Lecture 17
Gametogenesis at the Chromosomal level: Mitosis and Meiosis

Animal Science 434
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Definitions
Chromosome - linear DNA molecule
Centromere - special region of spindle attachment
Homologous Chromosomes
• Have the same kind of genes in the same order
• 1 from father, 1 from mother
Sister chromosomes (X, Y)

DNA Replication
Chromatids
Homologous Chromosomes
A chromatid pair has an identical sequence of DNA

Cell Cycle
Interphase
M - Phase
Prophase
Metaphase
Anaphase
Telophase
Cytokinesis

Grand Scheme
Mitosis
Meiosis
Replicate Division
Division
Replicate Division
Mitosis

- **Go**: Gap 1
- **Gi**: Gap 2
- **S**: DNA synthesis

**G1** → **S** → **G2** → **M**-phase → **Prophase** → **Metaphase** → **Anaphase** → **Telophase** → **Cytokinesis**

- **Homologous chromosomes pair**: along side of each other
- **Chromosomes pull apart**
- **Nuclear envelopes reform**
- **Microtubules disappear**

**Spindles (microtubules)**

- **Centromere**

**MPF high** → **MPF decreases**

**Chromatids**

- **Pull apart**

**M-Phase**

- **Chromatids**

**Telophase**

- **Chromosomes pull apart further**
- **Microtubules disappear**
- **Nuclear envelopes reform**

**Cytokinesis**
### Mitosis
- Cytokinesis

### Meiosis
- $2N \rightarrow G_s \rightarrow G_1 \rightarrow S \rightarrow G_2 \rightarrow$ Prophase
- **Primary Spermatocyte**
- **Primary Oocyte**

### The Five Phases of Meiotic Prophase
1. **Leptotene**
   - Chromosomes condense
2. **Zygotene**
   - Homologous chromosomes begin to pair
   - Bivalents
3. **Pachytene**
   - Pairing is completed
   - Crossing over of homologues occur
4. **Diplotene/Dictyate**
   - Oocytes stop here before puberty
   - Homologous chromosomes pull apart but remain attached at crossover points (chiasma)
   - RNA synthesis is possible
5. **Metaphase I of Meiosis**
   - Homologous chromosomes move toward opposite poles and pair across from one another

### Crossover (chiasma)
- Centromere
- Chromatids linked at centromere
- Homologous chromosomes linked at chiasma
Anaphase I of Meiosis

Recombination as a result of crossing over

Telophase I

Telophase I

Cytokinesis

Secondary Spermatocyte or Secondary Oocyte

Meiosis

Metaphase II

No Replication

Rest Same As Mitosis

Oocytes stop here until fertilized

Abnormalities

- Anueploidy
  - Not an exact multiple
  - Hyper or hypo
  - Example: 2N - 1 or 2N + 1
- Euploidy
  - Exact multiple of haploid
  - Example: 3N, 4N, etc.
- Non-disjunction
  - Causes aneuploidy and occurs in meiosis
  - Example: N - 1 or N + 1
Abnormalities

**Non-disjunction**

- **XXYY**
- **XY**
- **O**
- **O**
- **XX**
- **YY**

- **XXX**
- **XXY**
- **O**
- **Y**
- **Y**
- **XY**

- **X**
- **XY**
- **XX**
- **YY**

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**Down’s Syndrome**

- **Non-disjunction**
- **Extra copy of chromosome 21**
- **Probability increases with age**
  - Age 35, 2 per 1000 births
  - Age 40, 6 per 1000 births
  - Age 45, 16 per 1000 births