

# CYTOSKELETON I: MICROTUBULES

12/4/91, rvsd 11/29/93, 11/28/94, 11/27/95, 12/4/96, 1 Dec 99, 29 Nov 00, 6 Dec 02, 29 Nov 04, 30 Nov 05, 19Nov07, 24Nov08, 25Nov09  
 B&D, P. 554, BRP: 644-674, BKH 5<sup>th</sup>: 742-754, BKH: 6<sup>th</sup>: 425-450, 7<sup>th</sup>: 425-437

Shape and movement of cytoplasm due to network of filaments and tubules  
**cytoskeleton controls distribution:** cytoplasm is 20-30% protein, not amorphous

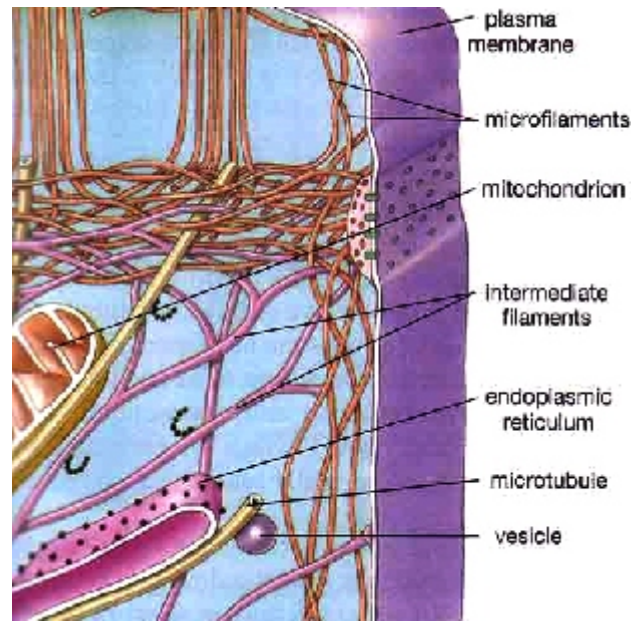
position and move organelles & ribosomes.

Enzymes clustered according to function

Acts therefore as **“muscles and skeleton”** of cell

**Immunofluorescence microscopy** aided understanding tremendously (p 426)

- 1) cells fixed, treated with detergent to make permeable
- 2) treated with primary (anti-tubule or filament Ab) then secondary fluorescein-labeled anti-Ab.



Three major structural elements of cytoskeleton (p 426):

Elements	Structure	Monomer	Function	Stable?
Microtubules	hollow tube	$\alpha$ , $\beta$ tubulin	cell motility, spindle	yes/ no
Microfilaments	two twined chains	F, G actin	muscle, ameboid movem't, cytokin	yes/no
Intermediate Fil'm'nts	protofilaments	several	support & scaffolding	yes

## MICROTUBULES:

FUNCTIONS: Two types **microtubules:**

**stable axonemal motility** cilia, flagella and their basal bodies  
**dynamic cytoplasmic movement in cell** maintain shape, mitotic spindles, vesicle movement

STRUCTURE: hollow tubes, polymerize linearly, dimers: alternate  $\alpha$  &  $\beta$  tubulin subunits.

**Axoneme = central shaft of cilium or flagellum**, stable bundle of microtubules

GENETICS: different species have similar, but identical genes

ASSEMBLY: **microtubule-organizing center (MTOC)** initiates proliferation

proliferation, disassembly from **same end.** P 431 and 436

**centriole in animal** best known MTOC: near nucleus towards Plasma Membrane  
 kinetochore and poles of mitotic spindle p. 435

**Add & subtract from cap end**, prob regulated by **GTP favors growth, GDP disassembly** (catastrophe)

Polarity of microtubule orientation: (p 436): nerves, ciliated epi, RBC marginal bundles, dividing cell

**DRUGS:**

Colchicine:	blocks addition of tubulin
Vincristine (& Vinblastine):	aggregate tubulin, thus do not assemble
Taxol	binds to, stabilizes microtubules, arrests cells in mitosis

**MICROTUBULE ASSOCIATED PROTEINS:** (p

MAP required for assembly, = 10-15% total microtubule mass

probably regulatory:  $PO_4$ ylated without MAP

slowed down, very slow.

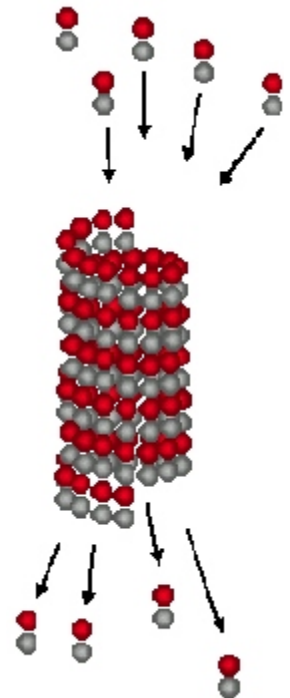
EFFECT ON CELL SHAPE:

govern asymmetry of cells,  
 configuration of plasma membrane  
 plane of cell division in plants  
 change in cell position in embryonic stages.

If microtubules are disrupted (as with colchicine), cells become spherical.

AXONAL TRANSPORT:

microtubule tracks conduct ribosomes, vesicles in nerve cells:  
 ATP-dependent movement of vesicles to synapses



**MOTILITY:** 9 pairs of tubes surround central pair in axoneme (p. 458, 460)