Outline - Meiosis

1. Sexual Life Cycle
2. Sister chromatids & Homologous chromosomes
3. Kayrotype
4. Meiosis
   - Synapsis & synaptonemal complex
   - Chiasma & crossover
   - Reduction division
   - Independent Assortment of Chromosomes
5. Comparison of Meiosis and Mitosis
6. Nondisjunction, aneuploidy & polyploidy

Sexual Life Cycle

- Adult male (diploid) 2n
- Adult female (diploid) 2n
- Germ-line cells
- Somatic cells
- MEIOSIS
- Sperm (haploid) n
- Egg (haploid) n
- Zygote (diploid) 2n
- MITOSIS
- FERTILIZATION

Haploid Gametes form Diploid Zygotes

- Haploid egg
- Haploid sperm
- Diploid zygote
- Paternal homologue
- Maternal homologue
- Fertilization

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**Homologous Chromosomes**

- Homologous Chromosomes
- Centromere
- Sister chromatids

**Differing genetic information on homologous chromosomes**

<table>
<thead>
<tr>
<th>Coat-color genes</th>
<th>Eye-color genes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown</td>
<td>Black</td>
</tr>
<tr>
<td>C</td>
<td>E</td>
</tr>
</tbody>
</table>

**Homologous Pair**

<table>
<thead>
<tr>
<th>C</th>
<th>e</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>Pink</td>
</tr>
</tbody>
</table>

**Fig. 06.05**

**Karyotype and Homologous Chromosomes**

**Stages of Meiosis**

- Meiosis I
  - Prophase I
  - Metaphase I
  - Anaphase I
  - Telophase I

- Meiosis II
  - Prophase II
  - Metaphase II
  - Anaphase II
  - Telophase II
Meiosis I - Prophase

1. Chromosomes condense
2. Nuclear envelope dissolves
3. Centrioles replicate & move apart
4. Spindle apparatus forms
5. Synapsis - Homologous chromosomes pair up

Meiosis I – Synaptonemal Complex

Synaptonemal Complex (Cohesin protein)

Meiosis I: Prophase; Synapsis and Crossover

Synapsis

Crossover & chiasma

Homologous Chromosomes after crossover

Meiosis I - Metaphase

1. Homologous chromosomes align in an equatorial plane
**Meiosis I - Anaphase**

1. Homologous chromosomes separate
2. Reduction division of chromosomes where
   \[ 2N \to 1N \]

**Meiosis I - Telophase**

1. Chromosomes decondense
2. Nuclear membrane forms
3. Spindle apparatus disappears
4. Cytokinesis – Two haploid daughter cells form

**Meiosis I: Summary**

<table>
<thead>
<tr>
<th>MEIOSIS I: Homologous chromosomes separate</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERPHASE</td>
</tr>
<tr>
<td>Centrioles</td>
</tr>
<tr>
<td>Chromatin</td>
</tr>
</tbody>
</table>

**Meiosis II**

<table>
<thead>
<tr>
<th>MEIOSIS II: Chromatids separate</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERPHASE</td>
</tr>
<tr>
<td>Cleavage furrow</td>
</tr>
</tbody>
</table>
Meiosis - Summary

- Independent Assortment of chromosomes at Metaphase I
  - Possibility 1
  - Possibility 2

Meiosis & Mitosis

Comparison

- Unique Features of Meiosis
  1. Synapsis and crossing over
  2. Sister chromatids remain joined at centromeres throughout meiosis I
  3. Kinetochores of sister chromatids attach to the same pole in meiosis I
  4. DNA replication is suppressed between meiosis I and meiosis II.
  5. Meiosis produces haploid cells.
  6. Independent assortment of chromosomes produces genetically different cells
Nondisjunction

<table>
<thead>
<tr>
<th>Nondisjunction in meiosis I</th>
<th>Normal meiosis II</th>
<th>Gametes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$n+1$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$n-1$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$n$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$n-1$</td>
</tr>
</tbody>
</table>

Number of chromosomes

Fertilization after Nondisjunction in the mother

- Egg cell: $n+1$
- Sperm cell: $n$ (normal)
- Zygote: $2n+1$

Preparation of a karyotype from a blood sample

- Blood culture
- Centrifuge
- Hypotonic solution
- Fixative
- White blood cells
- Stain
- Homologous chromosomes

Autosome Nondisjunction

1. Most common birth defect
2. 1 in 700
3. Physical features:
   - Round face
   - Flattened nose bridge
   - Short stature
   - Heart defects
4. Susceptibility to infections

Trisomy 21 or Down Syndrome
Maternal age and incidence of Down syndrome

Fig. 07.21

Nondisjunction of Sex Chromosomes

Klinefelter Syndrome (XXY)
- Poor beard growth
- Breast Development
- Under-developed testes

A woman with Turner Syndrome (XO)
- Sexually underdeveloped
- Short stature
- Web of skin
- Constriction of aorta
- Poor breast development
- Underdeveloped ovaries
- 99% die before birth
- Infertile
- Normal Intelligence
### Probability of Survival in Humans
**Chromosome Abnormalities**

<table>
<thead>
<tr>
<th>Chromosome abnormality</th>
<th>Probability of survival to term (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trisomy 16</td>
<td>0</td>
</tr>
<tr>
<td>Trisomy 13,18,21</td>
<td>15</td>
</tr>
<tr>
<td>XXX,XXY,XY</td>
<td>75</td>
</tr>
<tr>
<td>All other trisomies</td>
<td>0</td>
</tr>
<tr>
<td>45,X</td>
<td>1</td>
</tr>
<tr>
<td>Triploidy 3n</td>
<td>0</td>
</tr>
<tr>
<td>Tetraploidy 4n</td>
<td>0</td>
</tr>
</tbody>
</table>

### Genetic Versatility in Plants

**Polyploidy**
- **Diploid** (2n = 10)
  - Arabidopsis thaliana (2n = 10)
  - Cardaminopsis arenosa (4n = 32)
- **Tetraploid** (4n = 26)
  - Arabidopsis thaliana (4n = 20)
  - Hybrid
  - 26 chromosomes
- **Hexaploid**
  - Wheat 4x-6x
  - Banana 3X

### Meiosis

END