Reproduction of Cells

- Bacterial Reproduction
- Eukaryotic Chromosomes
- Cell Cycle
- Cytokinesis
- Control of Cell Division
- Cancer
Bacterial Reproduction

- Prokaryotic Cells
- No nucleus
- One Chromosome
- Divide by Binary Fission
- Time: 15 min & longer
Binary Fission

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Fission
Eukaryotic Chromosomes

• DNA + Histone Proteins
• Haploid or Diploid
• Homologous Chromosomes
• Sister Chromatids
Cell Cycle

• Production of new cells for repair, growth, asexual reproduction
• Interphase (3 stages)
• Mitosis = separation of chromosomes
• Go
• Environmental factors
• Hormonal factors
Cell Cycle

Table:

<table>
<thead>
<tr>
<th>Phase</th>
<th>Main Events</th>
<th>Vicia faba</th>
<th>Homo sapiens (cultured fibroblasts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>G_1</td>
<td>Organelles begin to double in number</td>
<td>4.9 hours</td>
<td>6.3 hours</td>
</tr>
<tr>
<td>S</td>
<td>Replication of DNA</td>
<td>7.5</td>
<td>7.0</td>
</tr>
<tr>
<td>G_2</td>
<td>Synthesis of proteins</td>
<td>4.9</td>
<td>2.0</td>
</tr>
<tr>
<td>M</td>
<td>Mitosis</td>
<td>2.0</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Total: 19.3 hours 16.0 hours
Mitosis & Cytokinesis

Mitosis and Cytokinesis Overview

- Nucleolus
- Cell nucleus
- Microtubules
- Mitotic spindle
- Chromosomes
- Mitotic spindle microtubules
- Centromere and kinetochore
- Polar microtubules
- Spindle microtubules (pink)
- Chromatids
- Chromosomes aligned on metaphase plate
- Kinetochore microtubules
- Cytoplasm
- Cell wall
- Daughter nuclei and nucleoli
- Cell plate
- Telophase
- Anaphase
- Metaphase
- Prophase
- Condensed chromosomes
- Mitosis and Cytokinesis Overview

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Mitosis

Prophase
- nuclear membrane disintegrates
- nucleolus disappears
- chromosomes condense
- mitotic spindle begins to form between centrioles
- kinetochores begin to mature and attach to spindle

Metaphase
- kinetochores attach chromosomes to mitotic spindle and align them along metaphase plate at equator of cell

Centromere and kinetochore

Mitotic spindle microtubules

Chromosomes aligned on metaphase plate
Mitosis

Anaphase
- kinetochore microtubules shorten, separating chromosomes to opposite poles
- polar microtubules elongate, preparing cell for cytokinesis

Microtubules in Metaphase
- Pole
- Overlapping microtubules

Microtubules in Anaphase
- Pole
- Overlapping microtubules

Spindle microtubules (pink)
Cytokinesis

Telophase and Cytokinesis

**CYTOKINESIS**
- *plant cells*: cell plate forms, dividing daughter cells
- *animal cells*: cleavage furrow forms at equator of cell and pinches inward until cell divide in two

**Telophase**
- chromosomes reach poles of cell
- kinetochores disappear
- polar microtubules continue to elongate, preparing cell for cytokinesis
- nuclear membrane re-forms
- nucleolus reappears
- chromosomes decondense
Plant Cells

Cytokinesis in Plant Cells

- Cell wall
- Nuclei

Vesicles containing membrane components fusing to form cell plate
Control of Cell Division

- CDC mutations: 3 checkpoints involved with cyclins
- G1/S: cell size, DNA damage, cannot proceed to S
- G2/M: Replication or damage
- M: formation of spindle fiber system, not attached properly
- Tumor suppressor genes: P53 program cell death
Abnormal Cell Division

Cell Division and Normal \(p53\) Protein

**NORMAL \(p53\)**
- Stage 1: DNA damage is caused by heat, radiation, or chemicals.
- Stage 2: DNA repair enzyme repairs damaged DNA.
- p53 triggers the destruction of damaged region.

Cell Division and Abnormal \(p53\) Protein

**ABNORMAL \(p53\)**
- Stage 1: DNA damage is caused by heat, radiation, or chemicals.
- Stage 2: The \(p53\) protein fails to stop cell division and repair DNA. Cell divides without repair to damaged DNA.
- Stage 3: Damaged cells continue to divide. If other damage accumulates, the cell can turn cancerous.
Cancer

Mutations and Cancer

Key proteins associated with human cancers

<table>
<thead>
<tr>
<th>Protein</th>
<th>Human cancers percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth factor receptor</td>
<td>More per cell in many breast cancers</td>
</tr>
<tr>
<td>Ras protein</td>
<td>Activated by mutations of ras in 20–30% of all cancers</td>
</tr>
<tr>
<td>Src kinase</td>
<td>Activated by mutations in 2–5% of all cancers</td>
</tr>
<tr>
<td>Rb protein</td>
<td>Mutated in 40% of all cancers</td>
</tr>
<tr>
<td>p53 protein</td>
<td>Mutated in 50% of all cancers</td>
</tr>
</tbody>
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