The Cell Cycle

Series of changes a cell undergoes from the time it forms until the time it divides-

Stages:
- interphase
- mitosis
- cytoplasmic division
- differentiation
The Cell Cycle

A. The Cell Cycle

1. During the first growth phase, $G_1$, (your text refers to G as "gap") the cell synthesizes new proteins and grows in size. At the end of this phase, centrioles replicate.

2. During the $S$, or synthesis phase, the cell undergoes semiconservative replication of DNA.

3. $G_2$, the second growth phase, is a brief period in which the cell makes the enzymes needed for cell division. $G_1$, S, and $G_2$ are collectively known as interphase.

4. During the M, or mitotic, phase, the nucleus replicates its contents (karyokinesis).

Interphase

- very active period
- cell grows
- cell maintains routine functions
- cell replicates genetic material to prepare for nuclear division
- cell synthesizes new organelles to prepare for cytoplasmic division

- Phases:
  - $G$ phases – cell grows and synthesizes structures other than DNA
  - $S$ phase – cell replicates DNA
Mitosis

• produces two daughter cells from an original cell
• nucleus divides – karyonkinesis
• cytoplasm divides – cytokinesis

Stages:

• **prophase** – chromosomes form; nuclear envelope disappears
• **metaphase** – chromosomes align midway between centrioles
• **anaphase** – chromosomes separate and move to centrioles
• **telophase** – chromatin forms; nuclear envelope forms

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LAB ATLAS
REFERENCE:
pp. 6 - 7
Morton & Perry, 1998
Cytoplasmic Division

(CYTOKINESIS)

- begins during anaphase
- continues through telophase
- contractile ring pinches cytoplasm in half (furrowing)

Be sure to get the separate, one-page download called: MITOSIS SKETCH
Control of Cell Division

- cell division capacities vary greatly among cell types
  - skin and blood cells divide often
  - liver cells divide a specific number of times then cease
- chromosome tips (telomeres) that shorten with each mitosis provide a mitotic clock
- cells divide to provide a more favorable surface area to volume relationship
- growth factors and hormones stimulate cell division
  - hormones stimulate mitosis of smooth muscle cells in uterus
  - epidermal growth factor stimulates growth of new skin
- contact inhibition
- tumors are the consequence of a loss of cell cycle control

Tumors

Two types of tumors
- **benign** –
  - usually remains localized
- **malignant** –
  - invasive and can metastasize; cancerous

Genes that cause cancer
- **oncogenes** –
  - activate other genes that increase cell division
- **tumor suppressor gene** –
  - normally regulate mitosis; if inactivated they will not regulate mitosis
MITOSIS SKETCH

INTERPHASE
90% of life cycle
time varies

<table>
<thead>
<tr>
<th>G₁</th>
<th>cell growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>DNA replication</td>
</tr>
<tr>
<td>G₂</td>
<td>↑ protein synthesis</td>
</tr>
<tr>
<td></td>
<td>prep for Mitosis</td>
</tr>
</tbody>
</table>

cellular metabolism; DNA replication (DNA duplication).

Human cells entering interphase:

>>>46 unduplicated chromosomes

Human cells exiting interphase:

>>>46 duplicated chromosomes

PROPHASE
1- several hrs

- diagram: 2n = 4
- human: 2n = 46

Chromatin >>>>>> Chromosomes
The chromatin is actually coiling (condensing); becomes visible.
Nuclear membrane and nucleoli become indistinct.
Centrioles move toward opposite poles of cell.
Spindle forms.

METAPHASE
5 - 15 minutes

- diagram: 2n = 4
- human: 2n = 46

Chromosomes line up along center of spindle.
(equatorial plate)

ANAPHASE
2 - 10 minutes

Centromeres split; Chromatids separate-
then move toward opposite poles of the cell.
Cytokinesis actually begins (see below).

TELOPHASE
10 - 30 min.

- diagram: 2n = 4
- human: 2n = 46

Cytokinesis: cell invaginates >>> 2 cells. Each “daughter” cell possesses the exact
 genetic material (info) as the original cell. Know cell plate formation vs. furrowing.
Chromosomes >>>>>> chromatin (i.e., uncoil).
Nuclear membrane and nucleoli become distinct. Spindle disappears.