


Definition

1. *Reproduction* - is the *process* by which plants and animals *produce new individuals*.

2. *Key phrase* is the *production of new individuals*

3. *Reproduction* is *different* from the previous *organ systems* and processes we have *studied*, like the *circulatory*, *respiratory*, and *excretory*. These three are important for the *survival* of the *individual*.

4. *Reproduction* is *critical* to the *survival* of the *species* and *preservation* of the *genetic material* possessed by each *species*. This is how we inherit our grandfather's nose, our mother's eyes, and a host of outer traits.

Review of Reproduction in Animal Kingdom

The *many* different *ways* that animals *reproduce* can be categorized as either *asexual* or *sexual*.

1. Asexual Reproduction

   - Does *not* involve *sex cells*, also called *gametes* (*sperm* and *eggs*)
   
   - *Offspring* are "carbon" *copies* of a *single parent*

   - *Asexual reproduction* most often *encountered* in more *primitive animals*

   - *Examples* include:

     a. *Budding*

     *Sponges* - *Phylum Porifera*
     *Hydras* - *Phylum Coelenterata*

     b. *Transverse fission*

     *Planarians* - *Phylum Plathyelminthes*
2. Sexual Reproduction

- *Sexual* reproduction *usually requires two parents*, a *male* and *female*. An *exception* to the two-parent *requirement* is for organisms that are *hermaphroditic* and practice *self-fertilization*.

- *Gametes* (*sperm* and *eggs*) are *produced*.

- The *egg* of one parent (*female*) is *fertilized* by the *sperm* of another parent (*male*) to form a *zygote*.

- *Sexual* reproduction is the *general rule* for reproduction in the *animal kingdom*.

- *Examples* are found in all the phyla of animals we have studied this term, even in the more *primitive* or simple *phyla* such as:
  
a. *Sponges* - Phylum *Porifera*

  b. *Hydras, Jellyfish, Corals* - Phylum *Coelenterata*

- In the more *advanced phyla*, often called *higher* animal forms, *sexual reproduction* is the *only method* of reproduction. *Examples* include:
  
a. *Mussels, snails, clams* - Phylum *Mollusca*

  b. *Insects, shrimp, crayfish* - Phylum *Arthropoda*

  c. *Fish, amphibians, reptiles, birds, mammals* (Vertebrates)- Phylum *Chordata*

**Meiosis**

One more *topic* we need to *discuss* before we *begin* the *Human Reproductive System* is a *process* called *meiosis*. But *before* we discuss *meiosis* we need to *briefly review* a few *facts* about *chromosomes*, *chromosome pairs*, and *chromosome numbers*.

1. *Review of Chromosomes, Chromosome Pairs, and Chromosome Numbers*

- *Chromosomes* are found in the *nucleus* of cell and *consist of DNA* and other *proteins*. They *transmit* genetic *information* from the *previous generation* of *cells* to the *next*.

- *Each species* of animal has a characteristic *chromosome number*. *Human cells* have 46 and *gorillas* have 48.
• Also, **similar chromosomes** normally occur in **pairs**, called **homologous chromosome pairs**.

• The **cell** or **organism** is called **diploid** if these **homologous chromosome pairs exist** and the **diploid condition** is represented by the symbol \(2N\).

• Thus for **humans** the **diploid chromosome number** can be written as \(2N = 46\) and \(2N = 48\) for **gorillas**

• Hopefully, this is enough **background and review** to now look at the process of **meiosis**

2. **Overview of Meiosis** (refer to the handout of Figure 10.2 from page 169 of our text book).

• For a formal definition - **Meiosis** - is the type of nuclear division of a germ cell that reduces the chromosome number from the diploid (2\(N\)) to the haploid (\(N\)) number.

  a. **diplos** - is Greek for two-fold

  b. **haplos** - is Greek for single

• **Meiosis** occurs in **sexually reproducing** organisms

• In *animals*, like humans, **meiosis** only occurs in *germ cells* rather than *somatic cells*. Meiosis only occurs during the **formation of gametes** (sperm and egg)

  *(ask - if all know the difference in somatic cells vs germ cells)*

• The end result of **meiosis** is to produce **gametes** (sperm and egg cells) that possess **half** the number of **chromosomes** as the typical somatic cell of the body.

  a. This **condition** is called the **haploid chromosome number** and is represented by the symbol \(N\)

  b. Thus for **humans** the **haploid chromosome number** can be written as \(N = 23\) and \(N = 24\) for **gorillas**

  c. **Why is it important that egg and sperm contain only half of the genetic material of the normal body cells ??**. There are two reasons.

    (1) has to do with **growth of chromosome number** with each **generation**
(2) second reason has to do with normal biological functions and health.

- **Meiosis** can be divided into two steps called **Meiosis I** and **Meiosis II**
  
  **a. Meiosis I**
  
  1. each chromosome in the **primordial germ cell** nucleus is **replicated** to form a **sister chromatid**
  2. **homologous chromosomes** form **pairs**
  3. **chromosome pairs** separate and move to **opposite poles** of the **germ cell**
  4. primordial germ cell splits apart to form 2 **new cells** called **daughter cells** that possess 1 chromosome from each of the **original homologous chromosome pair**. Each chromosome still consists to 2 sister chromatids.
  5. However, note that the **daughter cells** are **haploid**, rather than **diploid**.

  **b. Meiosis II**
  
  1. In each new **daughter cell, chromosomes** (each chromosome still composed to 2 sister chromatids) **align** near center of **daughter cell**
  2. **sister chromatids split** to form **daughter chromosomes** that **migrate** to **opposite poles** of the **daughter cell**
  3. **Daughter cell divides** forming **two new daughter cells** and each **new daughter cell** contains **two daughter chromosomes**.
  4. Note that **final daughter cells** are **haploid**

- The **key result** of **meiosis** is that a **diploid** (2N) primordial **germ cell** is **converted** into **4 daughter cells** that are **haploid** (N)
3. Comparison of Meiosis and Mitosis

- **Mitosis** - is defined as process in which a parent nucleus produces two daughter nuclei, each having the same number and kinds of chromosomes as the parent nucleus.

- **Mitosis** is the kind of cell division that results in growth, development and repair of individual organisms.

- **Table** comparing **Meiosis** and **Mitosis** *(copy and hand out to class)*

<table>
<thead>
<tr>
<th>Meiosis</th>
<th>Mitosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. occurs only in the reproductive organs</td>
<td>1. occurs throughout the body</td>
</tr>
<tr>
<td>2. purpose to produce sperm and eggs</td>
<td>2. purpose to allow development, growth,</td>
</tr>
<tr>
<td></td>
<td>and maintenance of organism</td>
</tr>
<tr>
<td>3. requires 2 nuclear divisions</td>
<td>3. requires only 1 nuclear division</td>
</tr>
<tr>
<td>4. produces 4 daughter cells</td>
<td>4. produces 2 daughter cells</td>
</tr>
<tr>
<td>5. produces 4 haploid daughter cells</td>
<td>5. produces 2 diploid daughter cells</td>
</tr>
<tr>
<td>6. daughter cells genetically different from each other and from original germ cell</td>
<td>6. daughter cells are genetically identical to each other and to the original somatic cell.</td>
</tr>
</tbody>
</table>

**Human Reproduction**

1. **The Human Life Cycle** *(see handout of figure 10.9, page 176 of textbook)*

- In many ways The **Human Life Cycle** as shown on our handout summarizes much of what we have learned so far about the reproduction.

- The human **life cycle** refers to all the reproductive events that occur from one generation to the next.

- **Individual** humans are always **diploid (2N)**

- **Meiosis** creates **haploid (N) eggs** and **sperms** in the **reproductive organs** of the **female** and **male**, respectively
• Haploid (N) sperm fertilize a haploid (N) egg to form a diploid (2n) zygote.

• The zygote undergoes mitosis as development proceeds to the birth of a child.

• Mitosis continues throughout life during growth, development, maintenance, and repair of the human body.

2. Formation of Sperm and Eggs (see handout of Figure 10.10 from page 177 of textbook)

• Oogenesis

  a. Oogenesis is the process in females that leads to the production of eggs.

  b. Meiosis is an important part of oogenesis.

  c. Steps include:

    1. In the ovary, a diploid (2N=46) primary oocyte undergoes Meiosis I to form

      • 1 haploid (N=23) secondary oocyte and
      • 1 haploid (N=23) polar body

      (note that during our original discussion of meiosis these two represent the first two daughter cells. During oogenesis, one cell receives all the cytoplasm and the other cell becomes a polar body that may disintegrate or divide again.)

    2. The secondary oocyte begins Meiosis II and is ovulated and passes from the ovary into a fallopian tube (oviduct)

    3. In the fallopian tube, if a sperm penetrates the wall of the secondary oocyte, it completes Meiosis II to form a haploid egg (N=23) egg and another polar body.

    4. Note that meiosis does not go to completion unless the secondary oocyte is met and penetrated by a sperm cell.

    5. Fertilization occurs when the sperm nucleus merges with the egg nucleus to form a diploid (2N=46) zygote. This occurs in the oviduct.
• **Spermatogenesis**

  a. *Spermatogenesis* is the *process* in *males* that leads to the *production* of *sperm*

  b. *Meiosis* is an important *part* of *spermatogenesis*

  c. *Steps* include

  1. A *diploid* (2N=46) *primary spermatocyte* undergoes *Meiosis I* to form 2 *haploid* (N=23) *spermatocytes*

  2. 2 *haploid spermatocytes* undergo *Meiosis II* to form 4 *haploid spermatids*

  3. 4 *spermatids* mature to form 4 *haploid sperm*

  4. *all steps* *occur* in the *testes*

3. **Role of Hormones** *(see handout of Table of Major Hormones and Their Role)*

• *Hormones* are *chemical messengers* produced in *one* part of the *body* that *control activities* of *other parts*

• *Hormones* important in *reproduction* are *summarized* in the *following table*. *(You have this table as a handout.)*
Table of Hormones and Their Role in Reproduction

<table>
<thead>
<tr>
<th>Hormone</th>
<th>Sex</th>
<th>Origin</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gonadotropics</td>
<td>Males &amp; Females</td>
<td>Anterior Pituitary Gland</td>
<td>Stimulates testes to produce sperm and ovaries to produce eggs</td>
</tr>
<tr>
<td>Androgens, Estrogens</td>
<td>Males &amp; Females</td>
<td>Cortex of Adrenal Gland</td>
<td>Development of Male and Female Secondary Sex Characteristics</td>
</tr>
<tr>
<td>Androgens</td>
<td>Males Only</td>
<td>Testes</td>
<td>Development of Male Primary and Secondary Sex Characteristics</td>
</tr>
<tr>
<td>(Testosterone)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estrogen</td>
<td>Females Only</td>
<td>Ovaries</td>
<td>Development of Female Primary and Secondary Sex Characteristics</td>
</tr>
<tr>
<td>(Progesterone)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Secondary sex characteristics are those traits that are sometimes helpful but not absolutely necessary for reproduction. In terms of males vs females these traits include broad shoulders in males, deeper voice in males, greater muscular development in males, more facial and chest hair in males, and others.*

* Primary sex characteristics are those traits absolutely necessary for reproduction. Examples of these include the male and female sex organs.*

4. Male Reproductive System

The major structures and organs of the male reproductive system and their functions are as follows. (see the handout of male reproductive system from page 251 of the lab manual)

- **Testes** - produces sperm and sex hormones
- **Epididymis** - provides a place for maturation and some storage of sperm
- **Vas Deferens** - conducts and stores sperm
- **Semenal Vescicle** - contributes fluids to semen
- **Prostate Gland** - contributes fluids to semen
- **Urethra** - conducts sperm and urine
- **Cowpers Gland** - contributes fluids to semen
- **Penis** - organ of copulation
5. Female Reproductive System

The major structures and organs of the male reproductive system and their functions are as follows. See the textbook of female male reproductive system, from page 253 and 254 of the text manual.

- Ovaries - produces eggs and sex hormones
- Fallopian tubes (ovaries) - conduits for eggs and location of fertilization
- Uterus (womb) - houses developing embryo and fetus
- Vagina - opening to uterus
- Cervix - organ of copulation and serves as birth canal

6. pp. 251, 252
7. pp. 253, 254, 255
8. pp. 256

Comparison of spermatogenesis to oogenesis.