D II / Hons / Zoology Paper III Gr-A

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CYTOSKELETON

Cytoskeleton includes two words: The Cyto meaning cell and the skeleton – means the support system. The cytoskeleton is a complex, dynamic network of interlinking protein filaments present in the cytoplasm of cell of the cells including bacteria and archaea. It extends from the cell nucleus to the cell membrane and is composed of 1) Microfilaments

2) Intermediate filaments

3) Microtubules

① **Microfilaments** These are solid filaments of 7 nm diameter and upto several micrometers long.
They are formed of Protein Actin. Each actin monomer is a globular protein (G-unit) formed of 375 amino acids. The filament formed by Polymerisation of G actin subunits is called filamentous actin (F actin).

① **Actin Network** :– In a network actin filaments are cross-linked through actin binding proteins to form a 3 D (Three dimensional) meshwork. It serves as
(a) Provides mechanical support.
(b) Determines cell shape
(c) Allows movement of the cell and change in cell shape.
(d) Enables the cell to migrate, engulf particles and cell to divide.

② **Actin Bundles** :– In actin bundles the protein filaments are cross linked by actin binding proteins into closely

Packed parrelel arrays. The actin bundles are of two types

(a) Bundles with closely spaced actin filaments as in microvilli or other cell surface projections

(b) Bundles with widely spaced actin filaments are called contractile bundles. The actin fibres are cross linked with α-actinin. These bundles are more contractile

Functions of Actin Filaments:

(1) It forms cytoskeleton of cell. They determine cell shape and provide mechanical support.

(2) Actin bundles attach to plasma membrane by spectrin fibres & provide cell-cell adhesion.

(3) Actin filaments support permanent protrusions of the cell surface such as microvilli & stereocilia which help in absorption and hearing respectively.

(4) Actin filaments support transient protrusion like pseudopodia, filipodia or lamellipodia.

(5) Actin-Myosin filaments help in muscle contraction. Myosin act as a motor protein that uses energy from ATP and generates force and movement.

(6) Contractile assemblies of actin & myosin in non-muscle cells produce a variety of movements and are responsible for cytokinesis during cell division.

(2) INTERMEDIATE FILAMENTS (IFs)

These are tough solid, smooth surfaced unbranched filaments having a diameter of approx. 10nm. There are composed of more than 65 types of proteins. They are intermediate in diameter microtubules and microfilaments.

Assembly of Intermediate Filaments:- The protein forming intermediate filaments contain a rod shaped central domain formed of approx. 310 amino acids, The N terminal head and C-terminal tail. The central domains of 2 polypeptides wound each other in a coiled structure to form the dimers.

These two dimers then associate in antiparallel fashion to form a tetramers. The tetramers are united end to end to form Protofilaments. Approx. 8 Protofilaments are wound each other to form a rope like intermediate filament.

The intermediate filaments ramify through the cytoplasm and are connected with the microfilaments and microtubules. They are found in animal cells but absent in plant cell. They form a ring surrounding the nucleus to the P. Mem.

Functions:- IFS provides mechanical stability to cells and also perform specialized tissue specific functions as follows:

1. The Keratin filaments that attach to the nuclear envelope anchor the nucleus within the cell.
2. IFs provides a scaffold that integrates the component of cytoskeleton and organises the internal structure of cell.
3. Keratin filaments are epithelial cells are attached to desmosomes and hemidesmosomes and serves as mechanical link between adjacent cells.
4. Neurofilaments present in neurons and their axons provide mechanical support.
5. Desmins in muscle cells connect individual actin-myosin assemblies to one another and to Plasma Membrane.

3 Microtubules

These are hollow, rigid, cylindrical structure which occur in all eukaryotic cells except mammalian RBC. They are components of variety of cell structure. They are found in core of cilia and flagella and in the mitotic spindle of dividing cells and in the centrioles and basal bodies.

Structure:- They have a diameter of about 25 nm (i.e. 250 A°) and a wall of approx. 5 nm thickness. They are formed of Protein tubulin. The wall of microtubules is formed of

13 rows of globular subunits. Each subunit consists of a single molecule of Protein tubulin which is a dimer being formed of 2 globular polypeptide α-tubulin and β tubulin. The subunits in the wall of microtubule are arranged in longitudinal rows called Protofilaments. The Protofilament are arranged helically around a central axis & are aligned parralled to the long axis.

Microtubules are Polar structures. Their one is called positive end or plus end and other as negative or minus end. New subunits are added to the microtubules at the +ve end. Some microtubules associated proteins (MAPS) are required during polymerisation of microtubules.

Assembly of Microtubules :- Microtubules extend outward from the centrosome which functions as a microtubule organizing Centre to which negative end of each microtubule are anchored.

Functions of Microtubules

① It acts as a internal skeleton that provides structural support and help to maintain the position of cytoplasmic organelles.

② They form part of machinery that moves materials and organelles from one part of a cell to another.

③ They form motile elements of cilia and flagella. Both of them are microtubule based extensions of plasma membrane.

④ They form components of machinery responsible for chromosome movement during mitosis and meiosis.

FUNCTIONS of CYTOSKELETON.

① Structural Support – Cytoskeleton acts as scaffold, providing structural support that helps maintain the cell shape.

② Internal frame work – It forms an internal frame work which is responsible for maining position of various organelles within the cell.

(3) Movement of Substance :- The microfilaments & microfibrils form a machinery which helps in transport of vesicles from ER (endoplasmic reticulum) to Golgi, to lysosome, formation of Pinocytic or phagocytic vesicles, movement of chromosome during cell division and movement of neurotransmitter containing vesicles along the length of nerve cells.

(4) Cell Movement :- Movement of unicellular organisms or cellular locomotion by certain WBC are dependent on cytoskeleton.
Microtubules form mitotic spindle, centrioles & core or axoneme of cilia & flagella. So, microtubules are associated with chromosome movement during cell division. Microtubules composing axonemes of cilia & flagella helps in locomotion.
Microfilaments play a key role in all types of contractility and motility in cell.

(5) Change in Cell Shape :- During embryonic development contraction of a band of microfilament change the cell shape of embryo.

(6) Protein Synthesis :- The translation machinery of the cell remains attached with the cytoskeleton. It provides a site for attachment of mRNA & ribosomes.

(7) Signal Transduction :- cytoskeleton makes contact with inner surface of Plasma membrane and plays a key role in transmitting signals from extracellular environment into the cell interior.

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