

IX. CELL AND ORGANELLE MOVEMENT

A) MYOSIN AND CELL MOVEMENT IN MUSCLE

1) THREE TYPES OF MUSCLE CELLS

- a) skeletal
- b) cardiac
- c) smooth

2) FOCUS ON SKELETAL MUSCLE

- a) Structure of Myosin II
 - i) 2 heavy chains
 - ii) 4 light chains
- b) skeletal muscles are bundles of muscle fibers
 - i) large single cells formed by fusion
 - ii) myofibrils

iii) SLIDING FILAMENT MODEL OF MUSCLE CONTRACTION

- a. contraction of sarcomeric unit
- b. myosin head binds actin
- c. myosin head hydrolyzes ATP
- d. myosin conformational changes
- e. muscle contraction is initiated by a sudden rise in cytosolic Ca
 - i. signal from a motor nerve, action potential in muscle cell
 - ii. spreads into T tubules,
 - iii. activation of voltage sensitive proteins
 - iv. Ca channels open in the sarcoplasmic reticulum
 - v. Ca is released, response is amplified
 - vi. muscle contraction
 - vii. Ca is pumped back into SR
- g. role of Calcium

B) MYOSIN AND MOVEMENT IN NON-MUSCLE CELLS

1) MYOSIN II

- a) functions of myosin II in non-muscle cells
 - i) allows molecules to polymerize into bipolar filaments
 - ii) moves groups of actin filaments past each other
- b) contractile assemblies involving myosin II (conventional)
 - i) contractile ring
 - ii) stress fibers
 - iii) adhesion belts
- c) myosin light chain phosphorylation
 - i) myosin light chain kinase
 - ii) calmodulin
 - iii) role of calcium

2) myosin I

- a) structure
 - i) globular head group - molecular motor - like myosin II
 - ii) lack the long tails of myosin II
 - iii) do not form dimers
- b) movement along an actin filament
- c) role in transport of vesicles and organelles
 - i) the tails bind cellular structures
 - ii) movement along an filament transports the attached cargo
- d) role in microvilli
 - i) form the lateral arms, link actin bundles to the membrane
 - ii) the motors may move the membrane along the actin bundles

- e) movement of the plasma membrane during cell locomotion

C) CELL CRAWLING

1) TYPES OF CELLS THAT CRAWL

- a) amoebas
- b) migration of embryonic cells during development
- c) invasion of tissues by white blood cells during infection
- d) migration during wound healing
- e) metastasis
- f) phagocytosis
- g) extension of nerve processes

3) STEPS IN CELL CRAWLING

- a) protrusions (pseudopodia, lamellipodia, filopodia)
- b) attachment
- c) dissociation of trailing edge

D) MICROTUBULE MOTORS AND MOVEMENTS

1) TYPES OF CELL MOVEMENTS AND MICROTUBULES

- a) intracellular transport
- b) positioning of membrane vesicles and organelles
- c) separation of mitotic chromosomes
- d) beating of cilia and flagella

2) KINESIN AND DYNEIN ARE MOTOR PROTEINS

- a) use ATP hydrolysis to produce force and movement
- b) move along microtubules in opposite directions

- c) kinesin moves toward the plus end
- d) dynein moves toward the minus end
- e) **STRUCTURE OF KINESIN**
 - i) two heavy chains and two light chains
 - ii) The heavy chains wind around each other
 - iii) heavy chains have an amino terminal globular head
 - iv) C terminus of the heavy chains complex with the light chains
 - v) the C terminus binds cell components (organelles, vesicles, ..)
- f) **STRUCTURE OF DYNEIN**
 - i) large molecule (up to 2000 kd)
 - ii) two or three heavy chains
 - iii). variable number of light and intermediate chains
- g) dynein and kinesin make up a family of related proteins

3) CARGO TRANSPORT IN NEURONAL CELLS

- a) kinesin and dynein carry their cargos to and from axon tips
- b) kinesin carries secretory vesicles containing neurotransmitters
- c) dynein transports endocytic vesicles from axon to cell body

4) POSITIONING OF ORGANELLES

- a) ER
 - i) ER extends to periphery of the cell in association with MTs
 - ii) requires polymerized microtubules
 - iii) positioning of ER is thought to involve kinesin
- b) golgi
 - i) located near center of cell

- ii) disruption of microtubules causes golgi to disperse
- iii) reformation of microtubules - golgi reassembles
 - dynein transports golgi vesicles transported to cell center

5) SEPARATION OF MITOTIC CHROMOSOMES

a) Anaphase A

- i) movement of chromosomes toward the spindle
- ii) kinetochore microtubules shorten as chromosomes move
- iii) kinetochore associated motor protein
- iv) the motor protein translocates chromosomes
- v) disassembly and shortening of the kinetochore microtubules

b) Anaphase B

- i) separation of spindle poles, elongation of polar microtubules
- ii) overlapping polar microtubules slide past each
- iii) spindle poles are also moved apart by astral microtubules

6) CILIA AND FLAGELLA

- a) microtubule based projections of the plasma membrane
- b) responsible for movement of various eukaryotic cells
- c) cilia
 - i) around 10 micrometer long
 - ii) beat back and forth
 - iii) cell movement or -
 - iv) movement of fluids across a surface
 - v) cells can have many cilia
- d) flagella

- i) as long as 200 micrometer
 - ii) wavelike pattern of beating
 - iii) cells usually have only one or two flagella
 - iv) locomotion of protozoans and sperm
- e) structure of cilia and flagella
- i) basic structure is the axoneme
 - a. made of microtubules and associated proteins
 - b. 2 MTs surrounded by 9 fused MT pairs
 - c. radial spokes attach outer MTs to central pair
 - d. nexin connects outer MTs to each other
 - e. two dynein arms attach to outer MT pairs
 - ii) basal body is at the minus ends of the MTs
 - a. contains 9 MT triplets
 - b. pairs of the triplets extend into outer MTs of axoneme
 - iii) movement of cilia and flagella
 - a. sliding of outer MT doublets relative to each other
 - b. powered by dynein