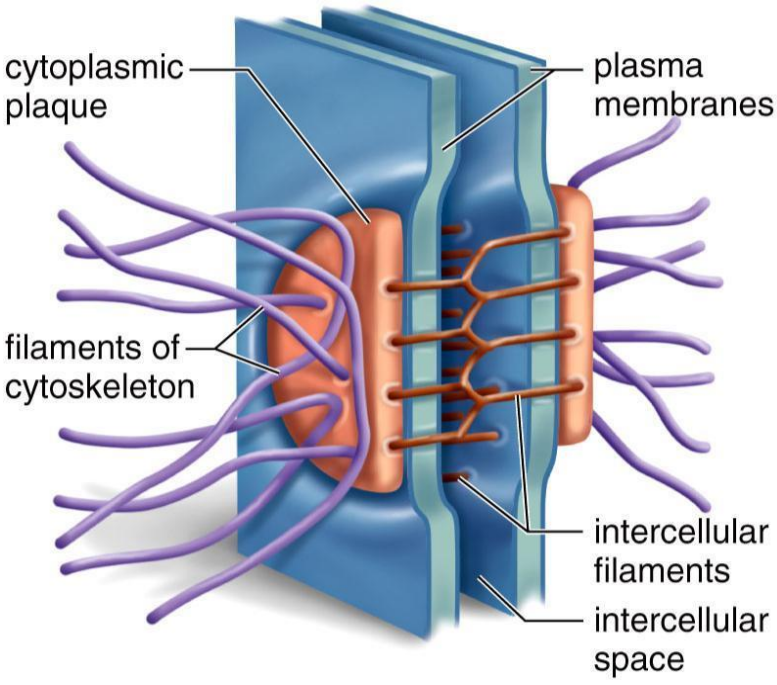
Found: Between epithelial cells of the skin.

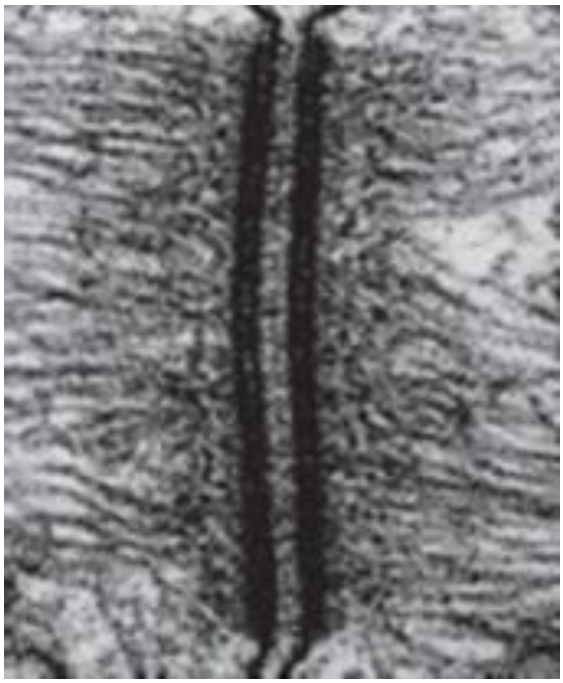



Tight junctions prevent fluid from moving across a layer of cells.
Tight junction
TEM
0.5 µm
Tight junction
Intermediate filaments
Desmosome
TEM
1 µm
Gap junction
Ions or small molecules
Extracellular matrix
Plasma membranes of adjacent cells
Space between cells
TEM
0.1 µm

Desmosomes

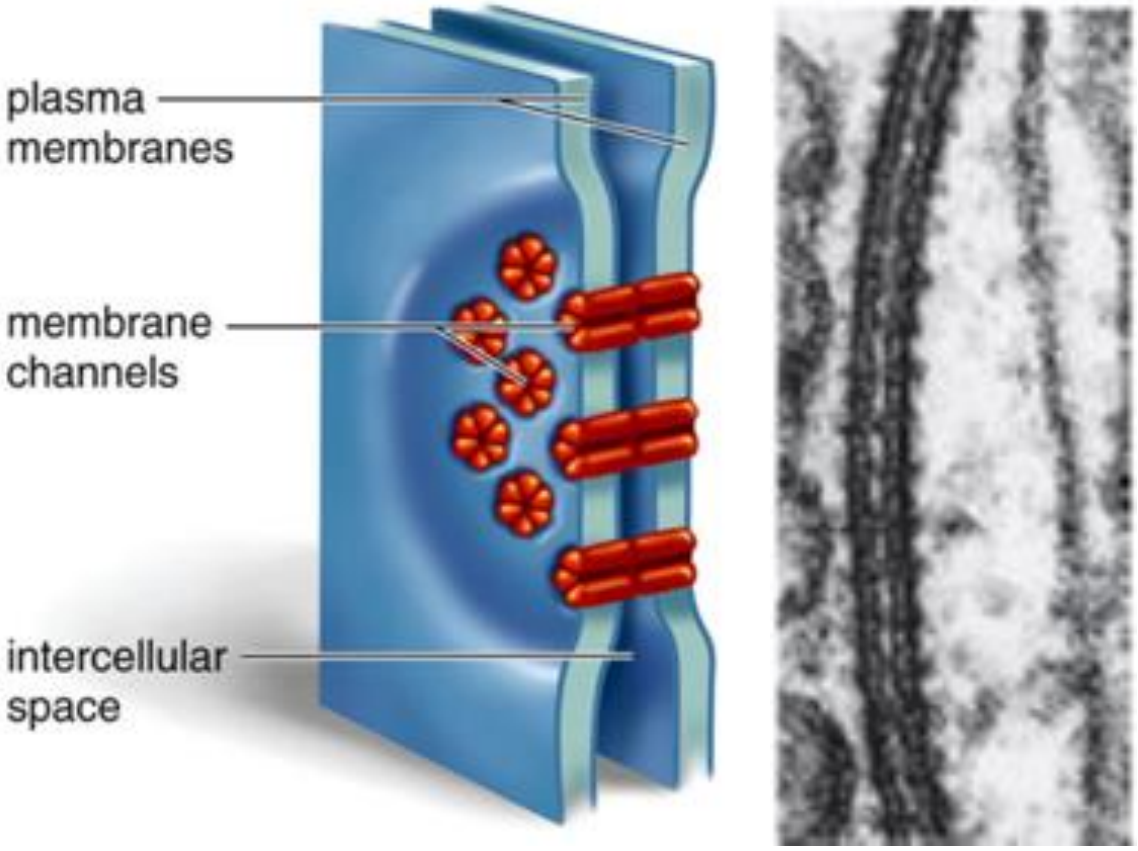
- **Also called *anchoring junctions*.**
- **Function like rivets, fastening cells together into strong sheets.**
- **Intercellular filaments made of strong keratin proteins anchor desmosomes in cytoplasm.**
- **Desmosomes attach muscle cells to each other in a muscle.**
- **Some "muscle tears" involve the rupture of desmosomes.**





Gap junctions

- **Also called *communicating junctions*.**
- **Provide cytoplasmic channels from one cell to an adjacent cell.**
- **It consists of membrane proteins surrounding a pore through which ions, sugars, amino acids, and other small molecules may pass.**
- **Necessary for communication between cells in many types of tissues (heart muscle & in animal embryos).**

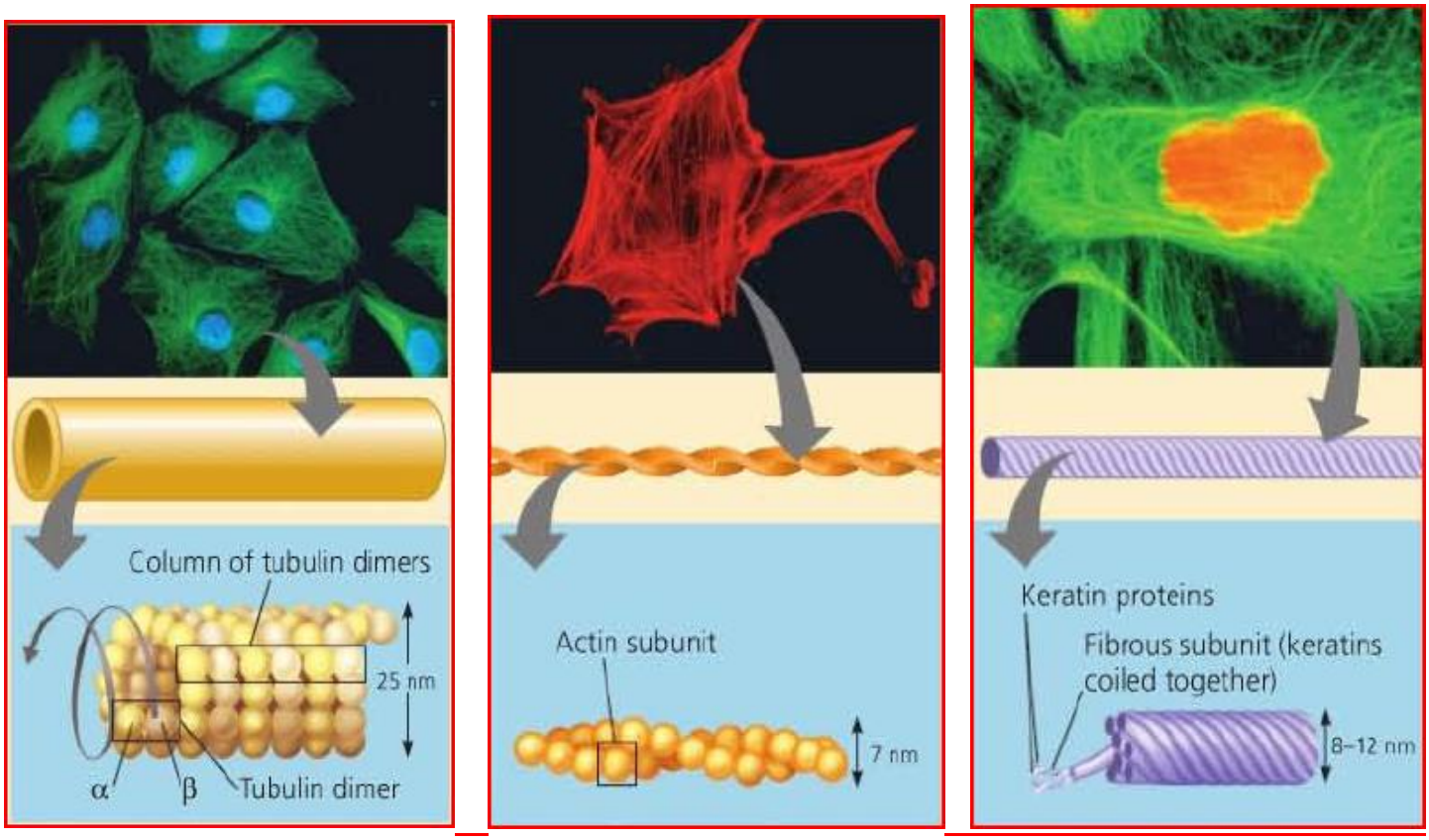


Cytoskeleton: cell shape and movement

- Before discovering an electron microscope, biologists thought that the organelles of a eukaryotic cell floated freely in the cytosol. But improvements in both light microscopy and electron microscopy have revealed the cytoskeleton.
- Cytoskeleton is a network of cytoplasmic filaments responsible for the cell's movement and gives the cell its shape.
- cytoskeleton, which plays a major role in organising the structures and activities of the cell.
- Cytoplasm - under an electron microscope - appears as a three-dimensional (3D) lattice of thin protein-rich strands.
- Lattices serve to interconnect and support the other "solid" structures in the cytoplasm.
- Cytoplasm is like a fence that is made up of lattices that are connected together. This fence's main purpose is to hold together the organelles within the cytoplasm.

Components of the cytoskeleton

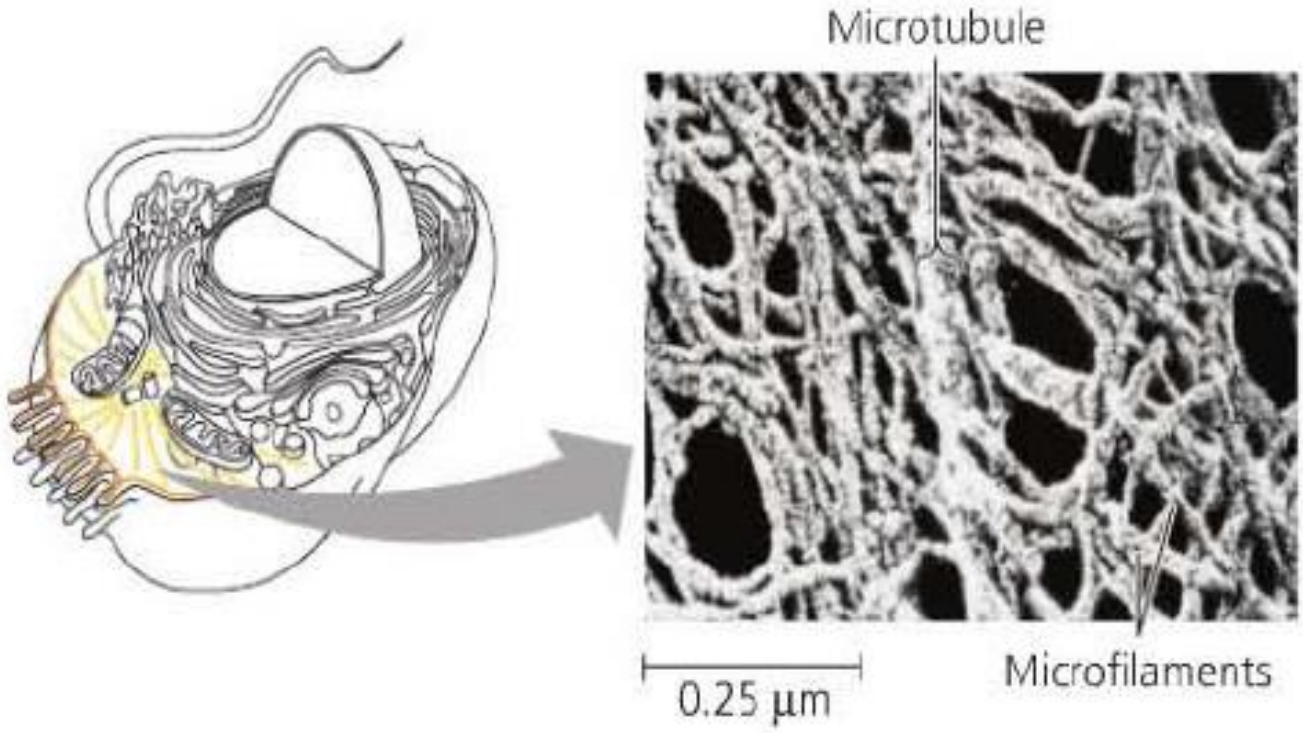
- ***Microtubules*** **(also called Tubulin polymer) are the thickest of the three types.**
- ***Microfilaments*** **(also called actin filaments) are the thinnest.**
- ***Intermediate filaments*** **are fibres with diameters in a middle range.**



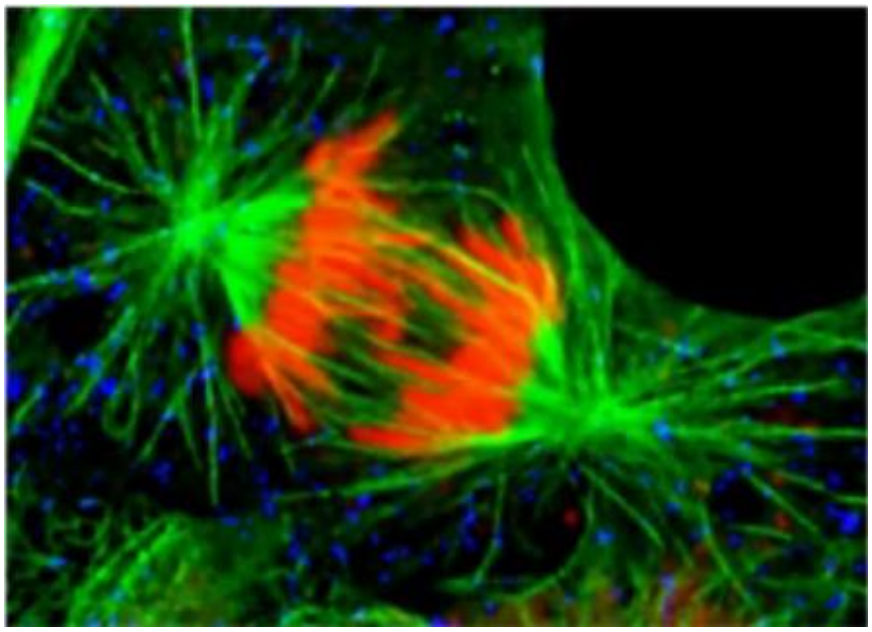
Microtubule **Microfilaments** **Intermediate filaments**

Microtubes

- **Present in all eukaryotic cells.**
- **Hollow rods measuring about 25 nm in diameter and from 200 nm to 25 µm in length.**
- **The wall of the hollow tube is constructed from a globular protein called tubulin.**
- **Each tubulin protein is a *dimer,* a molecule made up of two subunits α-tubulin and β-tubulin.**
- **Microtubules grow in length by adding tubulin dimers.**
- **Microtubules can be disassembled and their tubulin reused to build microtubules in other part of the cell.**
- **Function as compression-resisting girders of the cytoskeleton.**



- **Shape and support the cell.**
- **Serve as tracks along which organelles equipped with motor proteins can move.**
- **Help in cell motility (as in cilia and flagella).**
- **Separate chromosomes during cell division.**



Microfilaments

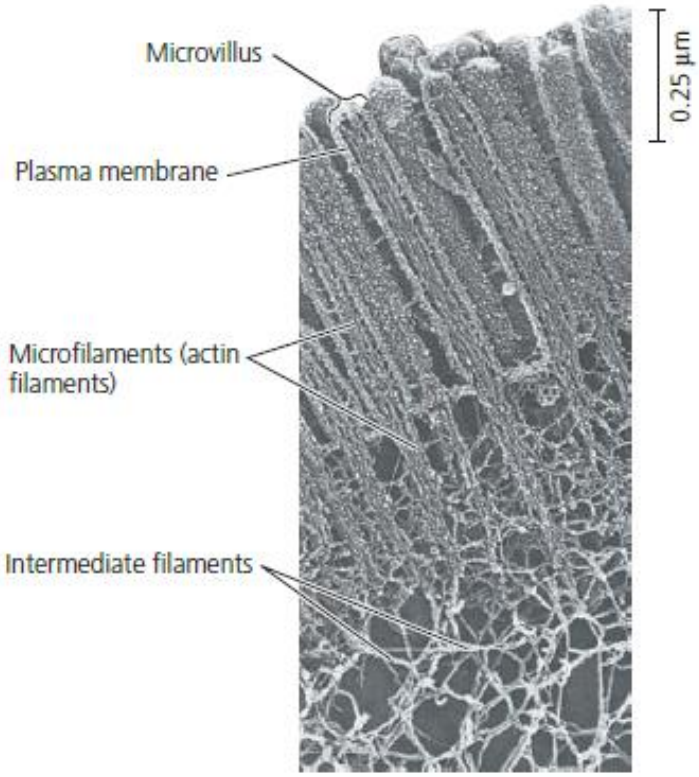
- **Also called *Actin filaments*.**
- **Present in all eukaryotic cells.**

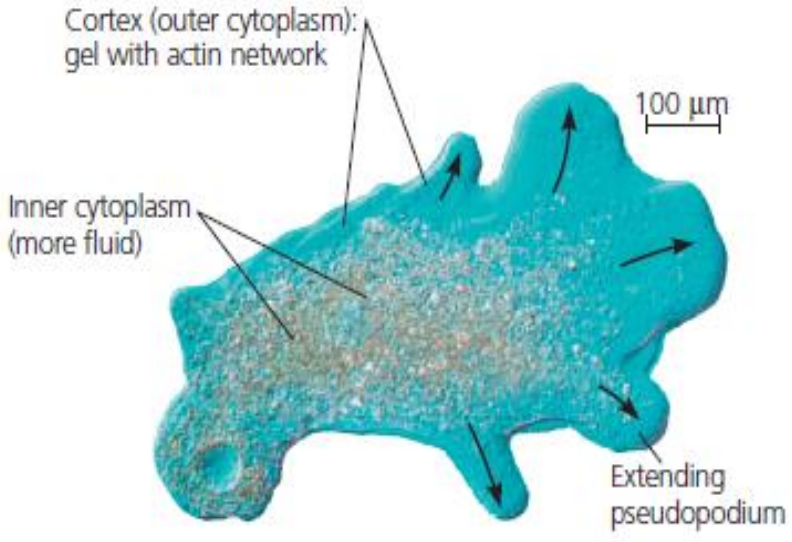
- **Solid rods about 7 nm in diameter.**
- **Built from globular protein molecules called actin which is twisted double chain of actin subunits.**
- **Can form structural networks like branches.**
- **Function as bear tension (pulling forces).**

Cortical microfilaments

- **A three-dimensional network formed by microfilaments just inside the plasma membrane.**
- **In animal cells specialised for transporting materials across the plasma membrane, such as intestinal cells, bundles of microfilaments make up the core of microvilli.**
- **Helps support the cell's shape and has a role in cell motility.**
- **Gives the outer cytoplasmic layer of a cell, called the cortex, the semisolid consistency of a gel, in contrast with the more fluid (sol) state of the interior cytoplasm.**
- **In *Amoeba* and some white blood cells:**

  Myosin and actin involve in amoeboid (crawling) movement of the cell by cellular extension called the pseudopodia (from the Greek *pseudes*, false, and *pod*, foot).

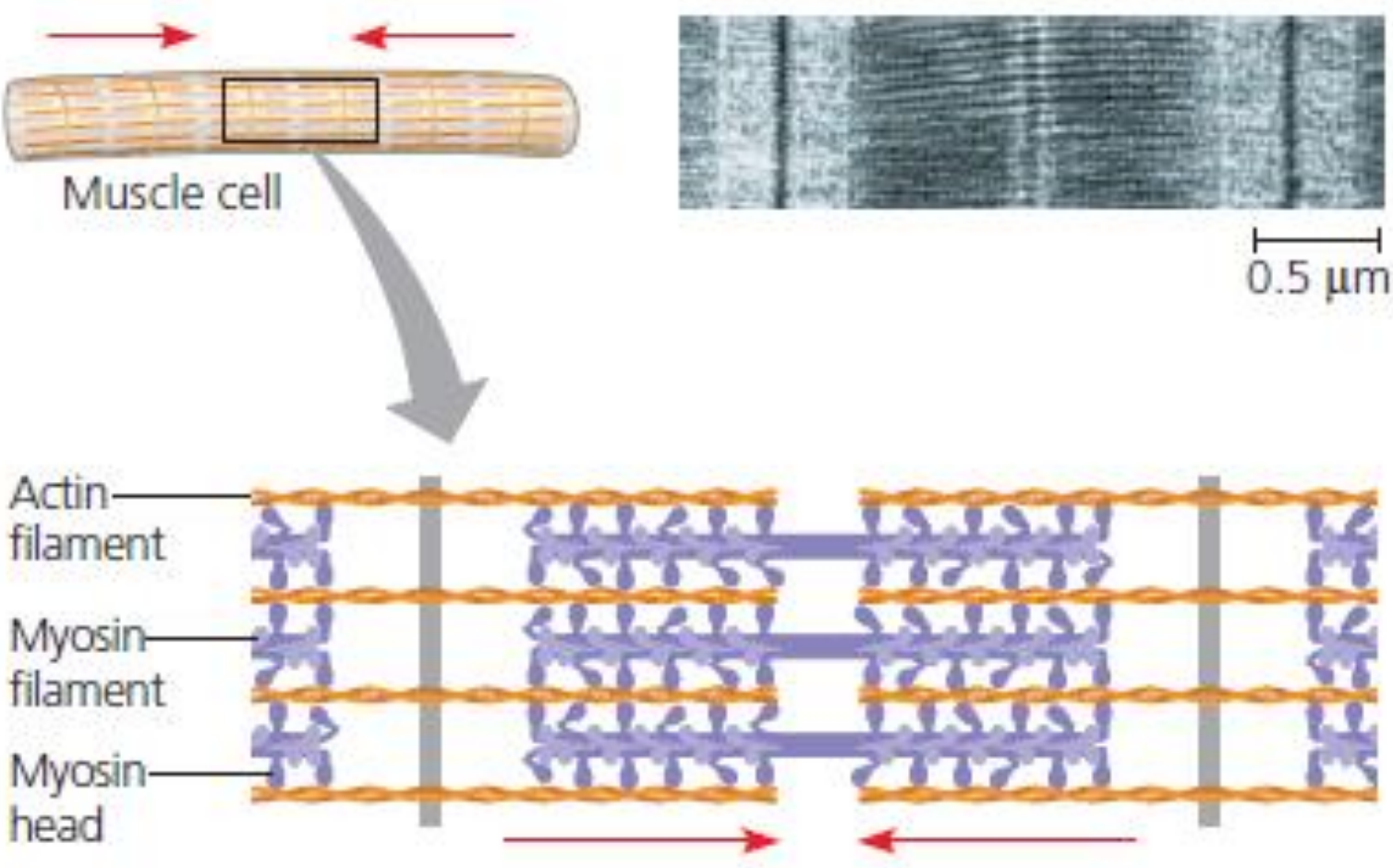




Role of microfilaments in cell motility

Role of microfilaments in contractile apparatus of muscle cells:

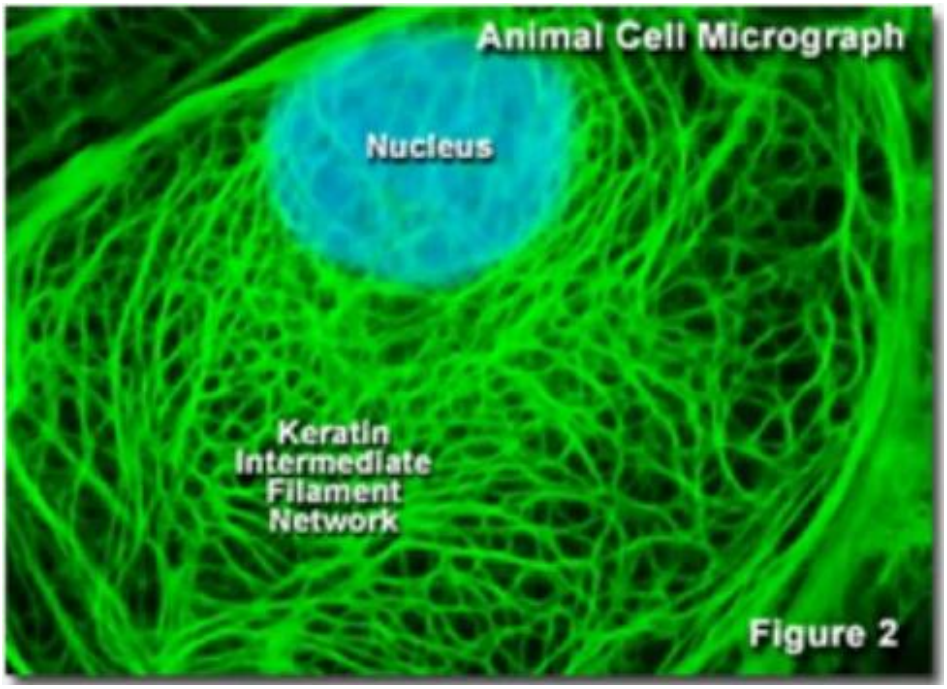
- **Thousands of actin filaments are arranged parallel to one another along the length of a muscle cell, interdigitated with thicker filaments made of a protein called myosin.**
- **Contraction of the muscle cell results from the actin and myosin filaments sliding past one another in this way, shortening the cell.**



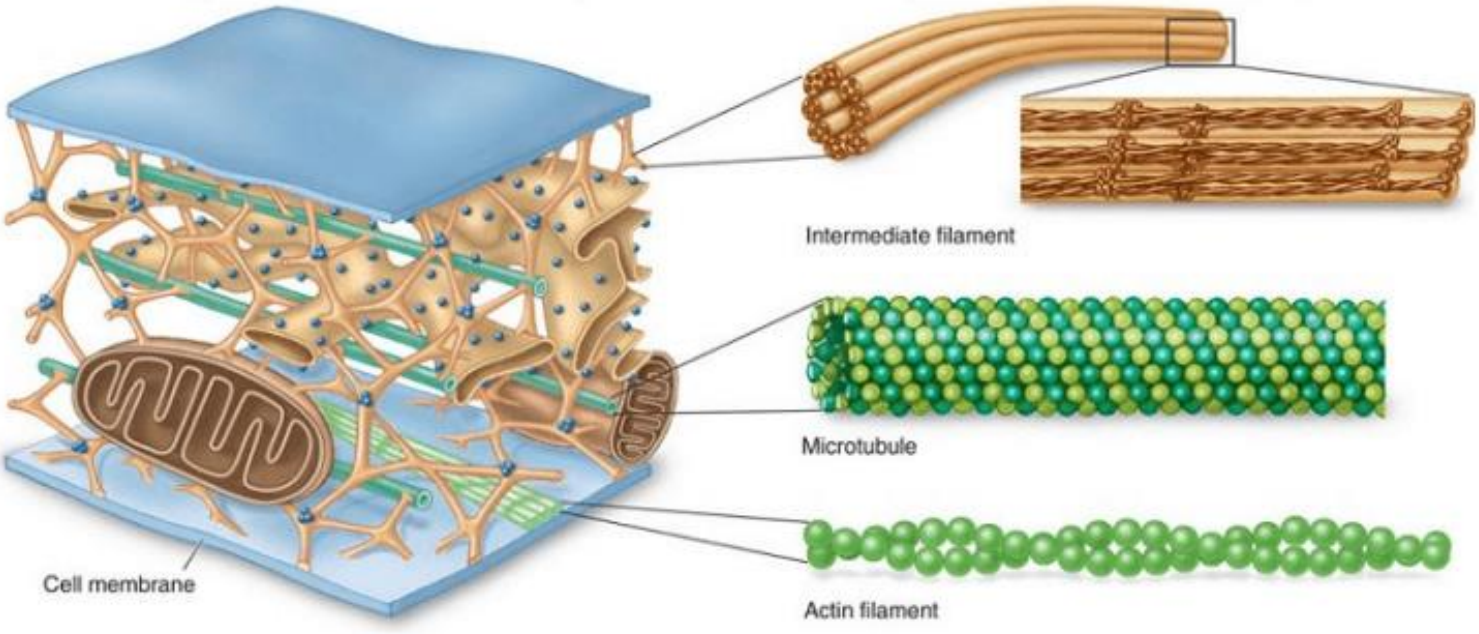
Myosin motors in muscle cell contraction

Intermediate filaments

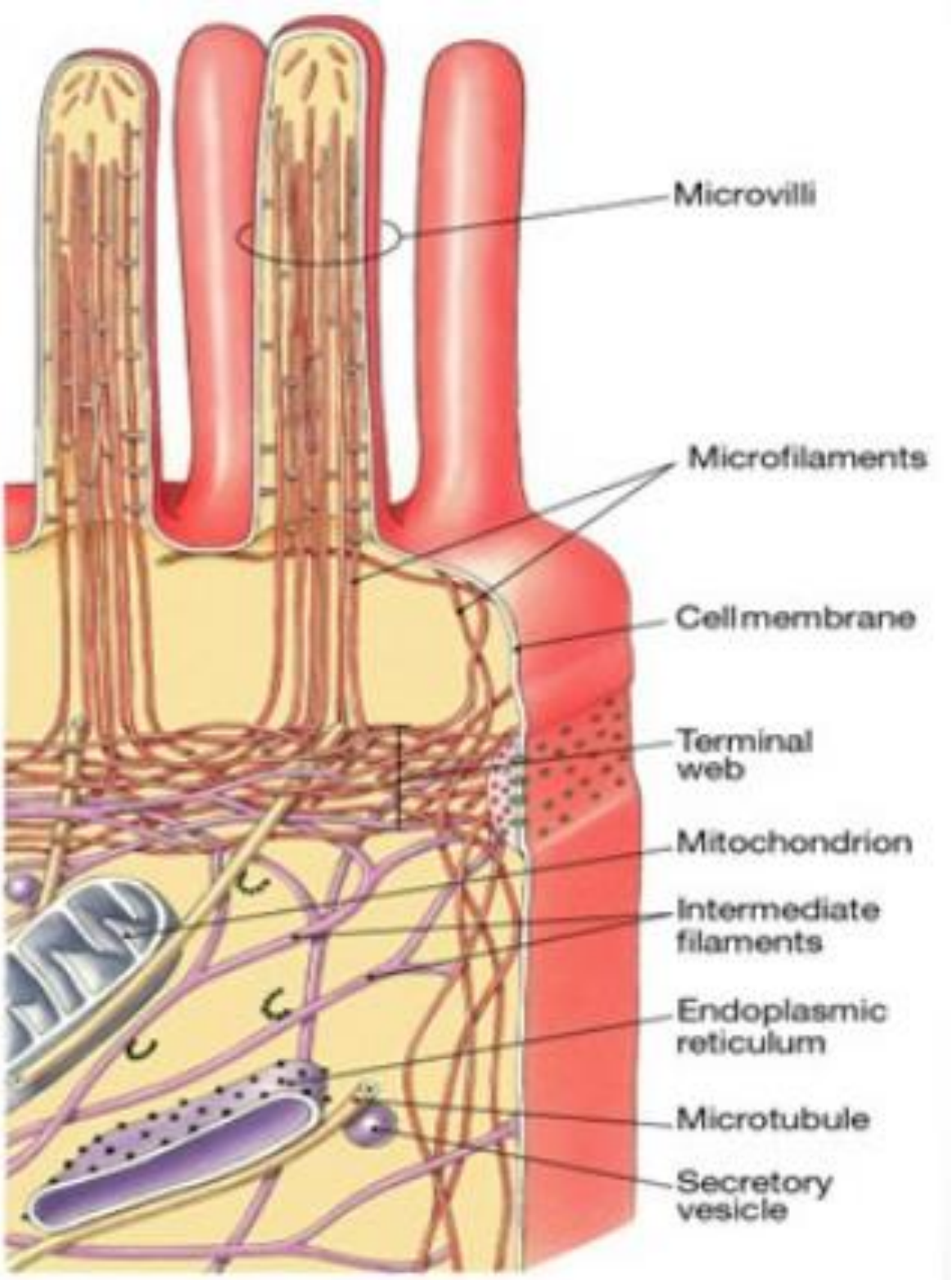
- **Named for their intermediate diameter size, about 8-12 nm.**
- **Diverse class of cytoskeletal elements but all belong to a family of protein called keratins.**
- **Specialised for bearing tension.**
- **More permanent fixtures of cells.**



- **Able to persist even after cells die (example: outer layer of our skin consists of dead skin cells full of keratin proteins).**
- **Helps to shape of a cell and fixing the position of certain organelles, such as fixed location of nucleus by branches of the filaments that extend into the cytoplasm.**



Types of cytoskeletal fibers


Microvilli
Microfilaments
Cell membrane
Terminal web
Mitochondrion
Intermediate filaments
Endoplasmic reticulum
Microtubule
Secretory vesicle

Definitions:

Tight junction: a type of intercellular junction that binds plasma membrane of neighbouring animal cells together by a row of specific proteins forming continuous seals that prevent the leakage of material through the space between cells.

Desmosomes: a type of intercellular junction in animal cells that functions as a rivet, fastening cells together into strong sheets. Intercellular filaments made of sturdy keratin proteins anchor desmosomes in the cytoplasm.

Gap junctions: a type of intercellular junction in animal cells that provides cytoplasmic channels from one cell to an adjacent cell that allows sugars, amino acids, and other small molecules to pass between cells.

Cytoskeleton: a network of cytoplasmic filaments that are responsible for the movement of the cell and give the cell its shape.

Microtubule: a hollow rod composed of tubulin proteins that make up part of the cytoskeleton in all eukaryotic cells and is present in the cytoplasm, centriole, cilia and flagella. Function as compression-resisting girders of the cytoskeleton.

Microfilament: a solid helical rod composed of actin proteins of almost every eukaryotic cell, making up part of the cytoskeleton. The function is to bear tension (pulling forces). It plays a role in cell movement and with myosin protein which is a part of the contractile mechanism of skeletal muscle.

Intermediate filament: a ropelike filament composed of keratin protein and it is part of cytoskeleton. Specialised for bearing tension.