Meiosis Part 2 – Gamete Formation

Section 4.2 in Text
Gamete Formation in Animals

• The products of meiosis are 4 haploid gametes
• In humans these gametes are the sperm and egg cells
Spermatogenesis

• Meiosis in mature males takes place in the testes, the male reproductive organs
• The production of sperm starts with a diploid germ cell called a spermatogonium
• This cell enlarges and undergoes meiosis I and meiosis II
• The final product is four haploid sperm cells
Oogenesis

• Meiosis in females, takes place in the ovaries and oviducts
• Starts with a diploid cell called an oogonium
• This process starts before a female is born but pauses in meiosis 1 before the cells divide
The meiotic process resumes at puberty with ovulation (and fertilization) for 1 cell every month
• After telophase 1 and 2 only one of the cells receives the majority of the cytoplasm resulting in one egg cell and 3 polar bodies.

• The unequal division occurs to allow the egg to have sufficient nutrients to support a zygote.
The Importance of Meiosis for Genetic Variation

• Genetic variation in genes allow organisms to survive different circumstances
• Genetic variation occurs through:
  • Independent assortment
  • Crossing over
Independent Assortment

- During metaphase 1 **homologous chromosomes** line up independently at the poles
  - That is maternal chromosomes and paternal chromosomes line up randomly
- This leads to a number of different chromosome combinations in the gametes
Crossing Over

• During prophase 1, homologous chromosomes line up & non-sister chromatids may exchange pieces of chromosomes

• This allows for chromosomes to contain genes from both maternal and paternal origin
Errors During Meiosis

• Errors in meiosis can be caused by:
  • Changes in chromosome structure
  • Changes in chromosome number
Errors Caused by changes in Chromosome Structure

• Errors in chromosome structure occur during crossing over
• These errors include:
  • **Deletion**: a piece of chromosome is deleted
  • **Duplication**: a section of chromosome appears two or more times in a row
  • **Inversion**: a section of chromosome is inverted
  • **Translocation**: a segment of one chromosome becomes attached to a different chromosome
Errors Caused by Changes in Chromosome Number

• Non-disjunction
  • Failure of chromosomes to separate properly
  • Resulting in a missing or an extra chromosome in a gamete cell
  • Can occur in anaphase 1 or 2
(a) Nondisjunction of homologous chromosomes in meiosis I

(b) Nondisjunction of sister chromatids in meiosis II
Genetic Disorders Associated with Chromosome Number

• **Monosomy**: the loss of a chromosome as a result of a non-disjunction
  • Common monosomy involves a missing X chromosome

• **Trisomy**: The gain of an extra chromosome as a result of non-disjunction
  • Common trisomies are 21, 18, & 3
<table>
<thead>
<tr>
<th>Conditions</th>
<th>Number of Live Births</th>
<th>Syndrome</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Autosome</strong></td>
<td></td>
<td></td>
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<tr>
<td>Trisomy 21</td>
<td>1 in 800</td>
<td>Down</td>
<td>Intellectual disabilities, abnormal pattern of palm creases, almond-shaped eyes, flattened face, short stature</td>
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<tr>
<td>Trisomy 18</td>
<td>1 in 18,000</td>
<td>Edward</td>
<td>Intellectual and physical disabilities, facial abnormalities, extreme muscle tone, early death</td>
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<tr>
<td>Trisomy 13</td>
<td>1 in 15,000</td>
<td>Patau</td>
<td>Intellectual and physical disabilities, wide variety of defects in organs, large triangular nose, early death</td>
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<tr>
<td><strong>Sex Chromosome</strong></td>
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<tr>
<td>XXY</td>
<td>1 in 1000 males</td>
<td>Klinefelter</td>
<td>Sexual immaturity (inability to produce sperm), breast swelling</td>
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<tr>
<td>XYY</td>
<td>1 in 1000 males</td>
<td>Jacobs</td>
<td>Typically no unusual symptoms; some individuals may be taller than average</td>
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<tr>
<td>XXX</td>
<td>1 in 1500 females</td>
<td>Triple X</td>
<td>Tall and thin, menstrual irregularity</td>
</tr>
<tr>
<td>XO (1 X chromosome, only)</td>
<td>1 in 5000 females</td>
<td>Turner</td>
<td>Short stature, webbed neck, sexually underdeveloped</td>
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</tbody>
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