1 The Cell Cycle

1.1 Tubulin Dimers

Free dimers are bound to GTP (the "T" form).

Tubulin subunits are enzymes that hydrolyse GTP.

When the hydrolysis occurs in the filament GDP is trapped in the tubulin subunits (the "D" form)

1.2 Cell Division

Not all cells in the culture will be dividing at the same time.

In fact, very few cells can be observed in the process of cell division at any given time.

1.3 Cell Cycle

M phase The nucleus and cytoplasm divide:

- Mitosis (nuclear division)
- Cytokynesis (cytoplasmic division)

Interphase The period between cell division:

- G1 phase
- S phase
- G2 phase

1.4 Cells in Multicellular Organisms

1. Many mature cells do not divide.
   - nerve cells, muscle cells, RBC
   - As specialisation develops, the ability to divide is lost
2. Some cells only divide when given an appropriate stimulus
   - liver cells
   - when part of the liver is surgically romevd the remaining liver cells start to divide to replace the lost tissue
3. Some cells normally divide on an ongoing basis.

Cells that do not divide are in G0 (in the state of cell cycle exit).

The cell-cycle control system delays later events until earlier events are complete (start checkponint, metaphase-to-anaphase transition). Problems with the cell-cycle control system cause chromosome segregation defects.

If the environment is not favourable at some checkpoint, the cell cycle arrest occurs.

1.5 Prophase

- replicated chromosomes condese
- Mitotic spindle assembly starts and requires centrosome duplication and bipolar spindle assembly.

When a mitotic cell is fused with another cell in G1, some of the proteins will move over and condense G1 proteins.

When a mitotic cell is fused with another cell in G2, then the S2 chromosomes are also condensed.

When a mitotic cell is fused with another cell in S phase, chromosomes are pulverized.

1.6 Chromosome Condensation

At the end of G2 the replicated chromosomes are dispersed and tangled.

At the beginning of mitosis choromosomes condense to a condensin protein complex.

The sister chromatids are resolved but remain associated due to the cohesin at the centromere.

1.7 Dynamic Microtubules

Dynamic microtubules are required for mitosis.

In an interphase cell microtubules are arranged in a radial pattern. Minus ends are stabilised at the MTOC.

In prophase, bipolar mitotic spindle starts, which requires dissasembly and reassambly of microtubules.

1.8 Centrosome Structure

The centrosome MTC consists of a pair of centrioles organised at right angles to each other and composed by nine fibrils of three mictrotubules each.

The centrosome MTOC is surrounded by γ-tubulin ring complexes.

1.9 Centrosome Duplication and Mitotic Spindle Assembly

Coentrosome duplication starts in S phase, while the bipolar mitotic spindle assembly starts in M phase.

Centrosome duplication occurs only once per cell cycle. Each centriole serves as a template for a new centriole.

Complete mitotic spindle assembly requires nuclear envelope breakdown.

1.10 Nuclear Envelope Breakdown

Nuclear envelope breakdown occurs at the boundary between prophase and prometaphase.

Nuclear lamina Meshwork of intreconnected nuclear lamin proteins

Lamin A special class of intermediatefilaments that form a two-dimensional lattice on the inner nuclear membrane.

Phosphorylation of lamins is thought to trigger nuclear envelope breakdown.

1.11 Prometaphase

Mitotic spindle assembly is completed. Chromosomes attach to spindle microtubules. Chromosome movement begins and ancompasses the microtubulene.

1.12 Mitotic Spindle Assembly

Requiremenets:

- Microtuble dynabics
- Microtubule motor protein activity (kinesins, dyenins)

1.13 Metaphase

In metaphase, all chromosomes are aligned on the metaphase plate.

1.14 Metaphase-Anaphase Transition

Anaphase does not start until all the chromosomes are aligned on the metaphase plate.

1.15 Anaphase

Sister chromatids separate to form the two daughter chromosomes, and the cohesin is cleaved.

They are pulled towards opposite poles, and kinetochore microtubules shorten.

When anaphase is triggered a protease called separase is activated which cleaves the cohesin complex and allows sister chromatids to separate.

1.16 Cytokinesis

Cytoplasm is divided in two by a contractile ring of actin and myosin (in animal cells). The interphase microtubules reform in each daughter cell, which marks the end of the M-phase.

Cytokinesis requires dynaic actin filaments. At the beginning of mitosis actin amd myosin arrays disassemble. They assemble at the contractile ring towards the ned of mitosis (starting in anaphase).