

# CELL CYCLE, MITOSIS

rvsd 11/22/93, 11/23/94, 11/27/96, 11/24/99, 22 Nov 00, 22 Nov 04, 28 Nov 05, 26Nov07, 3Dec08  
BRP, p. 472-490, BKH 533-, 555, BHK 5<sup>th</sup>: 523-525, 544-572, 554-, 7<sup>th</sup>: 572-594

Nuclear division: mitosis (p 574-575)  
cellular division: cytokinesis

Two interacting mechanisms regulate cell division:

- 1) **autonomous clock**, based on **synthesis and destruction of cyclin**
- 2) **clock adjustment, cyclin dependent kinases** etc: proteins providing feedback on state of the cell.

**Diagram cell cycle** (p 583) G1, S, G2, M

**Heterokaryon tech** (p 584) investigated chemical signal control: (fusion by polyethylene glycol or virus)  
S phase fused with G1 nucleus triggers DNA synthesis in in G1  
M fused with G1 nucleus triggers mitosis, but with single chromosome

## REGULATION OF MITOSIS:

**G-2 phase** (preparations are made for mitosis):  
cytoplasm from cleavage zygotes, causes mitosis immediately when injected into G-2 cell.

**Mitotic cyclin dependent kinases = Cdk**, bind to **Mitotic Cyclin**: = **Maturation-promoting factor (MPF)**  
CYCLE: P 586: trigger protein" (mitotic cyclin) accumulates, must be present in suff. amounts for division,  
destroyed following mitosis

(second resting state) **checkpoint here.**(p 587)

MPF is a protein kinase, triggers cascade of events at end of G2 including **activating more MPF**  
P 587: two PO<sub>4</sub> inhibit, third added ,two lost for active complex. It can activate more PO<sub>4</sub>ylated complexes.

**p 587 MPF triggers:**

- chromosome condensation
- spindle formation
- nuclear envelope breakdown
- proteolytic enzymes

**G-1 phase:** gap phase 1 (no DNA synthesis)

Decision to divide is made here: at end of G1 checkpoint.

(Called *Start* in yeast. Called control point, restriction point in mammals) phosphorylation:

G-1 control point: **cyclin dependant kinase = Cdk** is activated by **binding to G1 Cyclin**  
arrest easiest in G-1 (G0 = resting state in non-dividing cells)

**Another set: G1 cyclins and G1Cdk**

At **G1 checkpoint**, complex PO<sub>4</sub>lates Rb protein (an inhibitor of expression of replication enzymes.  
to pass into S phase.

**S phase:** Synthesis phase, replication of DNA, requires **G1 cyclins and G1Cdk**  
DNA synthesis only begins with

**Centrosome** (just outside fo the nucleus) duplicates, move to opposite ends of the cell  
microtubules are spun out from centrosome (note **centrioles** in animals), form spindle  
cytoskeletal microtubules disassemble, reassemble into spindle, aster (in animals)  
nuclear envelope breaks down, microtubules enter nucleus, attache to kinetochore

**M phase: MITOSIS**

ATP driven "motor" walks up the spindle fiber, pulling the chromosome along.

**cytokinesis:** in animals, cleavage caused by belt-like band of actin (a microfilament):  
contractile ring

**in plants:** cell plate forms, new cell wall assembled

**phragmoplast:** microtubules guide vesicles of cell wall precursors.