McGraw-Hill Ryerson

BC Science Connections 9

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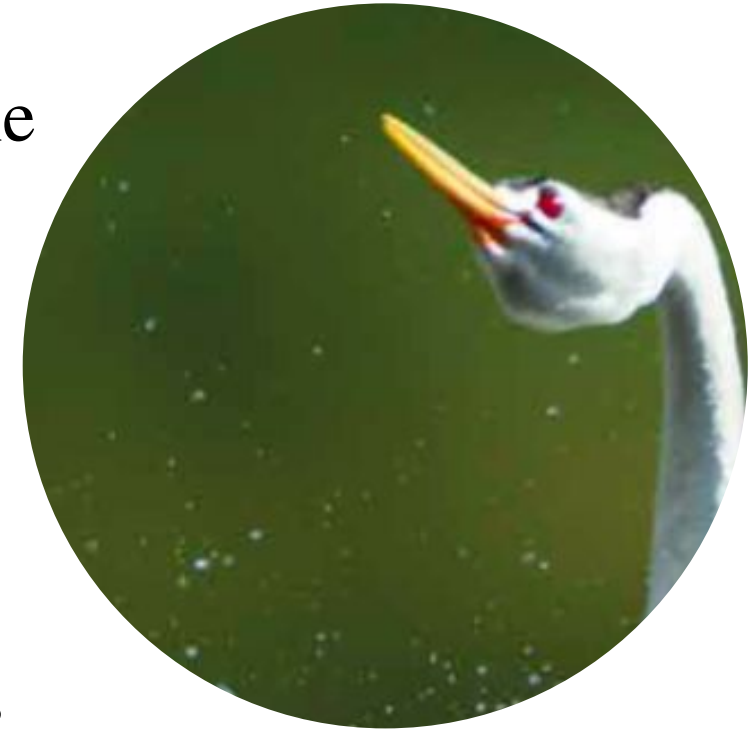
Unit 1: The continuity of life depends on cells being derived from cells

Topic 1.3: How do living things sexually reproduce?

- Male and female reproductive cells combine to produce a zygote.
- Reproductive cells are formed by meiosis.
- Development of the human zygote occurs in stages.
- Sexual reproduction takes many forms.



Concept 1: Male and female reproductive cells combine to produce a zygote.

Animals and many other living things reproduce sexually

- Half of an offspring's DNA is from the female parent
- Other half is from the male parent

Figure 1.14: In sexual reproduction, each of the two parents contributes characteristics to the offspring. What do you think the male and female parents of this litter might look like? What is your reasoning?

Sex Cells: Gametes

Sex cells (**gametes**):

Male or female reproductive cells; the cells that combine during sexual reproduction

- Male gamete: *sperm cell* produced in testes
- Female gamete: *egg cell* (ovum) produced in ovaries

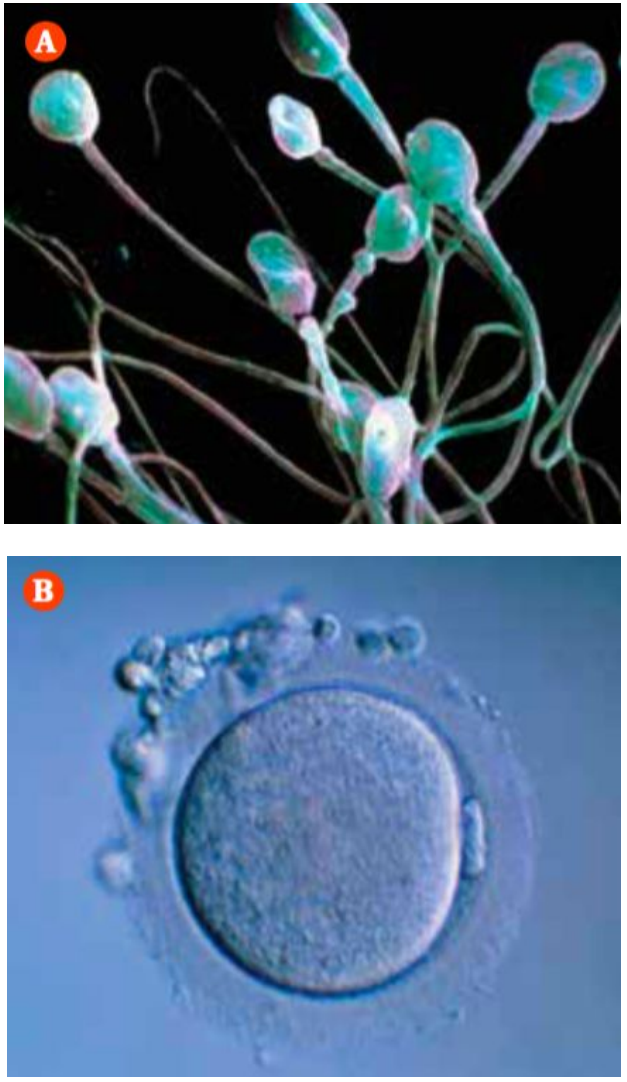


Figure 1.15: A) Sperm cells have a unique look, with their long “tails” or flagella. B) Egg cells are much bigger than sperm cells and lack flagella. What does the presence or absence of flagella on sex cells tell you about their mobility?

Sex Cells: Gametes (continued)

Central event of sexual reproduction:

- Contact between the gametes (sperm and egg)
- Sperm and egg (and their genetic information) combine to produce a new single cell that develops into an offspring

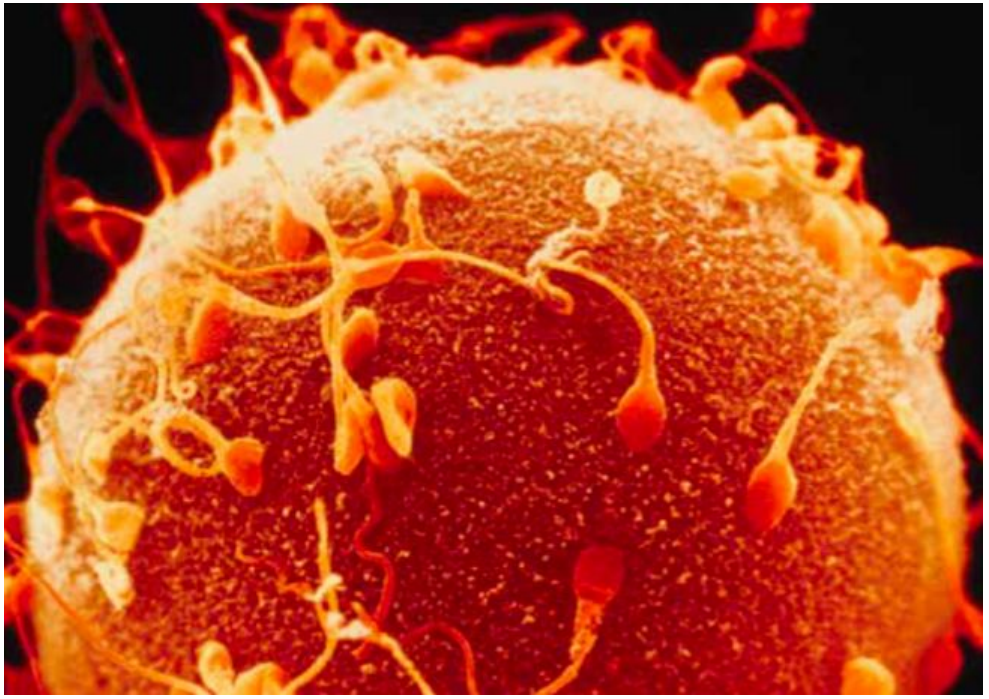


Figure 1.16: Of the many sperm that approach and surround an egg, only one can fertilize the egg.

Fertilization

Fertilization: the process in which male and female gametes combine

- Nuclei of two gametes fuse together to form a single cell called a *zygote*
- Zygote contains genetic information from the sperm cell and egg cell

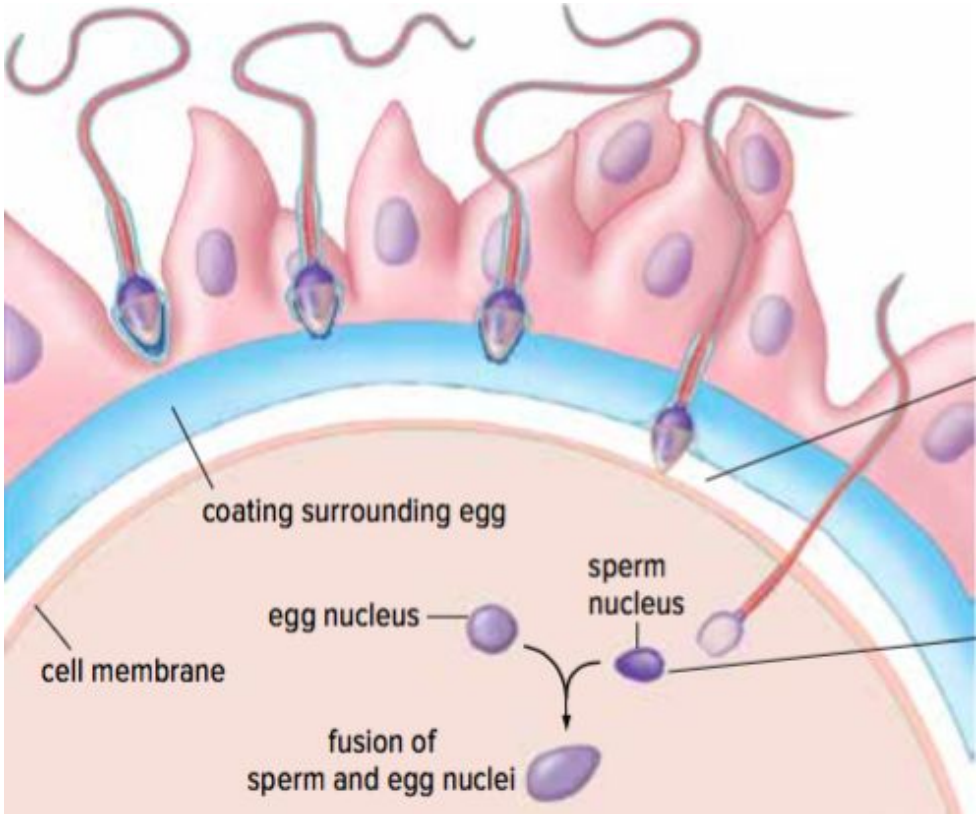


Figure 1.17: When a sperm cell fertilizes an egg cell, the two nuclei fuse and a zygote forms.

Fertilization (continued)

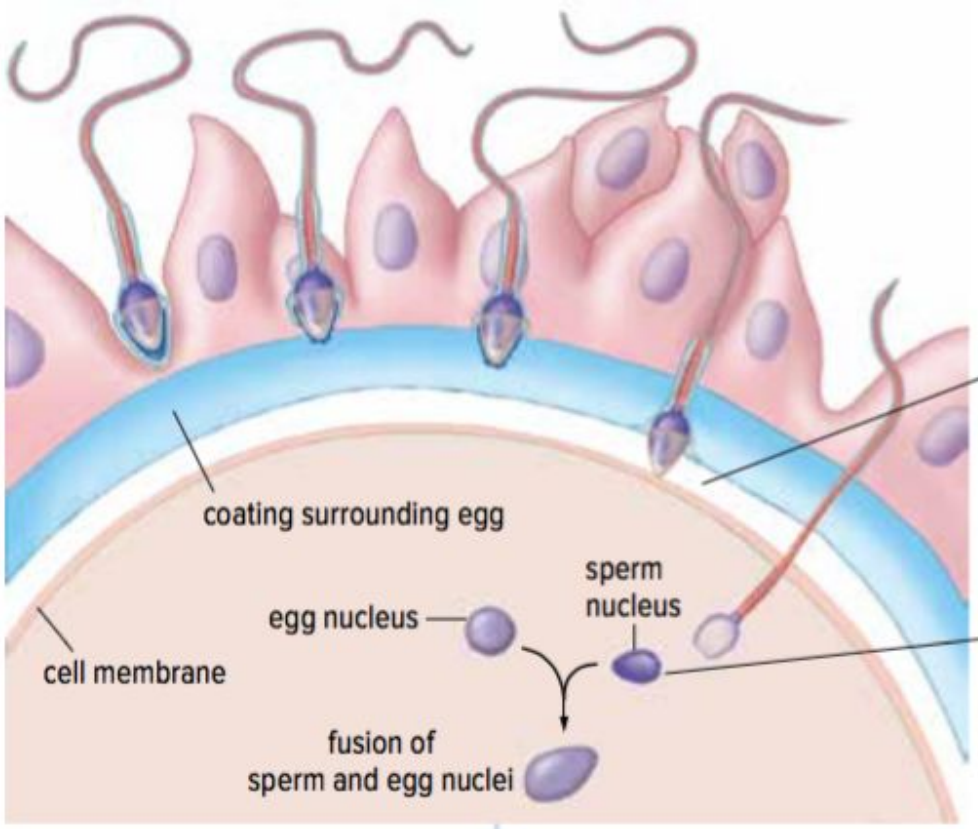


Figure 1.17: When a sperm cell fertilizes an egg cell, the two nuclei fuse and a zygote forms.

Sperm cells reach a jelly-like coating surrounding the egg cell and release substances that digest a path through the coating. This helps sperm cells get closer to the cell membrane of the egg.

The head of one sperm cell eventually enters the egg cell, where the sperm nucleus fuses with the egg nucleus.

Discussion Questions

1. How does the process of fertilization occur?

2. What is needed for fertilization to occur?

Concept 2: Reproductive cells are formed by a cell-dividing process called meiosis.

Humans have 46 chromosomes (23 pairs)

- Paired chromosomes are called *homologous chromosomes*
- During fertilization, each parent contributes one chromosome of each pair

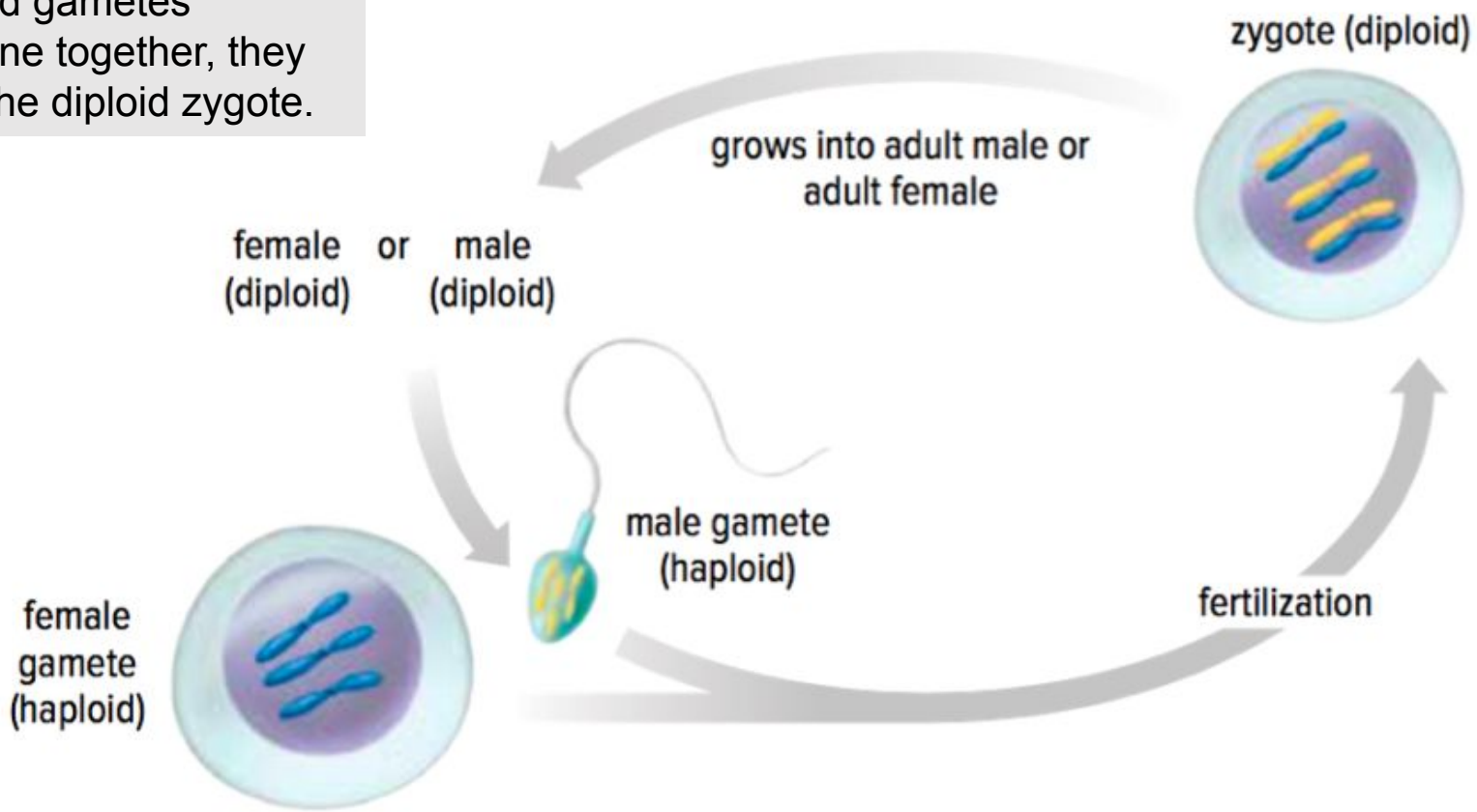
Figure 1.18: A duplicated pair of homologous chromosomes, the female parent contributes one chromosome, and the male parent contributes the other.

Number of Chromosomes in Cells: Haploid and Diploid

- Gametes are **haploid** cells (have half the number of normal chromosomes)
- When they combine in sexual reproduction, they form a zygote which is a **diploid** cell (have the full number of chromosomes)
  - Body cells are diploid cells (example: skin cells)

Number of Chromosomes in Cells: Haploid and Diploid (continued)

Figure 1.19: When haploid gametes combine together, they form the diploid zygote.



- How do diploid organisms produce haploid gametes?

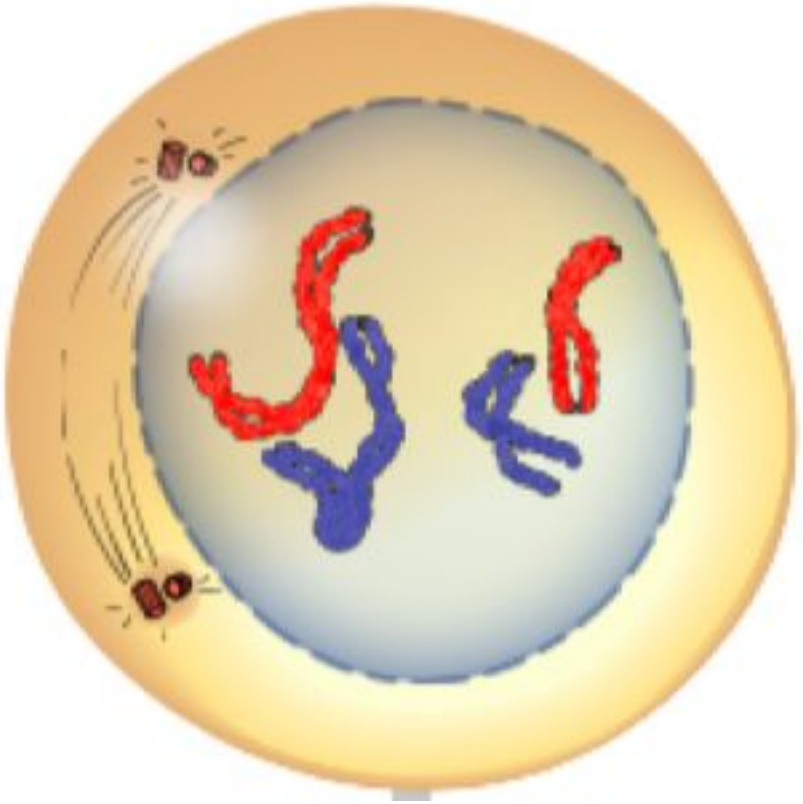
Meiosis Produces Unique Gametes

Cells that produce gametes undergo a type of cell division called *meiosis*

- **Meiosis**: a diploid cell divides twice to produce four haploid cells
- Offspring are genetically different from parents and from one another (gametes from parents are not genetically the same)

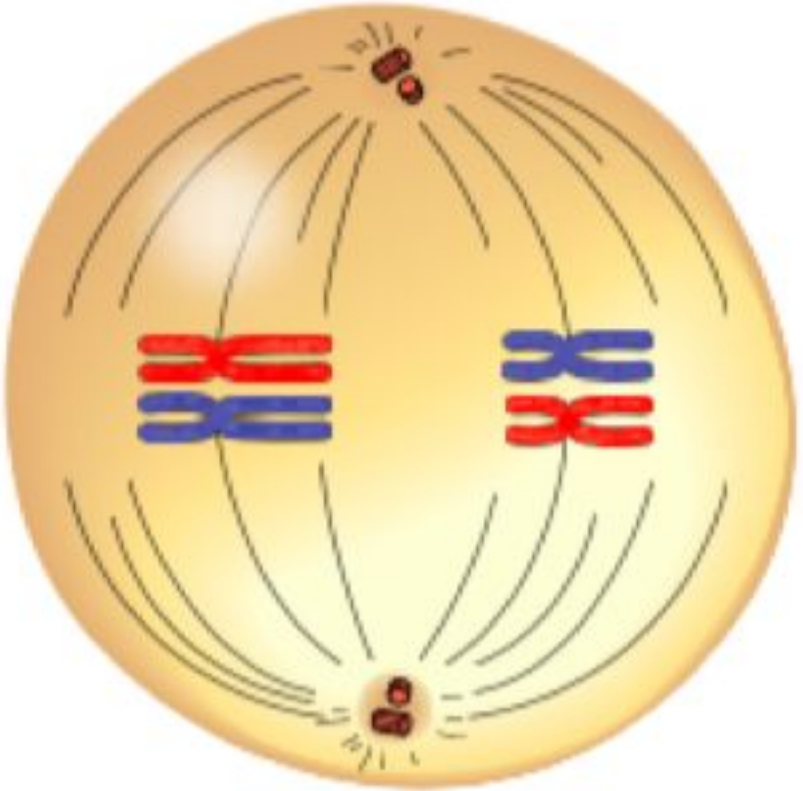
Meiosis: Prophase I

- Nuclear membrane begins to disappear
- DNA condenses into duplicated chromosomes
- Homologous chromosomes are paired



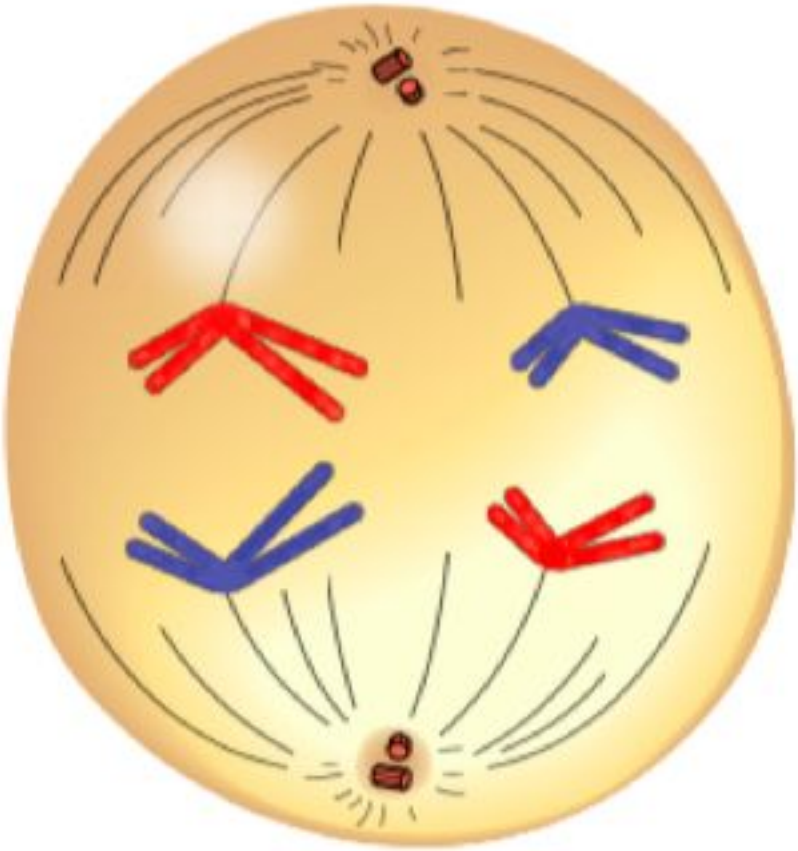
Meiosis: Metaphase I

- Spindle fibres guide chromosome movement
- Homologous chromosome pairs line up along the middle of the cell



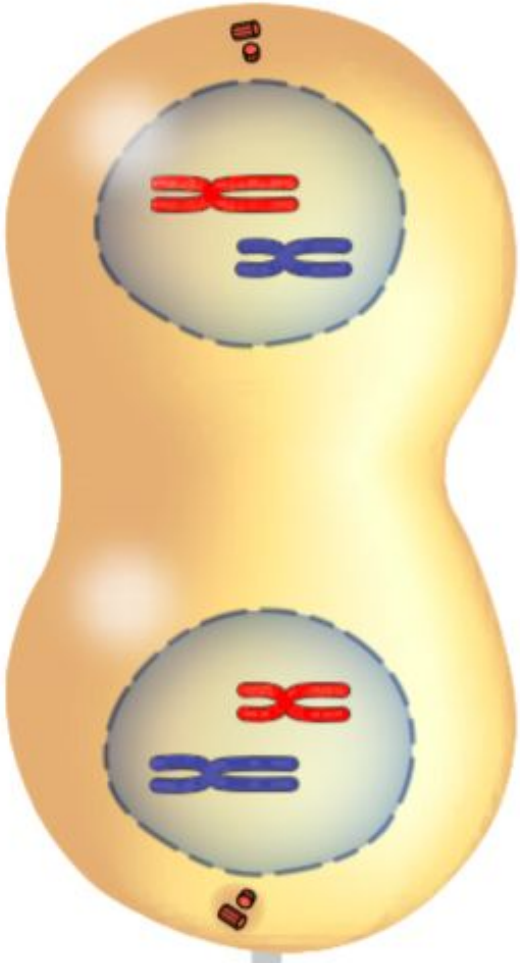
Meiosis: Anaphase I

- Homologous chromosome pairs separate and go to each end of the cell



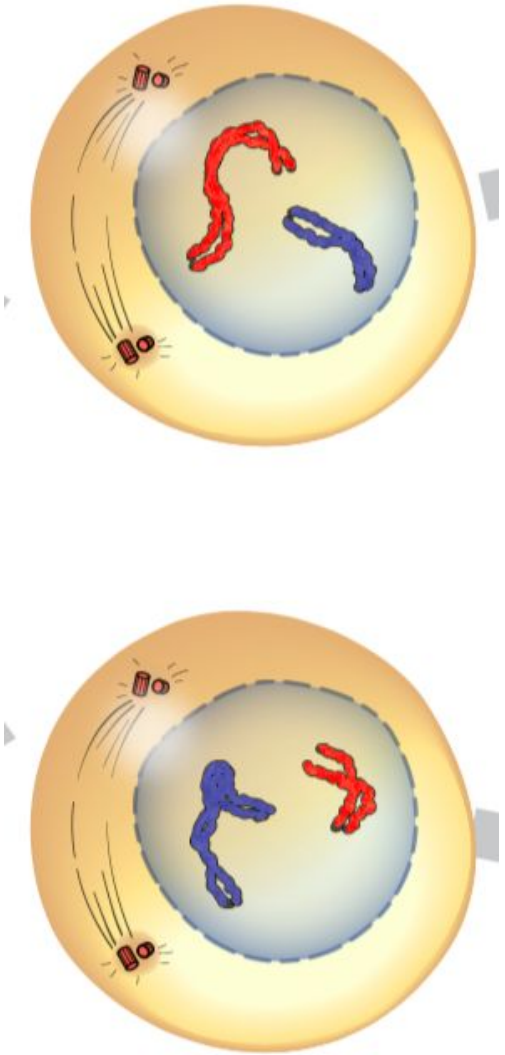
Meiosis: Telophase I

- Two nuclei form
- Each nucleus contains half of the parent cell's chromosomes but still in pairs
- Cell divides, forming two cells



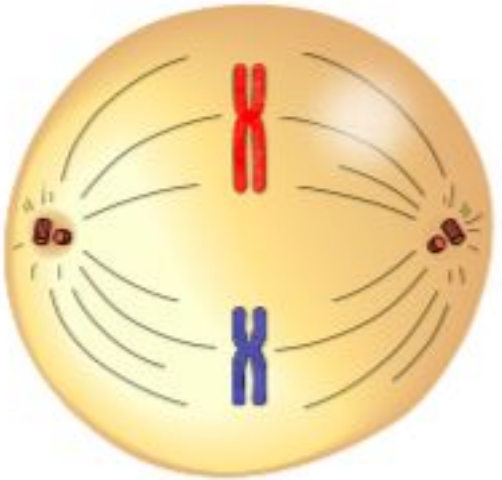
Meiosis: Prophase II

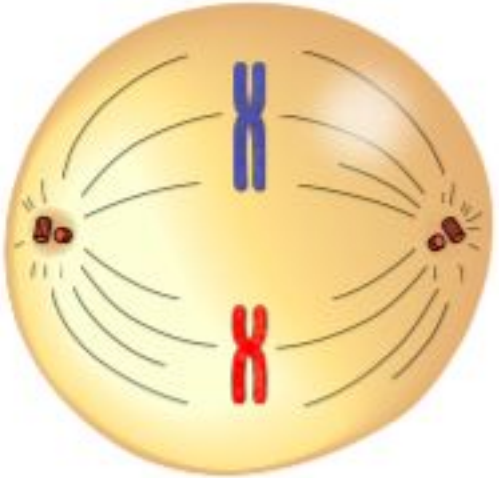
- Nuclear membrane begins to disappear
- DNA exists as chromosomes



Meiosis: Metaphase II

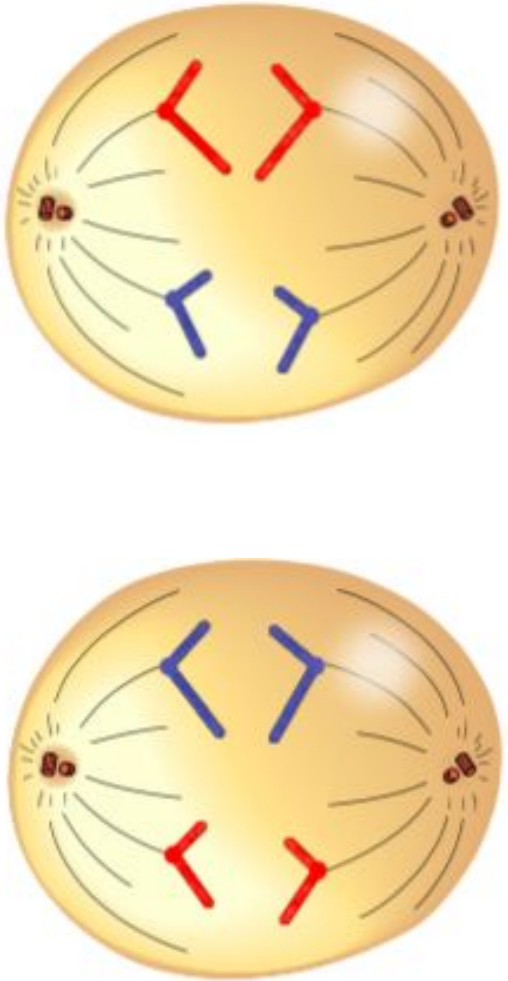
- Chromosomes line up along the middle of the cell





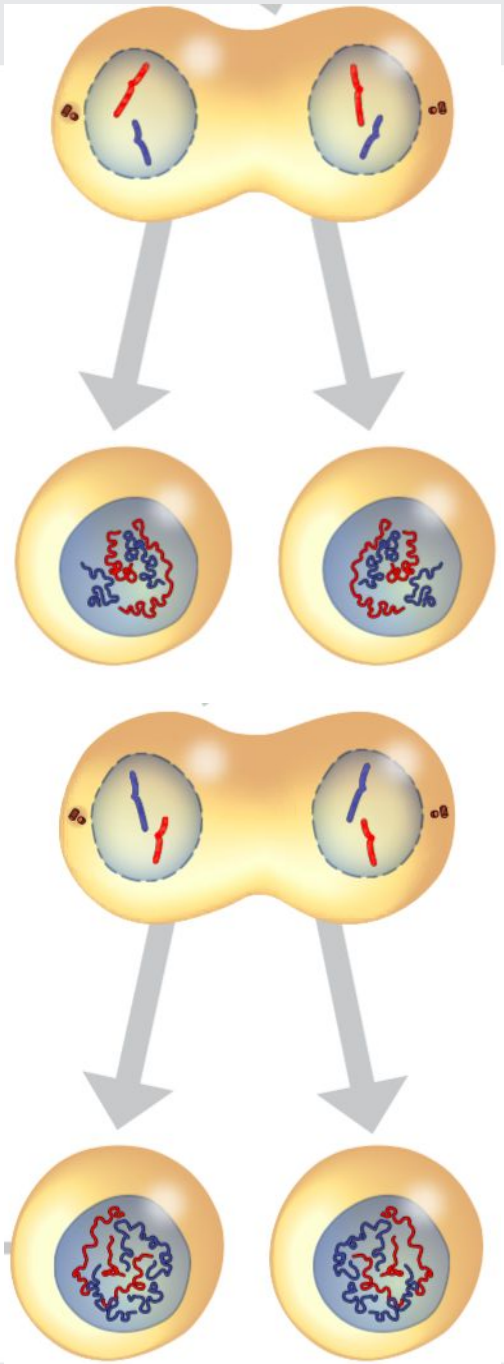
Meiosis: Anaphase II

- Copies of DNA are separated and go to each end of the cell



Meiosis: Telophase II

- Four nuclei form
- Cell divides, forming four new cells
- Daughter cells have one copy of each chromosome (instead of the usual two copies).
- **Whether they have the maternal or paternal version of each is random**



Meiosis: First Cell Division Summary

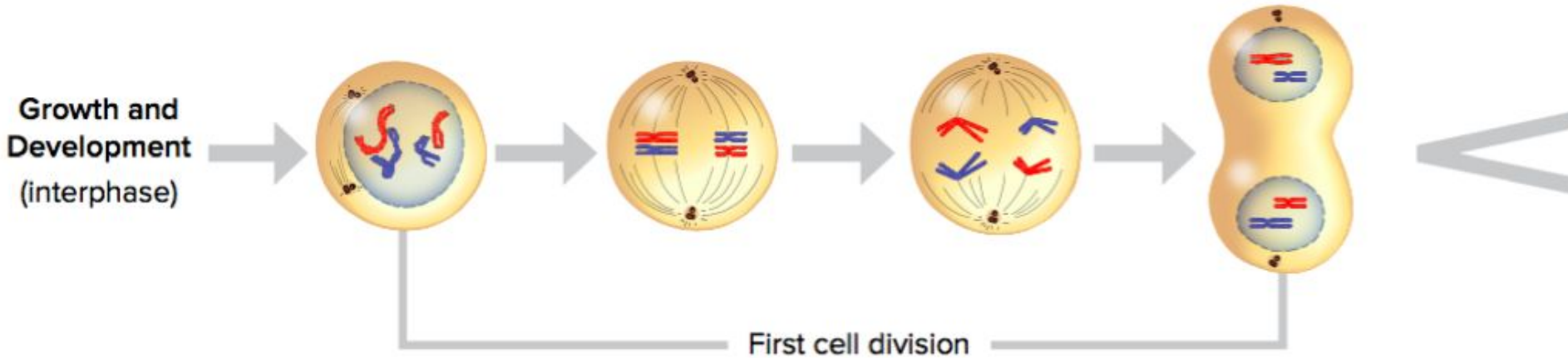
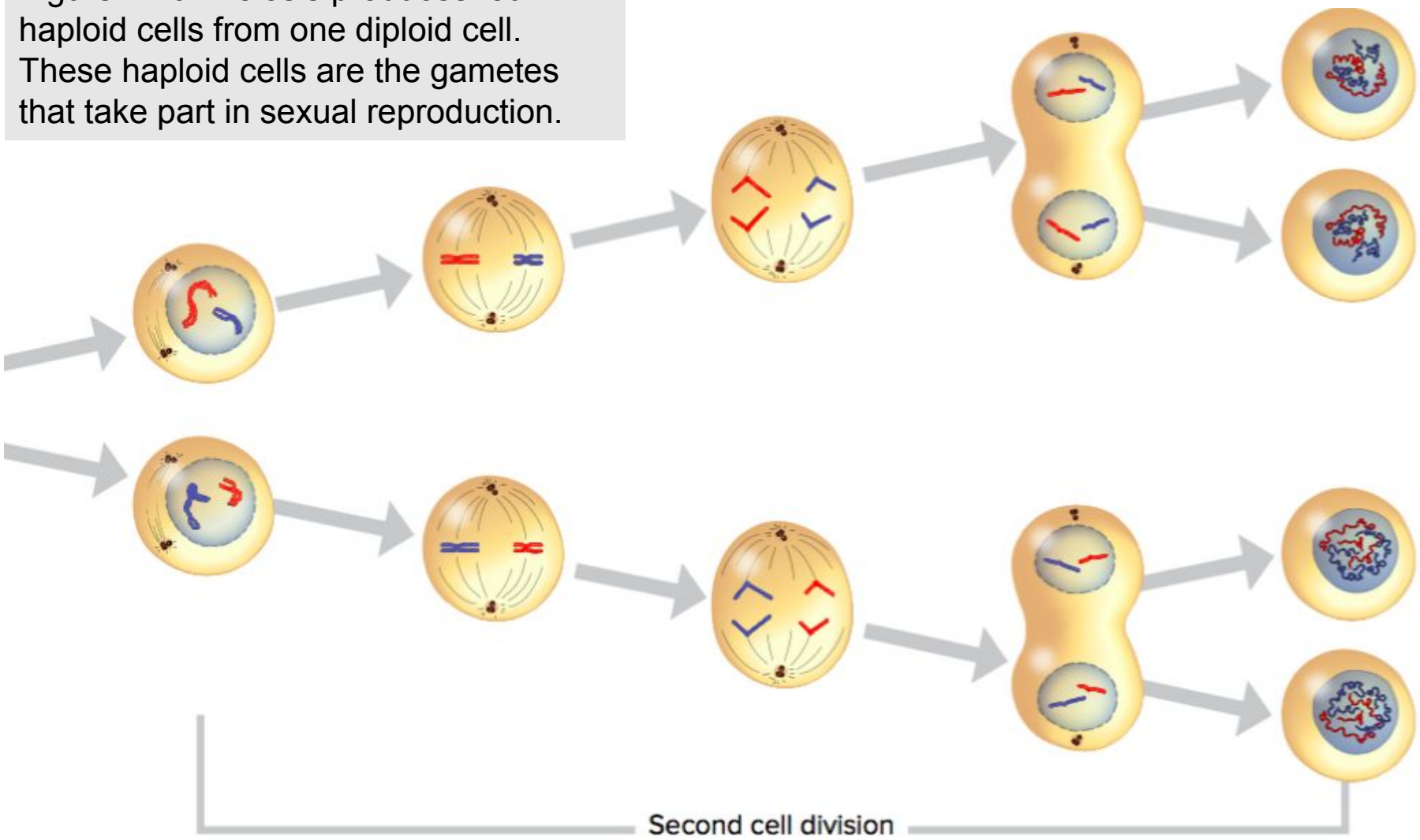


Figure 1.20: Meiosis produces four haploid cells from one diploid cell. These haploid cells are the gametes that take part in sexual reproduction.

Meiosis: Second Cell Division Summary

Figure 1.20: Meiosis produces four haploid cells from one diploid cell. These haploid cells are the gametes that take part in sexual reproduction.



Discussion Questions

1. What role does meiosis play in sexual reproduction?

2. Use a graphic organizer to show how meiosis is similar to and different from mitosis.

Concept 3: Development of the human zygote occurs in stages.

Human *prenatal* (before birth) development begins when fertilization occurs

- Within 30 hours: Zygote divides by mitosis
- Cell division continues rapidly
- Mass of dividing cells travels and implants to the lining of the uterus

Figure 1.21: In the first stages of cell division, the overall size of the zygote stays the same.

Human Prenatal Development: Embryonic and Fetal Stages

- Embryonic stage: 8 weeks
- Fetal stage: 30 weeks
- Total: 38 weeks from fertilization to birth
  - However pregnancy is often measured by doctors from the date of the last menstrual period = 40 weeks

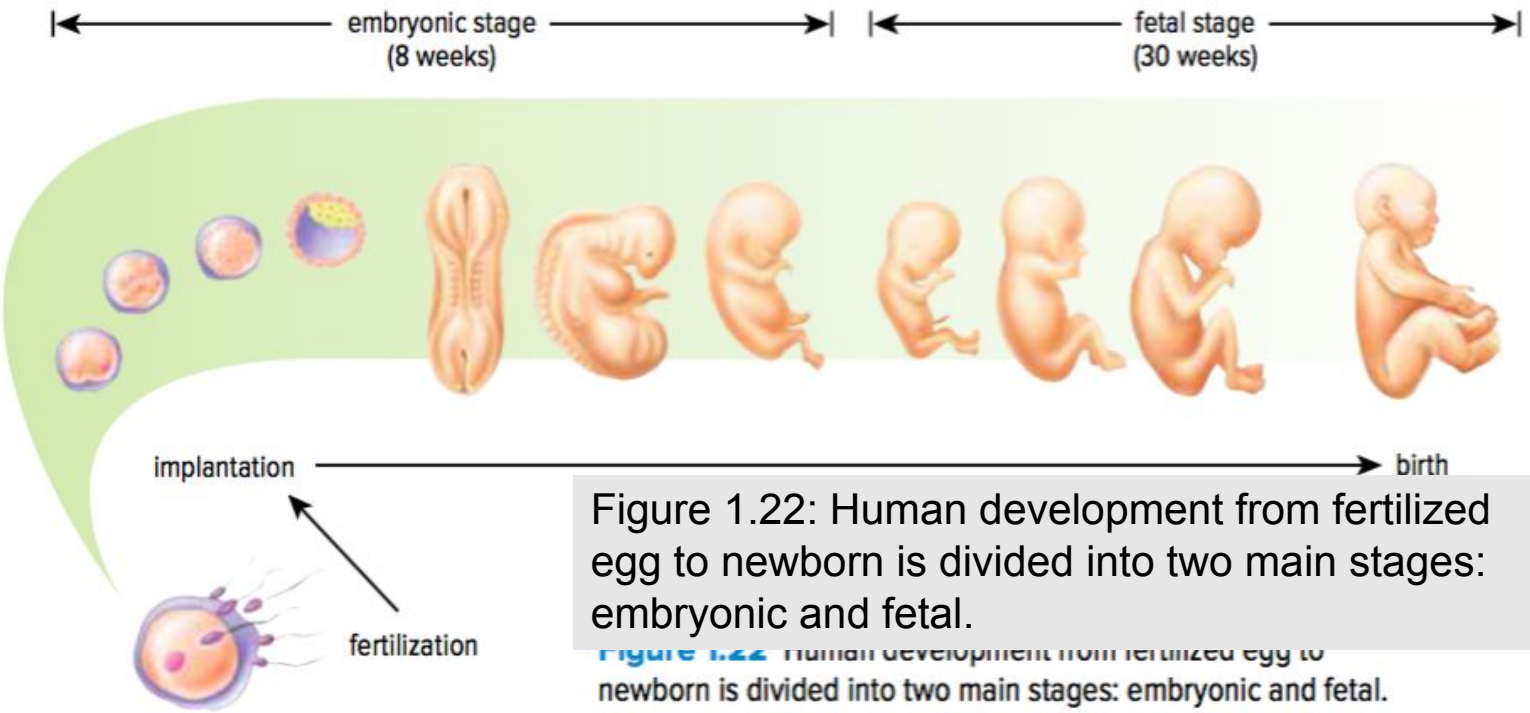


Figure 1.22: Human development from fertilized egg to newborn is divided into two main stages: embryonic and fetal.

Figure 1.22 Human development from fertilized egg to newborn is divided into two main stages: embryonic and fetal.

Human Prenatal Development: Summary

Table 1.2 Human Prenatal Development

Month	Mass at End of Month (g)	Some Key Developments
1	< 1	• Spinal column and central nervous system start to form • Appendages are represented by small limb buds • Heart begins beating (around day 22)
2	1	• Eyes form, but eyelids are fused shut • Brain waves are detectable • Limb buds form paddle-like hands and form ridges
3	30	• Eyes are well developed, but eyelids are fused • Limbs are well-formed, with nails on fingers and toes • Fetus moves but too weakly for mother to feel it
4	100	• Face looks more distinctly human • Heartbeat can be heard with a stethoscope • Scalp begins to grow hair
5	200–450	• Body covered with fine hair (lanugo) • Mother can feel fetal movements • Fetus is now bent forward into "fetal position"
6	500–800	• Eyes are open • Skin is wrinkled, pink, and translucent
7	1100–1350	• Fetus turns to an upside-down position • Fetus can usually survive if born prematurely
8	2000–2300	• Fetus has a "babyish" appearance, with less wrinkled skin
9	3200–3500	• More fat deposits • Nails extend to or beyond fingertips • Birth is imminent

Discussion Questions

1. During which part of human development are cells dividing by meiosis? by mitosis?

2. On page 52, the words *divides* and *multiplies* are both used in describing prenatal development.

   Explain why this isn't as confusing as it might seem at first.

Concept 4: Sexual reproduction takes many forms.

Sexual reproduction can vary based on:

- Reproductive behaviours
- Methods of fertilization
- Ways that offspring develop

Sexual Reproduction Features: Mammals

- Development from fertilized egg to offspring occurs inside the female
- Female is also source of nourishment

Sexual Reproduction Features: Insects

- Reproduction in insects is usually sexual
- Some insects (bees) develop without fertilization:
  - Unfertilized eggs become males
  - Fertilized eggs become females

Sexual Reproduction Features: Fungi

- Fungi (yeasts, moulds, mushrooms) reproduce sexually and asexually

Sexual Reproduction Features: Fish, Frogs, and Birds

- Fertilized eggs develop offspring outside the female's body
- Offspring are released when eggs hatch

Sexual Reproduction Features: Plants

- Plants the grow from seeds require pollination for fertilization
- Pollen (which produces sperm) can be transferred by wind or by animals (bees, birds)

Discussion Questions

1. Identify three ways that sexual reproduction differs in different organisms.

2. What do all forms of sexual reproduction have in common?

Topic 1.3 Summary: How do living things sexually reproduce?

- Male and female reproductive cells combine to produce a zygote.
- Reproductive cells are formed by meiosis.
- Development of the human zygote occurs in stages.
- Sexual reproduction takes many forms.