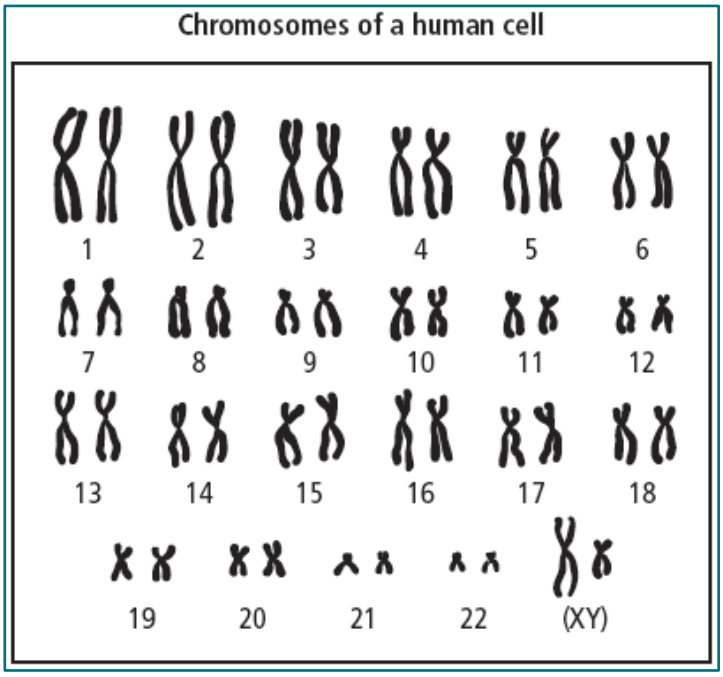
Chapter 6 - Meiosis is the basis of sexual reproduction.

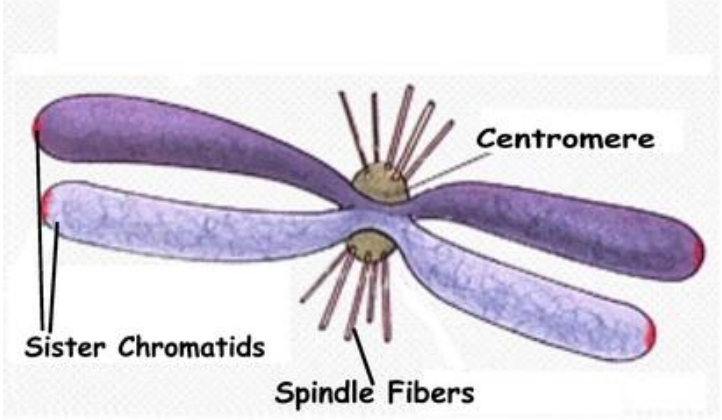
6.1 Meiosis

- **Sexual reproduction** requires two parents and produces offspring that are genetically different from each other, from either parent, and from any other member of their species.
- **Genetic diversity** allows a species to survive by ensuring that some individuals will survive or thrive if the environment changes.
- The process by which DNA is shuffled to create this diversity is called meiosis.

Chromosomes

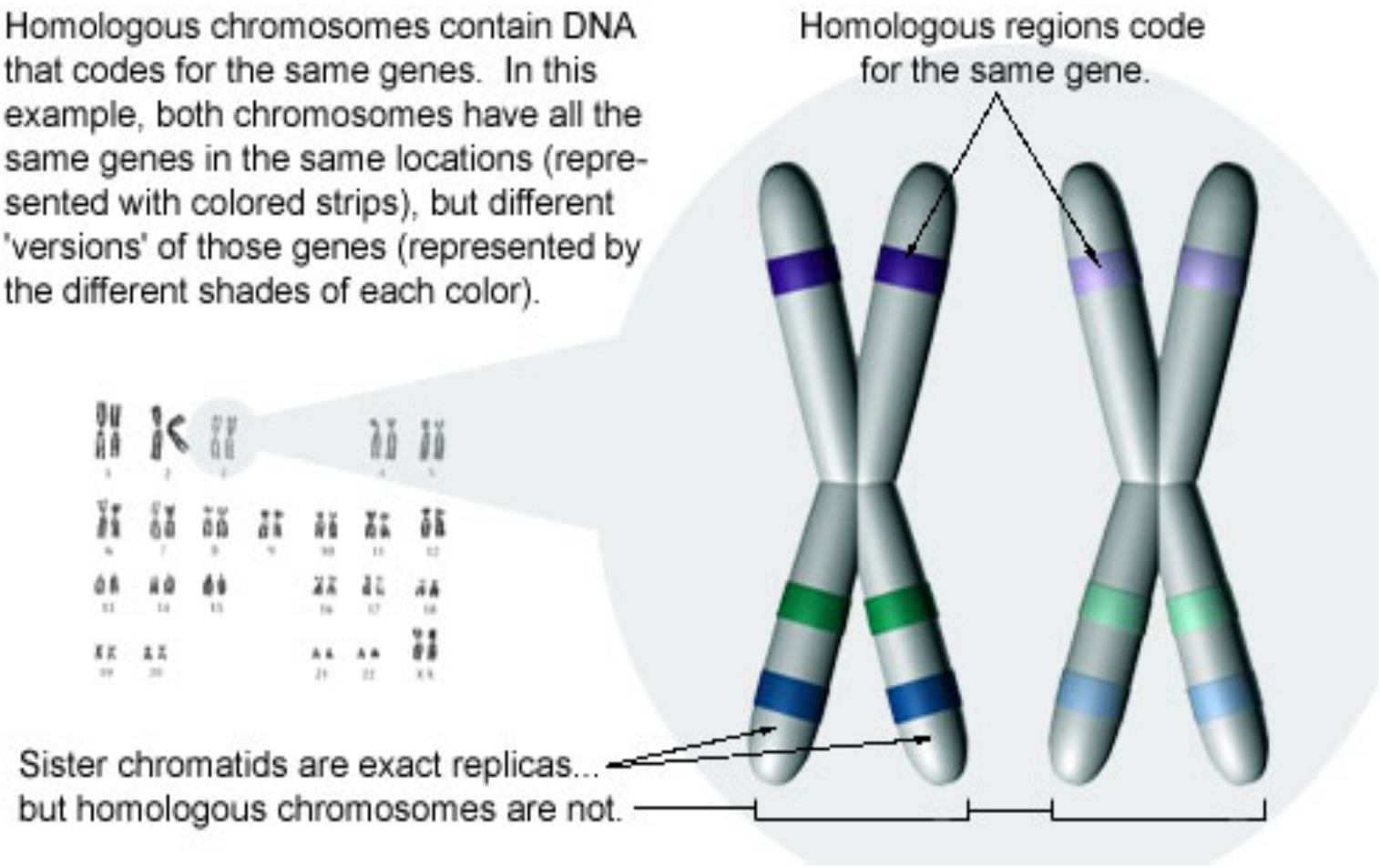
- There are 46 chromosomes in all human cells except sperm and eggs. 23 of these chromosomes came from the mother and 23 from the father.
- Chromosomes can only be seen once they have duplicated during interphase and condensed during mitosis or meiosis.
- The duplicated chromosomes are called sister chromatids and are connected by the centromere which eventually gets pulled apart by spindle fibres.





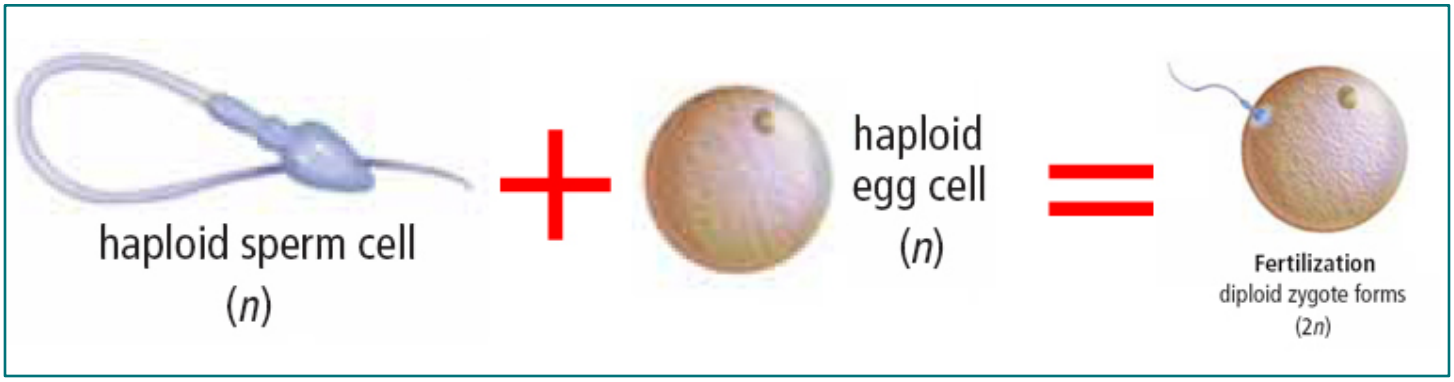
- Each pair are called **homologous chromosomes**.

Figure B-11: Homologous Chromosomes

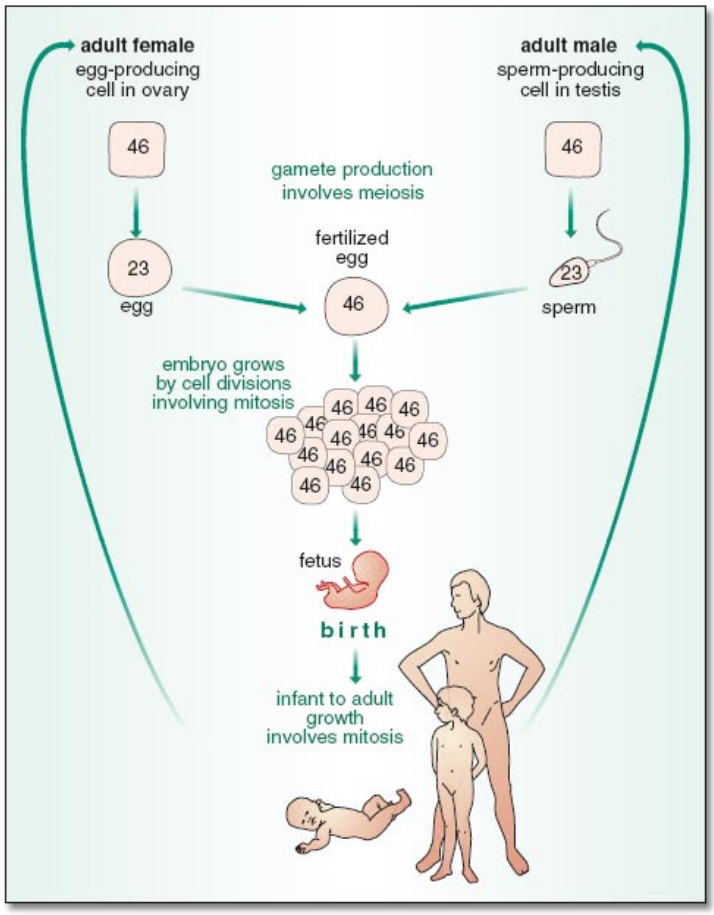


The Role of Gametes

- In eukaryotic organisms, the chromosome number is referred to as the **diploid number** (2*n*). This shows that the chromosomes appear in pairs.
- Humans inherit one set of 23 chromosomes from their female parent and one set of 23 chromosomes from their male parent. Each set of these inherited chromosomes is referred to as the **haploid number** (n).
- Haploid chromosomes are carried in **gametes**, which are specialized cells necessary for reproduction. In animals, the male gametes are called sperm cells and female gametes are called egg cells.



- **Fertilization** is when an egg cell is penetrated by a sperm cell, and the haploid genetic information of both male and female gametes combines. The result of this process is a diploid cell called a **zygote**.
- The zygote then undergoes mitosis and cell division and develops into an **embryo**.

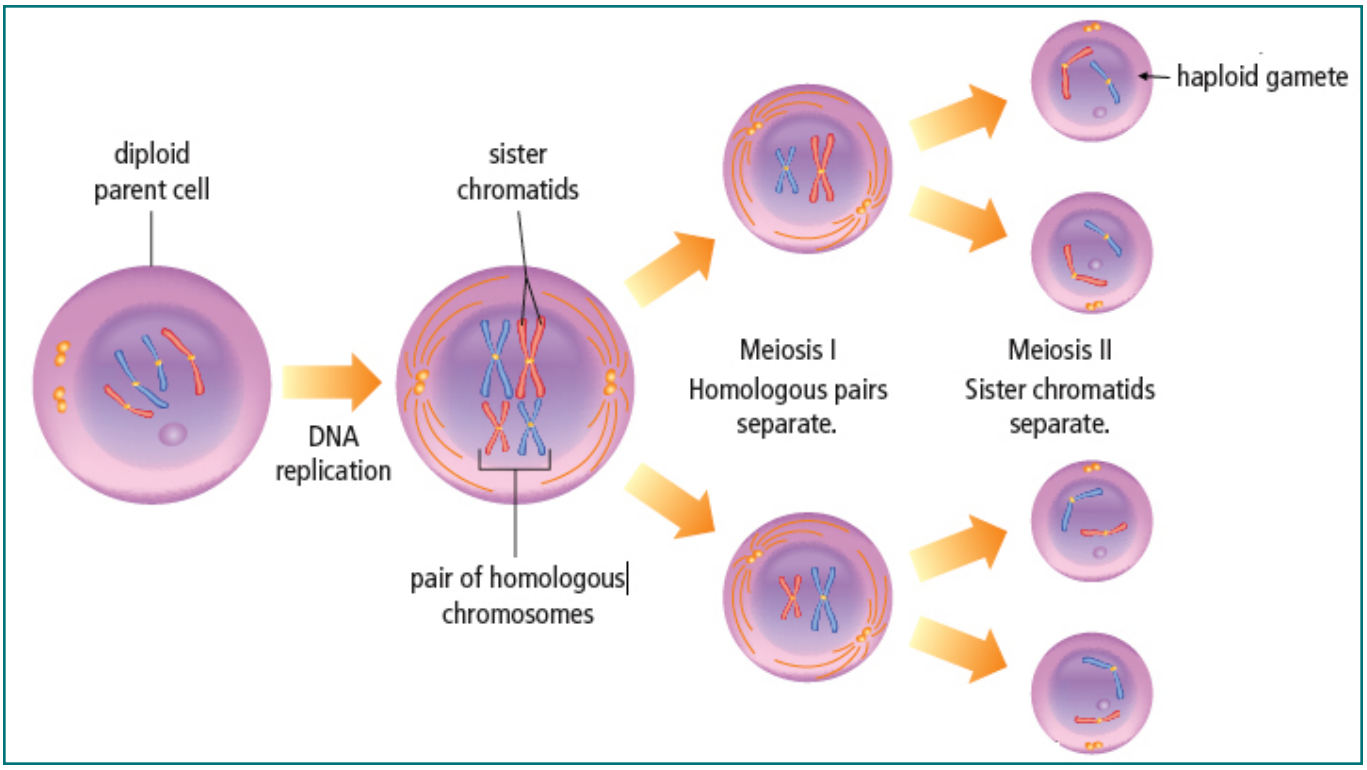


Meiosis

- **Meiosis** is the process that produces gametes with half the number of chromosomes.

- Meiosis is carried out in two parts:
  - **Meiosis I**: Matching chromosome pairs (**homologous chromosomes**) move to opposite poles of the cell - two daughter cells result.
  - **Meiosis II**: Chromatids of each chromosome are pulled apart - the end result is four haploid cells, each with half the number of chromosomes. These develop into gametes.

- Gametes do not form equally in males and females.
  - In males, all 4 cells resulting from meiosis develop into sperm.
  - In females, 1 cell gets most of the cytoplasm and becomes the egg.



Genetic Variation

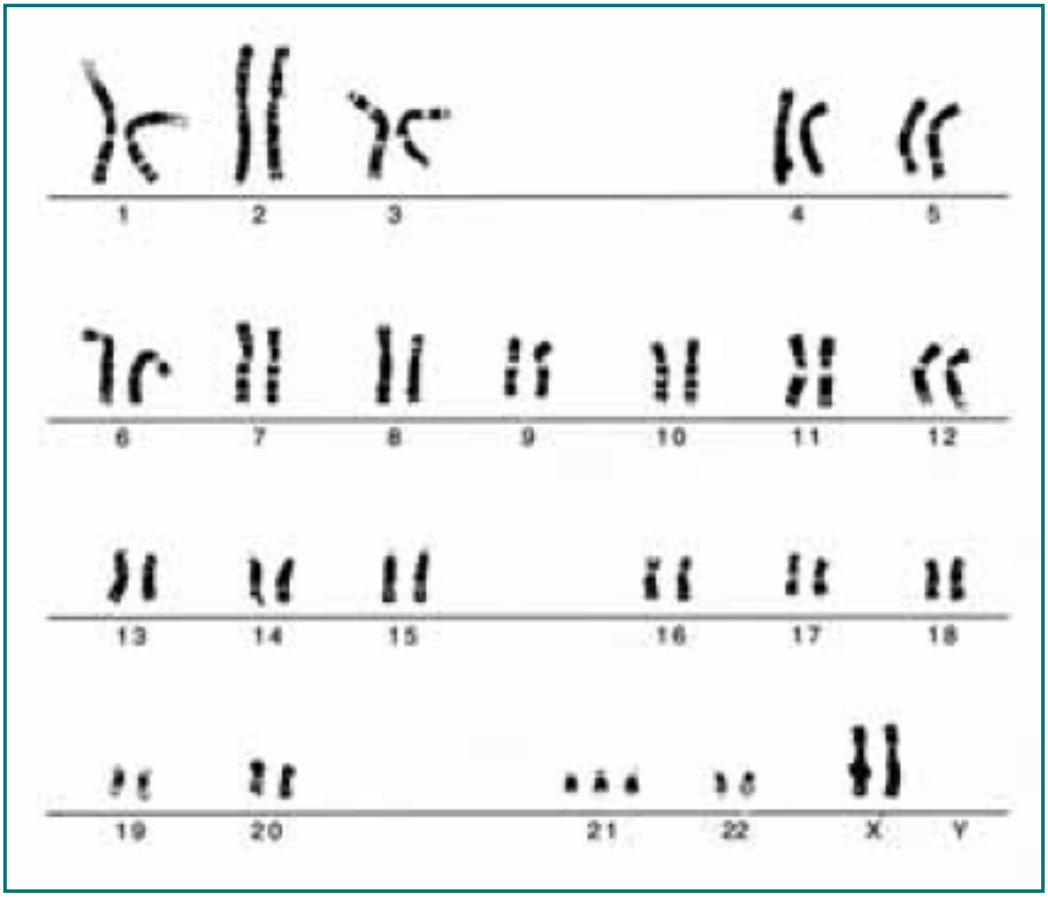
- **Crossing over**: In meiosis I, chromatids of chromosome pairs can cross over each other and exchange DNA segments - this increases genetic possibilities and produces more variation.
- **Independent assortment**: The pairs of chromosomes in meiosis I separate independently, creating many different combinations of chromosomes in the daughter cells.

Chromosome Mutations and Genetic Disorders

- Chromosome changes during meiosis can cause changes in the genetic information. Parts of chromosomes can be inverted, deleted, duplicated or moved to another spot.

- Chromosome changes, sometimes leading to genetic disease or death, can be cause by mutagens such as radiation or chemicals.

- Failed separation means that a gamete may end up with no chromosome or too many of a chromosome. Zygotes that result from these gametes rarely survive, and if they do, they will have serious genetic disorders.
- By using a **karyotype**, geneticists can view an individual's chromosomes.
- Certain genetic disorders or syndromes occur when there are specific chromosomes extra or missing.
- Down syndrome usually occurs when there is an extra 21st chromosome.



6.2 Sexual Reproduction

Sexual Reproduction

- Sexual reproduction brings non-identical gametes together to form a new organism - it occurs in 3 stages:
  1. **Mating** - the process by which gametes are bought together at same place and same time
  2. **Fertilization** - process by which egg and sperm join to form a new organism
  3. **Development** - the process by which an organism develops as an embryo

Methods of Fertilization

External Fertilization

- In external fertilization, sperm and egg join outside parents
- Advantages:
  - Very little energy required to mate
  - Large numbers of offspring produced
  - Offspring can be spread widely in the environment - less competition between each other and parents
- Disadvantages:
  - Many gametes will not survive
  - Many eggs will not be fertilized
  - Offspring are often not protected by parents, so many of them die

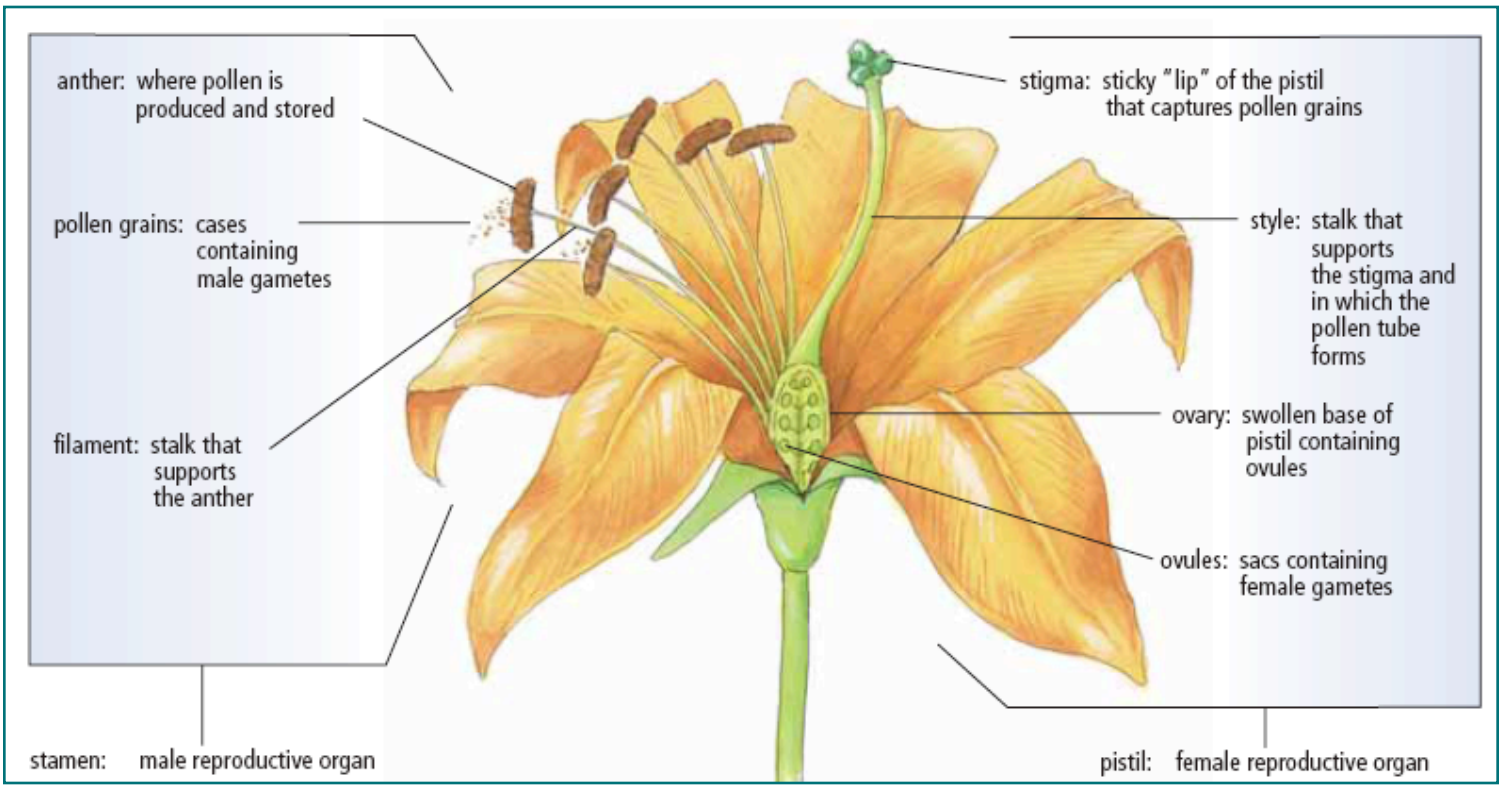
Internal Fertilization

- In internal fertilization, sperm and egg join inside parents, embryo is nourished inside mother
- Advantages:
  - Embryo protected from predators

- Offspring more likely to survive, as many species will protect them while they mature
- Disadvantages:
  - Much more energy required to find mate
  - Fewer zygotes produced, resulting in less offspring
  - More energy required to raise and care for offspring

Pollonation

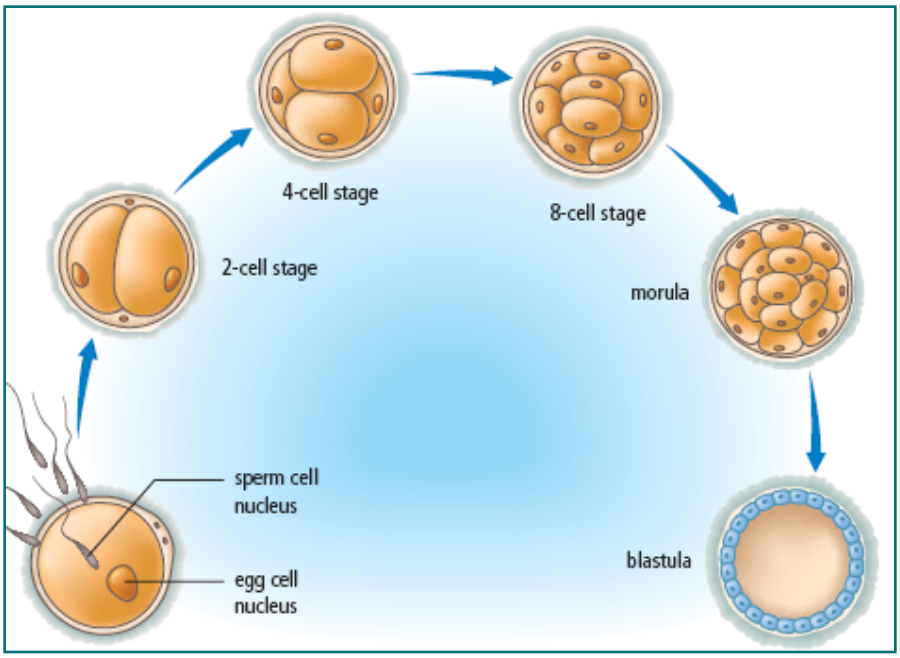
- Most plants transfer male gametes as pollen. Pollen can be carried by wind or other organisms.



- Once the egg is fertilized, cell division will only occur if the following conditions are met:
  - Embryo must have enough nutrients.
  - Temperature must not be too cold or too hot.
  - There must be enough moisture so that embryo does not dry out.
  - Embryo must be protected from predators and items in environment that can potentially harm it.

Embryonic Development

- **Embryonic development** is the early development of an organism - in humans, it is the first two months after fertilization



- Stages:
  - End of the first week - ball of cells called **morula**
  - By end of second week it is a hollow ball called a **blastula**
  - Cells at this stage are stem cells, and have the ability to develop into any kind of cell
  - In the next stage the embryo is known as a gastrula and develops 3 layers: **ectoderm** (skin, nerves), **mesoderm** (muscles, bones), and **endoderm** (lungs, liver, digestive system lining)

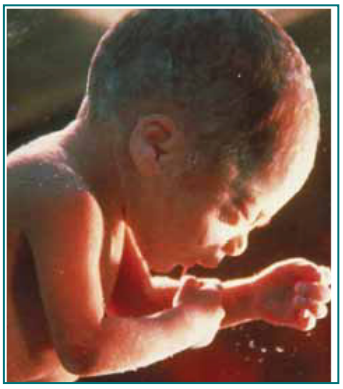
Fetal Development

- The cell layers now differentiate into the organs and tissues of a baby - this is divided into 3 trimesters.

- First Trimester (0-12 weeks)
  - Organ systems begin to develop and form. Bone cells form.

- Second Trimester (12-24 weeks)
  - Rapid growth from 12-16 weeks.

- Third Trimester (24+ weeks)
  - Continued growth, especially of brain. Fat begins to deposit at 32 weeks to keep baby warm at birth.



Advantages and Disadvantages of Sexual Reproduction

Advantages	Disadvantages
• Very little energy required to find a mate (external fertilization).	• More energy generally required to find a mate (internal fertilization).
• Greater numbers of offspring can repopulate an area after a disaster (external fertilization).	• Fewer offspring produced, so if the number of predators increases a population will decline (internal fertilization).
• More protection is given to the embryo and more parental care is given to offspring (internal reproduction).	• Gametes, embryos, and offspring are unprotected and are often preyed upon (external fertilization).
• Offspring are genetically different from their parents, so they may survive new diseases or other threats that appear in a population.	

6.3 Assisted Reproductive Technologies

- **Infertility** is the inability of a couple to have a baby
- **Assisted reproductive technologies** involve removing eggs from the woman, fertilizing them, and returning them to the uterus.

Types of Assisted Reproductive Technologies

- **Artificial Insemination** - donor sperm is placed in the female.
- **In vitro fertilization** (IVF) - egg and sperm are collected and fertilization takes place in a dish. Embryo(s) then placed in female's uterus.
- **Gamete intrafallopian transfer** (GIFT) - eggs and sperm are collected, mixed, then injected into the woman's fallopian tubes.
- **Intracytoplasmic Sperm Injection** (ICSI) - a single sperm is injected directly into an egg.

- Reproductive technologies help childless couples, but carry a higher risk of birth defects. Also creates the problem of "unwanted" embryos. What should be done with them?