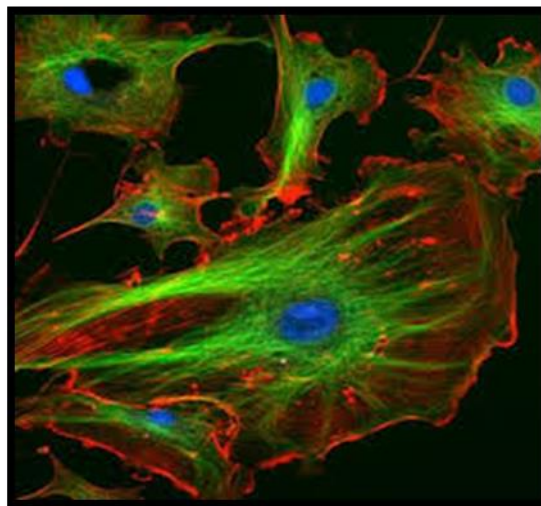
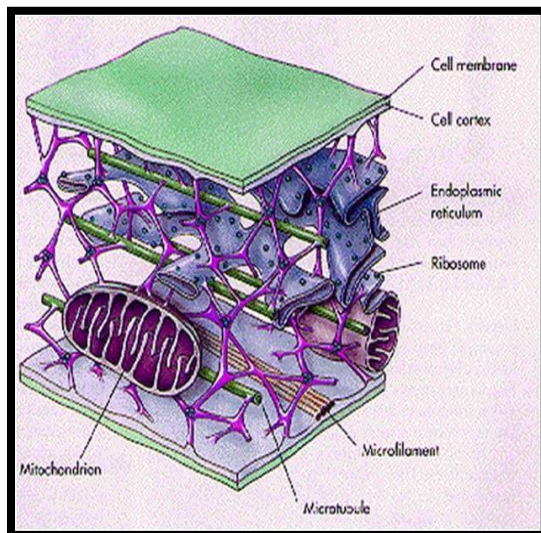




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| SUBJECT | ZOOLOGY |
| PaperNo. And Title | V Cell Biology |
| Module No. and Title | Cytoskeleton |
| Module tag | DAYA-ZOO-CS |

Cytoskeleton-Structure and Function



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Learning Outcomes

The course provides a detailed insight into basic concepts of cytoskeleton structure and function.

Understand the structure and function of cytoskeleton –microtubules,microfilaments and intermediate filaments.

Develop an understanding how cells move and spindlefibres help in chromosome movement during cell division.How cell shape is maintained. Movement of cell is understood.

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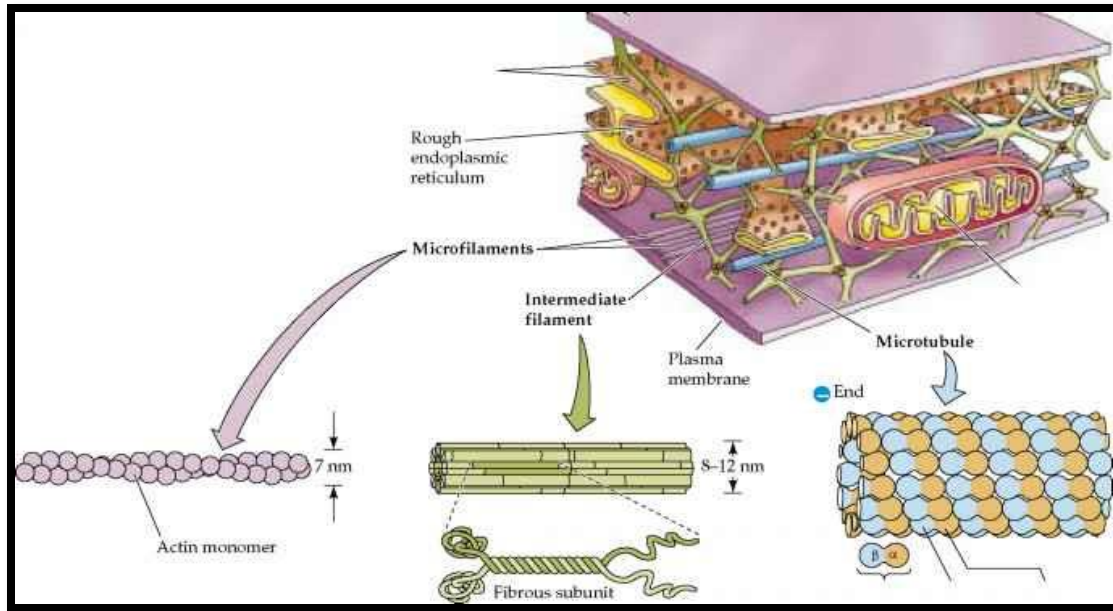
| S.No. | Cytoskeleton |
|-------|---|
| 1 | Introduction |
| 2 | Structure of Microtubules |
| 3 | Functions of Microtubules |
| 4 | Microfilaments -structure and Function |
| 5 | Intermediate filaments-Structure and Function |

Cytoskeleton

Introduction:

- In 1903, Nikolai Koltsov proposed that the shape of cells is determined by a network of tubules that he termed the ‘cytoskeleton’.
- The cytoskeleton is a complex, dynamic network of interlinking protein filaments present in the cytoplasm of all cells including bacteria and archaea.
- It extends from the cell nucleus to the cell membrane and is composed of similar proteins in various organisms.

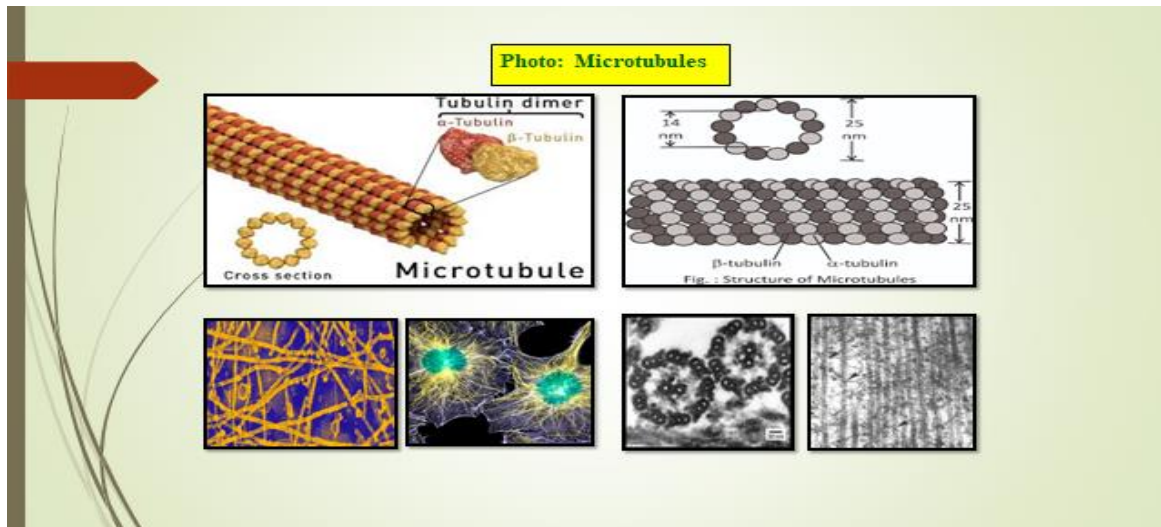
- In eukaryotes, it is composed of three main components, microfilaments, intermediate filaments and microtubules.
 - All are capable of rapid growth or disassembly dependent on the cell's requirements.
- Cytoskeleton's primary function is to give the cell its shape and mechanical resistance to deformation.
 - The cytoskeleton can also contract, thereby deforming the cell and the cell's environment, which allows the cells to migrate.
 - Cytoskeleton is involved in many cell signalling pathways and in the uptake of extracellular material. During cell division it helps in the segregation of chromosomes.
 - Helps in intracellular transport of vesicles and organelles within the cell. It can be a template for the construction of a cell wall. It can form specialized structures, such as cilia, flagella, lamelliopodia and podosomes
 - The structure, function and dynamic behaviour of the cytoskeleton can be very different, depending on organism and cell types.
 - The cytoskeleton consists of three components:
 - Microtubules.
 - Microfilaments (Actin filament).
 - Intermediate filament



Microtubules-Structure

- Microtubules are long, hollow cylindrical and filamentous or fibrillar structures found in the cytoplasm of all eukaryotic cells. Absent in prokaryotes.
- Microtubules are found in the thrombocytes (blood platelets) of human and rat.
- They are about 25 nm in diameter and 200 nm to 25 micrometre in length.
- Microtubules are composed of many subunits called protofilaments. The number of protofilaments in microtubules is variable.
- The protofilaments are composed of a series of globular protein (tubulin) units.
- The tubulin is a dimer, made up of two similar polypeptides.
- The two tubulin dimers are α - tubulin and β - tubulin.
- These two units are arranged alternately in the protofilament.

- The tubulin shows helical structure with 13 tubulin molecules per turn of the helix. They grow in length by adding tubulin dimer or they can be disassembled.



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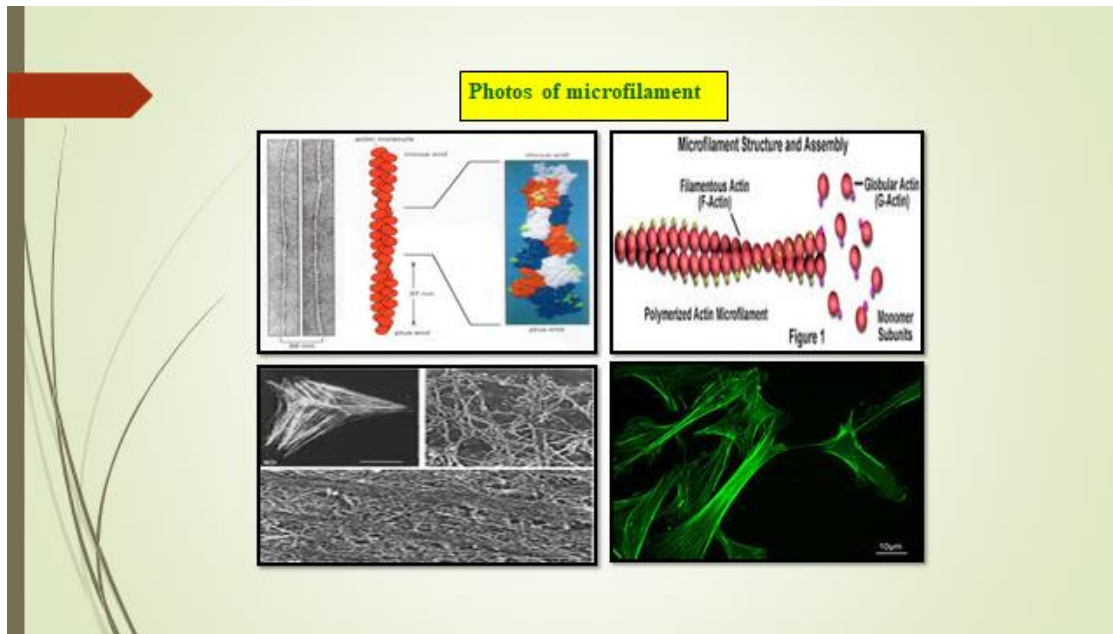
Microtubules-Function

- Microtubule are rigid structures which work as a supporting framework and give shape to the cell.
- They maintain shape of long processes such as cilia, flagella, axons of nerve cells, axopodia of protozoa.
- The motion of the cilia and flagella is created by the microtubules. The centrioles are morphologically identical to the basal body of cilia or flagella
- Microtubules changes the cell shape during cell differentiation. Help in the elongation of the cells in the lens of eye.

- The microtubules of many sensory cells act as transducers which convert stimuli into the nerve impulses.
- Microtubules help in the transport of cellular materials. During cell division, the spindle fibre appear, they are the bundles of microtubules. Help in the formation of cell wall in plants. They also help in separation of chromosome.

Microfilaments: structure

- Microfilaments also known as actin filaments are solid rods of protein.
- The diameter of filament is about 7 nm and they are smallest of the cytoskeletal filaments.
- They occur in almost all eukaryotic cells.
- They are called as actin filaments because they are mostly composed of the protein actin.
- Actin is the protein building blocks of microfilament. Actin is found abundantly in all eukaryotic cells.
- Their structure is two strands of actin wound in a spiral.
- It is synthesized as a single polypeptide consisting of 375 amino acids.
- Individual actin molecules are referred as G- actin. The G- actin molecule polymerize to form microfilament which is called as F- actin (Filamentous actin).

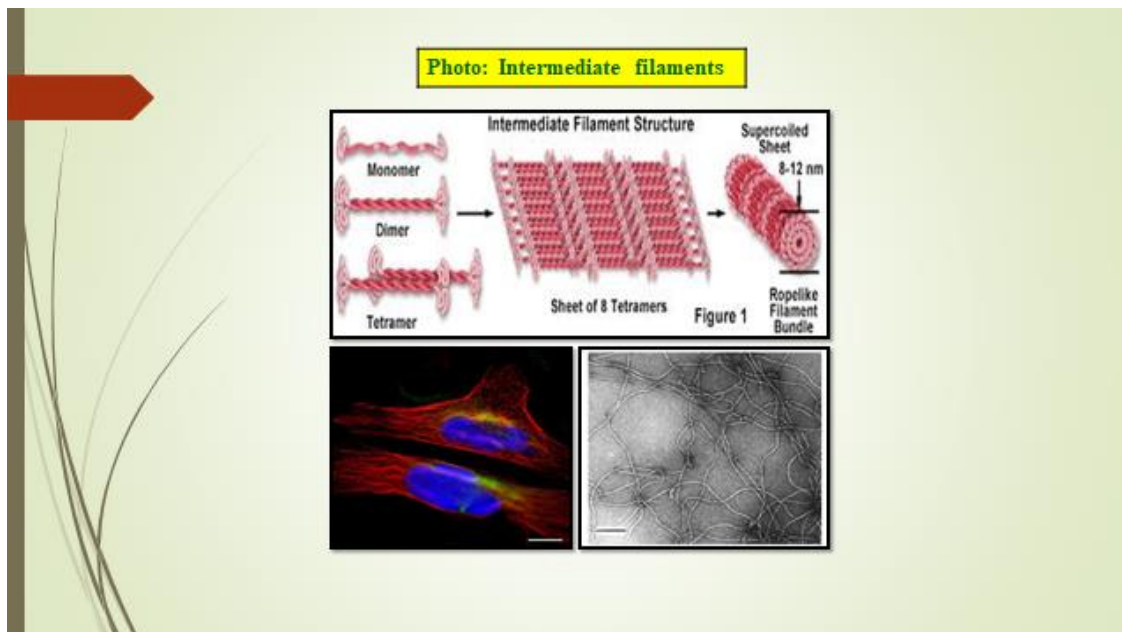


Microfilaments-Function

- Microfilaments are the part of muscle cells and allow these cells to contract, along with myosin. Actin and myosin are the two main components help in the contraction of muscles.
- They play role in cell migration via lamellipodia and filopodia, amoeboid movement, cytoplasmic streaming (flow of cytoplasm).
- The parallel bundles of microfilament form the microvilli.
- They produce cleavage furrows that divide the cytoplasm of cell during cytokinesis. Help to maintain the cell shape.

Intermediate Filaments-Structure

- Intermediate filaments are a part of the cytoskeleton of many eukaryotic cells.
- They are more stable (strongly bound) than microfilaments and are heterogeneous constituents of the cytoskeleton
- Intermediate filaments are about 8-12 nm wide. They are called intermediate because they are in-between the size of microfilaments and microtubules.
- Intermediate filaments are made of different proteins such as keratin (found in hair and nails, and also in animals with scales, horns, or hooves), vimentin (mesenchymal cell), desmin (muscle cell), and lamin (nuclear envelope).
- All intermediate filaments are found in the cytoplasm except for lamins, which are found in the nucleus and help support the nuclear envelope that surrounds the nucleus.



Intermediate Filaments-Function

- The intermediate filaments in the cytoplasm maintain the cell's shape, bear tension, and provide structural support to the cell.
- Fix the organization of certain cell organelles.
- Intermediate filaments organize the internal tridimensional structure of the cell, anchoring organelles and serving as structural components of the nuclear lamina.
- Keratin intermediate filaments in epithelial cells provide protection for different mechanical stresses that skin may endure.
- They also provide protection for organs against metabolic, oxidative, and chemical stresses.
- Strengthening of epithelial cells with these intermediate filaments may prevent onset of apoptosis, or cell death, by reducing the probability of stress.
- In combination with proteins and desmosomes, the intermediate filaments form cell-cell connections and anchor the cell-matrix junctions that are used in messaging between cells as well as vital functions of the cell.

Summary

- The cytoskeleton is the structure consisting of fibrous proteins that occur in the cytoplasm and maintain the shape of the cell.
- It composed of three different types of components, namely microtubule, microfilament and intermediate filaments,

- The microtubules are made up of α - tubulin and β - tubulin arranged alternately to form a protofilament.
- The microfilament also called as actin filament is solid rod of protein formed by two strands of actin filament and it shows spiral arrangement.
- The intermediate filaments are made up of different types of proteins like keratin, desmin, lamin and vimentin.
- All these cytoskeletal elements perform many functions like maintain the cell structure, acts as supporting framework, help in cell movement, intracellular transport of material , locomotion and fix the organization of cell organelles.

Links:

https://docs.google.com/presentation/d/1473WiJB9-IZICCr_MFgAcUbnnXBvLwFk/edit#slide=id.p1

https://docs.google.com/document/d/1QnXllcm1m4PFcSEWeDN7qyA_F3lpJy3FeVjCvIKUirg/edit?usp=sharing

<https://drive.google.com/file/d/1DiEw1LvdEWwf0NVGCMkunIUPhbx3j7mR/view>

Vedio

<https://youtu.be/VC1zbUEEw9k>

<https://drive.google.com/drive/folders/1Rbsb059X6OU171vR6BuSS06O-hR0SUWR>

<https://drive.google.com/file/d/1qmx7w9zWMrHEVM3WblvPV9mx8eEU04t/view?usp=sharing>

<https://docs.google.com/forms/d/1IFDtxTGUIYVfl7eu8-SiUxJz72hMrSgcA0U0FqJNLrc/edit>

<https://drive.google.com/file/d/14Gwzy4g8jkQyRyfdpiCKsp6l8w5YwIOP/view?usp=sharing>

Explore more

1. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments (6th edition) John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006) Cell and Molecular Biology (8th edition) Lippincott Williams and Wilkins, Philadelphia.

3. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. (5th edition) ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA

4. Becker, W.M.; Kleinsmith, L.J.; Hardin. J. and Bertoni, G. P. (2009) The World of the Cell. (7th edition) Pearson Benjamin Cummings Publishing, San Francisco.

ASSESSMENT

| Module / Topic: CellBiology | | | |
|---|---|---|---|
| Year: SYBSc-Sem-III | | | |
| ILO | Teaching Activity | Assessment Type | Assessment Mode & Tool |
| | | | |
| 1.Students will be able to draw neat labelled diagrams of different types of cytoskeleton | Strategies Used & Explanation drawing the diagram. Showing models and discussing. Ask students to prepare animation PPT's | Assessment type: Draw a chart of the different parts of Cell Give a diagrammatic sketch with arrows and ask them to label the different parts. Sketch & label types of cytofilaments | Google class room code:un5po2c |
| | | | |
| 2. Students will be able to differentiate between types of cytoskeleton | Strategies Used Quiz, MCQ https://docs.google.com/document/d/1o_8fa3y7FH2f10XdWp0T1esK4-zRnInj26_PPbuQ5Dk/edit | Assessment type: Grading till they are able to get minimum score of 60% | https://docs.google.com/forms/d/1IFDtxTGUIYVfl7eu8-SiUxJz72hMrSgcA0U0FqjNLrc/edit |
| | | | |
| 3.To explain the mechanism & functions of each part of the cytoskeleton. | Strategies Used Explanation- Concept map | Give a concept map with blanks in different columns to be filled by the students, Quiz, https://forms.gle/dJ2EJBG5adFUYSpd7 | MCQ's Class test https://forms.gle/dJ2EJBG5adFUYSpd7 MOODLE LMS has these |

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| | | <p>MCQ, Shortanswer https://docs.google.com/forms/d/1IFDtxTGUIYVfI7eu8-SiUxJz72hMrSgcA0U0FqJNLrc/edit</p> | <p>activities which can be designed https://docs.google.com/forms/d/1IFDtxTGUIYVfI7eu8-SiUxJz72hMrSgcA0U0FqJNLrc/edit</p> |
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