## LEC 8 Q – CYTOLOGY:

1. **What are microtubules primarily composed of?**

   A) Actin filaments
   B) Intermediate filaments
   C) Tubulin dimers
   D) Collagen fibers

2. **Which end of a microtubule grows faster?**

   A) Minus end
   B) Plus end
   C) Both ends
   D) Neither end

3. **What role does γ-tubulin play in microtubule dynamics?**

   A) Stabilizes existing microtubules
   B) Initiates microtubule assembly
   C) Binds to ATP
   D) Promotes disassembly

4. **Which of the following drugs stabilizes microtubules and is used in cancer treatment?**

   A) Colchicine
   B) Vinblastine
   C) Taxol
   D) Colcemid

5. **What is the primary function of MAPs (Microtubule-Associated Proteins)?**

   A) Polymerization of actin
   B) Regulate microtubule dynamics
   C) Transport organelles
   D) Synthesize tubulin

6. **In neurons, what is the orientation of microtubules in axons?**

   A) Plus end towards the cell body
   B) Minus end towards the synapse
   C) Plus end towards the axon tip
   D) Both ends oriented randomly

7. **Which motor protein moves towards the plus end of microtubules?**

   A) Dynein
   B) Myosin

C) Kinesin
D) Tubulin

8. **What is a consequence of tau protein misfolding in neurons?**

   A) Enhanced neurotransmitter release
   B) Formation of amyloid plaques
   C) Aggregation leading to cell death
   D) Increased microtubule stability

9. **What phenomenon describes the continuous addition and loss of tubulin at opposite ends?**

   A) Catastrophe
   B) Treadmilling
   C) Polymerization
   D) Hydrolysis

10. **What triggers the fusion of vesicles with the plasma membrane in nerve cells?**

    A) GTP binding
    B) $Ca^{2+}$ influx
    C) ATP hydrolysis
    D) MAP activation

## Answers

1. C
2. B
3. B
4. C
5. B
6. C
7. C
8. C
9. B
10. B

1. **Which component of microtubules directly affects their stability and dynamics during polymerization?**

   A) α-tubulin
   B) β-tubulin
   C) γ-tubulin
   D) MAPs

2. **During dynamic instability, what primarily causes a microtubule to switch from a growth phase to a shrinkage phase?**

A) Excessive GTP binding
B) GTP hydrolysis on β-tubulin
C) Stabilization by MAPs
D) Calcium ion influx

3. **What is the significance of the GTP cap in microtubule dynamics?**

   A) It prevents disassembly
   B) It initiates polymerization
   C) It promotes catastrophe
   D) It stabilizes intermediate filaments

4. **How do motor proteins like kinesin and dynein differ in their functional roles in neurons?**

   A) Kinesin transports cargo towards the minus end, while dynein moves towards the plus end
   B) Dynein is involved in organelle transport, while kinesin is primarily for vesicle transport
   C) Kinesin moves towards the plus end, facilitating transport away from the cell body, while dynein moves towards the minus end, transporting towards the cell body
   D) Both kinesin and dynein transport in the same direction but differ in cargo type

5. **What potential cellular consequence arises from the aggregation of tau protein in neurons?**

   A) Increased neurogenesis
   B) Enhanced synaptic plasticity
   C) Disruption of axonal transport leading to neurodegeneration
   D) Stabilization of microtubule networks

6. **In the context of microtubule-associated proteins (MAPs), what is the function of CLASP proteins?**

   A) Facilitate GTP hydrolysis
   B) Promote rapid shrinkage of microtubules
   C) Rescue microtubules from catastrophe
   D) Initiate microtubule disassembly

7. **What mechanism allows vesicles to transition from microtubule transport to fusion with the plasma membrane?**

   A) Direct binding to kinesin
   B) Interaction with intermediate filaments
   C) $Ca^{2+}$ binding to actin-binding proteins
   D) Hydrolysis of ATP by kinesin

8. **What structural arrangement do microtubules have that contributes to their function in the cytoskeleton?**

   A) Spiraled formation with solid core
   B) Randomly oriented filaments
   C) Hollow tubes composed of protofilaments arranged in head-to-tail fashion
   D) Interwoven networks with elastic properties

9. **Which of the following statements about treadmilling is true?**

   A) Treadmilling occurs when tubulin addition exceeds loss at both ends.
   B) It describes the addition of tubulin at the minus end and loss at the plus end.
   C) Treadmilling helps maintain a constant microtubule length while allowing for dynamic changes.
   D) It is a phenomenon only observed in actin filaments, not microtubules.

10. **What is the primary role of centrosomes during cell division?**

    A) To synthesize new tubulin dimers
    B) To anchor microtubules and organize the mitotic spindle
    C) To promote actin polymerization
    D) To regulate calcium levels in the cytoplasm

## Answers

1. B
2. B
3. A
4. C
5. C
6. C
7. C
8. C
9. C
10. B

1. **Which molecular event is primarily responsible for the transition from microtubule growth to shrinkage during dynamic instability?**

   A) Binding of ATP to tubulin
   B) GTP hydrolysis on β-tubulin
   C) Phosphorylation of MAPs
   D) Calcium ion binding

2. **What effect does colchicine have on microtubules, and how is it utilized clinically?**

   A) It stabilizes microtubules; used in cancer therapy
   B) It promotes polymerization; used to enhance cellular motility

C) It inhibits polymerization; used in treating gout and inflammation
D) It promotes disassembly; used in muscle relaxants

3. **Which aspect of microtubule structure is critical for their function in cellular transport and mitosis?**

   A) The random arrangement of tubulin dimers
   B) The rigid structure of microtubules
   C) The polar arrangement with distinct plus and minus ends
   D) The presence of actin filaments alongside them

4. **In the context of axonal transport, what is the consequence of kinesin mutations?**

   A) Enhanced transport of neurotransmitters
   B) Impaired transport of organelles leading to neurodegeneration
   C) Increased stability of microtubules
   D) Reduction in synaptic plasticity

5. **How does the interaction of MAPs with microtubules influence cellular functions?**

   A) They solely promote microtubule disassembly.
   B) They facilitate the stabilization and organization of microtubules.
   C) They inhibit vesicle transport along microtubules.
   D) They directly mediate the fusion of vesicles with membranes.

6. **What is the significance of the GTP-bound β-tubulin in microtubule stability?**

   A) It is crucial for initiating microtubule disassembly.
   B) It enhances the binding affinity of tubulin dimers to microtubules.
   C) It serves as a marker for microtubule catastrophe.
   D) It allows for the interaction with motor proteins.

7. **Which feature of tau protein contributes to its pathological role in Alzheimer's disease?**

   A) Its ability to stabilize microtubules
   B) Its tendency to aggregate, disrupting axonal transport
   C) Its role in promoting microtubule polymerization
   D) Its function as a motor protein

8. **What is the primary function of the centrosome during the cell cycle?**

   A) To synthesize ATP for energy
   B) To serve as the microtubule-organizing center for spindle formation
   C) To regulate the pH of the cytoplasm
   D) To initiate the process of cell division

9. **What molecular mechanism drives the movement of motor proteins along microtubules?**

   A) Passive diffusion
   B) ATP hydrolysis and conformational changes
   C) Calcium-mediated activation
   D) Direct binding to vesicles

10. **In the process of treadmilling, what occurs when GTP hydrolysis exceeds the addition of new tubulin?**

    A) Increased microtubule stability
    B) Continuous growth of microtubules
    C) Rapid disassembly and shortening of microtubules
    D) Enhanced interaction with MAPs

## Answers

1. B
2. C
3. C
4. B
5. B
6. B
7. B
8. B
9. B
10. C

1. **What is the role of the GTP cap in maintaining microtubule stability?**

   A) It prevents the binding of MAPs.
   B) It facilitates the polymerization of actin filaments.
   C) It protects the microtubule from rapid depolymerization and promotes growth.
   D) It enhances the hydrolysis of GTP into GDP.

2. **In dynamic instability, what condition primarily leads to the phenomenon of "catastrophe"?**

   A) High levels of GTP-bound tubulin
   B) GTP hydrolysis outpacing the addition of new tubulin dimers
   C) Increased activity of microtubule stabilizing proteins
   D) The presence of excess MAPs

3. **Which feature of microtubules allows them to facilitate intracellular transport efficiently?**

   A) Their random, disorganized structure
   B) The presence of a uniform diameter

C) Their ability to undergo rapid polymerization and depolymerization
D) Their attachment to the nuclear envelope

4. **How do microtubules and actin filaments coordinate to facilitate vesicle transport?**

   A) Microtubules provide structural rigidity, while actin mediates vesicle fusion.
   B) Microtubules transport vesicles to the actin cortex, where myosin facilitates movement toward the membrane.
   C) Actin filaments carry vesicles directly to the plasma membrane without microtubules.
   D) Microtubules act independently of actin in vesicle transport.

5. **What is the consequence of tau protein phosphorylation in the context of Alzheimer's disease?**

   A) It enhances microtubule stability.
   B) It promotes the aggregation of tau, leading to neurofibrillary tangles.
   C) It facilitates axonal transport.
   D) It reduces synaptic signaling.

6. **Which of the following statements about motor proteins is true?**

   A) Both kinesin and dynein move towards the plus end of microtubules.
   B) Kinesin transports vesicles towards the minus end, while dynein transports towards the plus end.
   C) Dynein primarily functions in retrograde transport, while kinesin primarily facilitates anterograde transport.
   D) Motor proteins do not require ATP to function.

7. **During cell division, what is the primary function of microtubules in the mitotic spindle?**

   A) To provide structural integrity to the nucleus
   B) To separate sister chromatids and pull them towards opposite poles
   C) To stabilize the cell membrane
   D) To facilitate cytoplasmic streaming

8. **What is a potential therapeutic implication of understanding microtubule dynamics in cancer treatment?**

   A) Enhancing cell motility to promote metastasis
   B) Targeting microtubule stabilizers to enhance drug efficacy
   C) Inhibiting GTP hydrolysis to prevent cell division
   D) Using motor proteins to transport drugs directly to tumor sites

9. **Which statement about the centrosome is correct?**

A) It is solely responsible for the transport of organelles.
B) It organizes microtubules during interphase but not during mitosis.
C) It anchors the minus ends of microtubules while allowing the plus ends to grow.
D) It is not involved in the formation of the mitotic spindle.

10. **What distinguishes treadmilling from other microtubule dynamics?**

A) It is a static process without addition or loss of subunits.
B) It maintains a constant length while allowing continuous turnover of tubulin subunits.
C) It only occurs at the minus end of the microtubule.
D) It results in complete disassembly of the microtubule.

## Answers

1. C
2. B
3. C
4. B
5. B
6. C
7. B
8. B
9. C
10. B

1. **In the context of microtubule dynamics, what molecular change leads to a reduction in the binding affinity of tubulin dimers for each other?**

A) Hydrolysis of GTP to GDP
B) Phosphorylation of α-tubulin
C) Binding of calcium ions
D) Acetylation of tubulin

2. **What is the role of γ-tubulin in microtubule organization, particularly during mitosis?**

A) It binds to the plus end of microtubules to stabilize them.
B) It is involved in the nucleation of microtubules at the centrosome.
C) It facilitates the transport of organelles along microtubules.
D) It promotes the disassembly of microtubules during cell division.

3. **Which of the following accurately describes the impact of taxol on microtubules?**

A) It promotes the dynamic instability of microtubules by preventing depolymerization.
B) It stabilizes microtubules, thereby inhibiting cell division.

C) It enhances the polymerization of tubulin dimers at the plus end.
D) It facilitates the interaction between motor proteins and microtubules.

4. **During axonal transport, how does dynein's mechanism of action differ fundamentally from that of kinesin?**

   A) Dynein uses GTP hydrolysis for movement, while kinesin uses ATP hydrolysis.
   B) Dynein moves vesicles towards the plus end, whereas kinesin moves them towards the minus end.
   C) Dynein operates independently of microtubules, while kinesin requires them for transport.
   D) Dynein primarily transports larger organelles, while kinesin is for smaller vesicles.

5. **What specific structural feature of microtubules contributes to their ability to resist compressive forces?**

   A) The presence of protofilaments arranged in a helical pattern
   B) The hollow cylindrical structure
   C) The rigidity of the tubulin dimers
   D) The dynamic instability of the microtubules

6. **How do mutations in kinesin affect neurotransmitter transport mechanisms in neurons?**

   A) They enhance the transport efficiency, leading to increased neurotransmitter release.
   B) They impair anterograde transport, disrupting neurotransmitter supply to synapses.
   C) They alter the affinity of kinesin for GTP, affecting energy consumption.
   D) They lead to the accumulation of vesicles at the axon terminals without affecting transport.

7. **In the context of microtubule-associated proteins (MAPs), what is the functional significance of the protein Tau?**

   A) It enhances the polymerization of actin filaments.
   B) It stabilizes microtubules, preventing their disassembly under stress.
   C) It promotes the depolymerization of microtubules during cell division.
   D) It serves as a motor protein that transports cellular components.

8. **What mechanism explains the concept of "treadmilling" in microtubules?**

   A) Continuous addition of GTP-bound tubulin at the minus end while losing GDP-bound tubulin at the plus end.
   B) Constant turnover where tubulin dimers are added at one end and lost at the other, maintaining a constant length.
   C) The simultaneous addition and removal of tubulin dimers from both ends, resulting in microtubule elongation.

D) The stabilization of microtubules through the addition of GTP-bound tubulin at both ends.

9. **What could be a potential consequence of a drug that selectively inhibits MAPs in neurons?**

   A) Increased stability and reduced plasticity of neuronal microtubules.
   B) Enhanced degradation of microtubules leading to neurodegenerative conditions.
   C) Increased axonal transport efficiency and neurotransmitter release.
   D) Stabilization of axonal microtubules, preventing synaptic function.

10. **In what way do centrosomes facilitate the organization of microtubules during cell division?** A) They produce ATP for energy-dependent microtubule polymerization.
    B) They provide a scaffold for the assembly of the mitotic spindle.
    C) They enhance the binding of motor proteins to microtubules.
    D) They disassemble existing microtubules to allow for new spindle formation.

## Answers

1. A
2. B
3. B
4. A
5. B
6. B
7. B
8. B
9. B
10. B

**Case 1: A 70-year-old patient presents with symptoms of memory loss and difficulty with coordination. Brain imaging reveals the presence of neurofibrillary tangles.**

1. **Which protein aggregation is primarily associated with the development of neurofibrillary tangles in this patient?**

   A) α-tubulin
   B) β-tubulin
   C) Tau protein
   D) Kinesin

2. **What is the impact of tau protein aggregation on microtubule dynamics in neurons?**

   A) It stabilizes microtubules and enhances axonal transport.
   B) It destabilizes microtubules, leading to impaired axonal transport.

C) It promotes the polymerization of microtubules.
D) It has no significant effect on microtubule stability.

**Case 2: A patient diagnosed with breast cancer is treated with a drug that stabilizes microtubules, preventing their disassembly during the cell cycle.**

3. **What is the mechanism of action of this drug?**

   A) It enhances the polymerization of tubulin dimers.
   B) It inhibits the function of motor proteins.
   C) It stabilizes the microtubule structure, preventing mitotic spindle formation.
   D) It promotes microtubule disassembly, allowing for normal cell division.

4. **Which drug is commonly known for its ability to stabilize microtubules in cancer treatment?**

   A) Colchicine
   B) Vincristine
   C) Taxol
   D) Dynein

**Case 3: A 30-year-old man presents with symptoms of muscle weakness and numbness. Genetic testing reveals mutations in the kinesin gene, affecting motor protein function.**

5. **What is the likely consequence of this kinesin mutation on neurotransmitter transport in the patient?**

   A) Increased transport efficiency of neurotransmitters to synapses.
   B) Impaired anterograde transport of organelles and neurotransmitters.
   C) Enhanced retrograde transport of materials from synapses.
   D) No significant impact on neurotransmitter transport.

6. **Which other protein may be affected due to kinesin dysfunction, leading to further complications?**

   A) Tau protein
   B) Dynein
   C) γ-tubulin
   D) Actin

**Case 4: A researcher is studying the effects of a new compound that disrupts the polymerization of microtubules in a laboratory setting.**

7. **What effect would this compound likely have on cell division?**

   A) Enhanced cell division and proliferation.
   B) Inhibition of mitotic spindle formation and cell division.
   C) Stabilization of microtubules leading to successful cytokinesis.
   D) No effect on the cell cycle.

8. **Which of the following drugs has a similar mechanism of action as the compound being studied?**

   A) Taxol
   B) Vincristine
   C) Colchicine
   D) Kinesin

## Answers

1. C
2. B
3. C
4. C
5. B
6. B
7. B
8. C

**Case 1: A 65-year-old female patient presents with progressive cognitive decline, motor impairment, and behavioral changes. Autopsy reveals significant neurofibrillary tangles composed primarily of hyperphosphorylated tau protein.**

1. **What mechanism underlies the neurotoxic effects of tau aggregation in neurons?**

   A) Stabilization of microtubules, leading to reduced transport of synaptic vesicles.
   B) Disruption of microtubule dynamics, leading to impaired axonal transport and cellular signaling.
   C) Enhancement of GTP hydrolysis, causing rapid depolymerization of microtubules.
   D) Promotion of mitotic spindle formation, leading to uncontrolled cell division.

2. **In the context of this patient's symptoms, which cellular process is most directly affected by tau aggregation?**

   A) Mitochondrial respiration and ATP production
   B) Intracellular transport of neurotransmitter vesicles

C) Calcium ion homeostasis
D) Activation of apoptotic pathways

**Case 2: A 50-year-old woman with ovarian cancer initially responds to Taxol, a microtubule-stabilizing agent, but later shows resistance to treatment.**

3. **Which cellular adaptation might explain her resistance to Taxol?**

   A) Increased expression of microtubule-associated proteins (MAPs) that promote stability.
   B) Upregulation of tubulin isotypes that have reduced affinity for Taxol.
   C) Enhanced hydrolysis of GTP on β-tubulin, leading to dynamic instability.
   D) Increased expression of dynein, facilitating effective transport despite stabilization.

4. **Which type of drug could potentially overcome this resistance mechanism?**

   A) A drug that promotes microtubule depolymerization.
   B) An agent that inhibits GTP hydrolysis on β-tubulin.
   C) A compound that enhances MAP activity to stabilize microtubules further.
   D) A drug that targets actin dynamics to compensate for microtubule dysfunction.

**Case 3: A 28-year-old male is diagnosed with a hereditary neuropathy caused by a mutation in the gene coding for kinesin-1. He exhibits progressive weakness and muscle atrophy.**

5. **What is the primary physiological consequence of kinesin-1 malfunction in neuronal cells?**

   A) Enhanced retrograde transport of neurotrophic factors to the cell body.
   B) Impaired anterograde transport of synaptic vesicles and organelles necessary for neurotransmission.
   C) Increased microtubule stability due to prolonged GTP binding.
   D) Compensatory activation of dynein to enhance retrograde transport.

6. **Given the role of kinesin-1, which of the following treatments might provide a therapeutic strategy for this patient?**

   A) Administration of a microtubule stabilizer.
   B) Gene therapy to correct the kinesin-1 mutation.
   C) Use of drugs that enhance retrograde transport mechanisms.
   D) Agents that inhibit tau protein aggregation.

**Case 4: A pharmaceutical company is developing a new drug that selectively inhibits the polymerization of microtubules without affecting actin filaments.**

7. **What therapeutic effect might this drug have on rapidly dividing cancer cells?**

   A) Induction of apoptosis by enhancing microtubule stability.
   B) Inhibition of mitotic spindle formation, leading to cell cycle arrest.
   C) Promotion of cell division by increasing polymerization dynamics.
   D) Facilitation of cellular migration due to increased microtubule dynamics.

8. **Which type of cancer would likely be most affected by this drug's mechanism of action?**

   A) Cancers with a high degree of microtubule stability.
   B) Cancers characterized by rapid cell division and high microtubule turnover.
   C) Cancers that rely heavily on actin for cell motility.
   D) Cancers that have developed resistance to conventional microtubule inhibitors.

## Answers

1. B
2. B
3. B
4. A
5. B
6. B
7. B
8. B

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