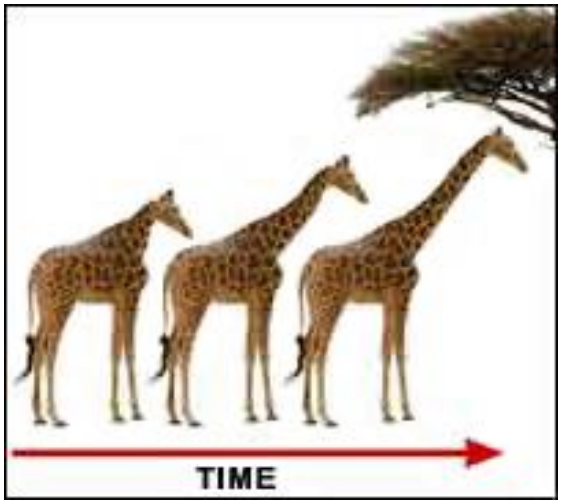
Intermediate Science 9

Unit 4: Reproduction

Section 1- Heredity and Traits

Heredity

Heredity = the process through which patterns of traits are passed on from an individual to it offspring.

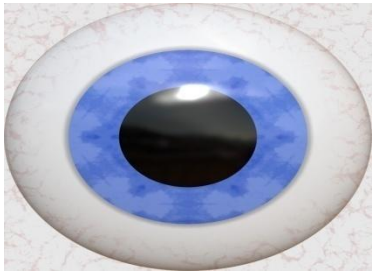


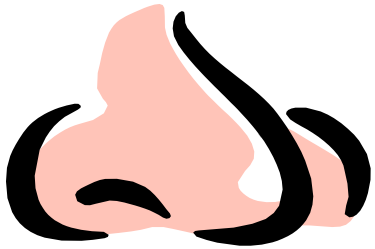
Traits

- **Trait:** a particular feature that can vary in size or form from individual to individual within a species.

Biological traits are inherited from biological parents.

Q: List 5 traits that you have inherited.

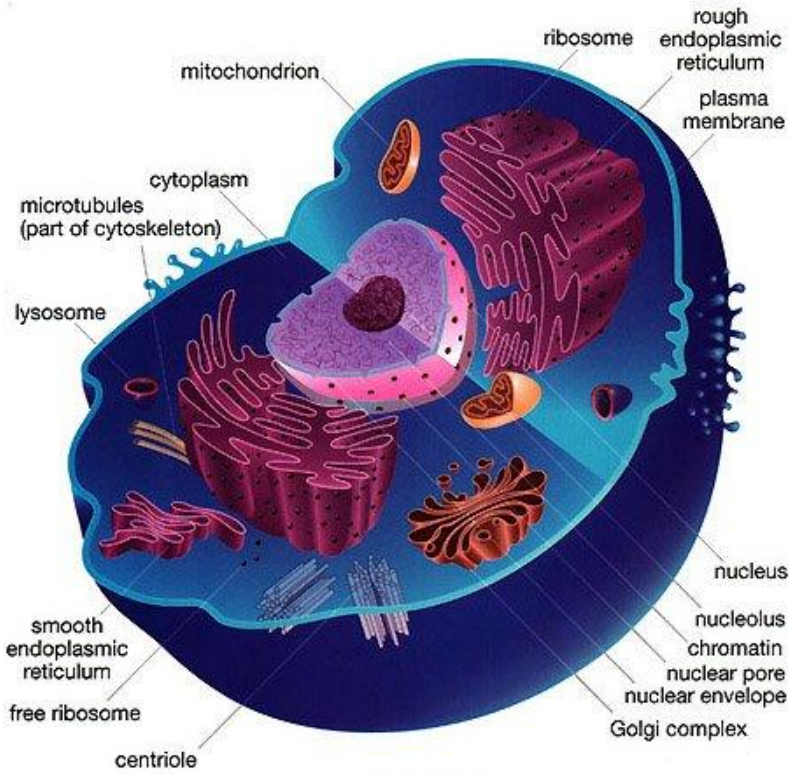


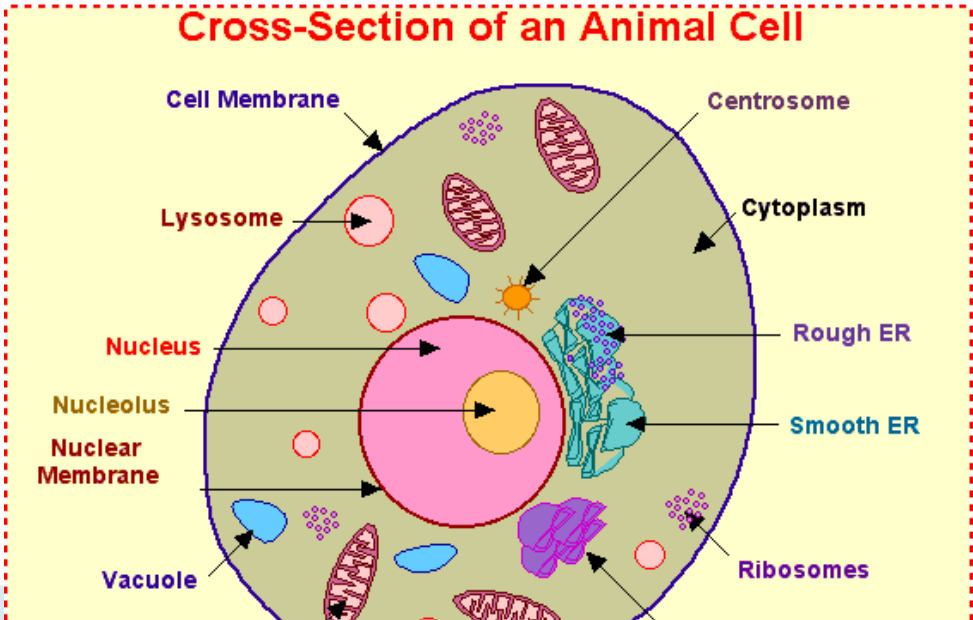


Section 2- The Role of the Nucleus

Cells

Cell : The basic unit of living matter in all organisms

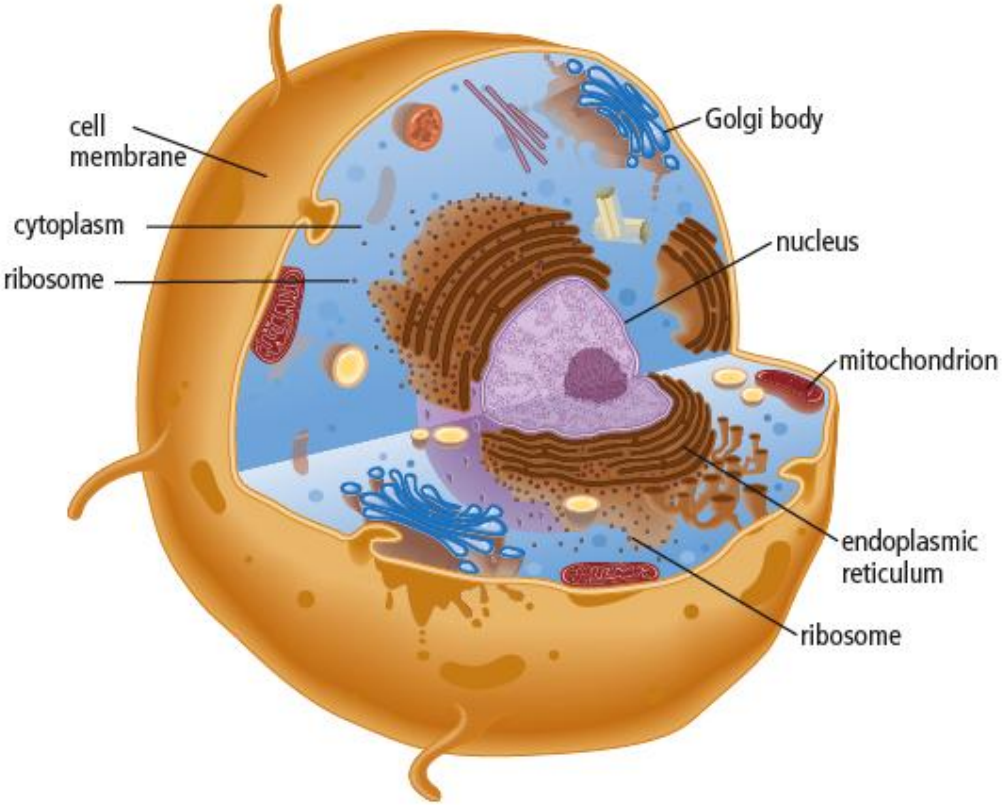




The Function of the Nucleus within the Cell

Animal Cells

Animal cells are equipped with many structures that allow the cell to perform a variety of functions.



See page 122

Cell Parts and Organelles

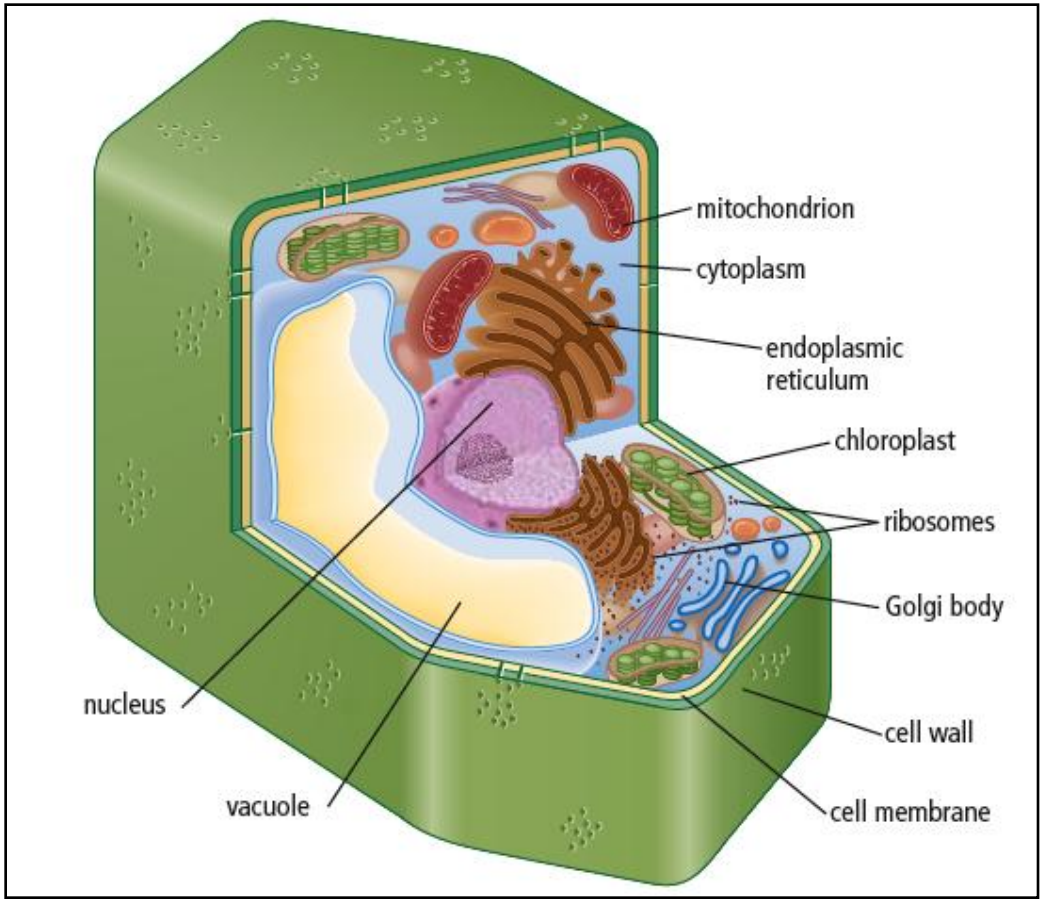
Plant Cells

Plant cells are equipped with some structures that animal cells do not have.

chloroplasts - trap energy from Sun to make glucose, food for the plant

cell wall - tough, rigid structure that surrounds cell membrane, provides protection and structural support

large vacuoles - plant cells are equipped with a large vacuole for storing water



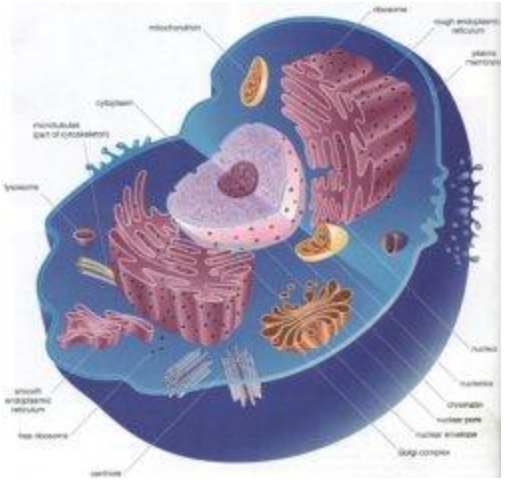
See pages 122 - 124

Function of the Nucleus

Nucleus control centre of the cell

- Also contains information which determines:
  - The type of cell
  - Its function
  - Its growth
  - When it will divide (reproduce)
  - When it will die

Nucleus is responsible for heredity



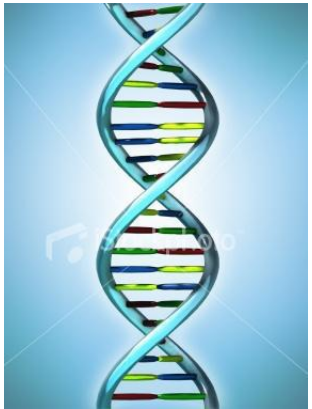
Deoxyribonucleic Acid (DNA)

Found in the nucleus.

A long, double-stranded molecule.

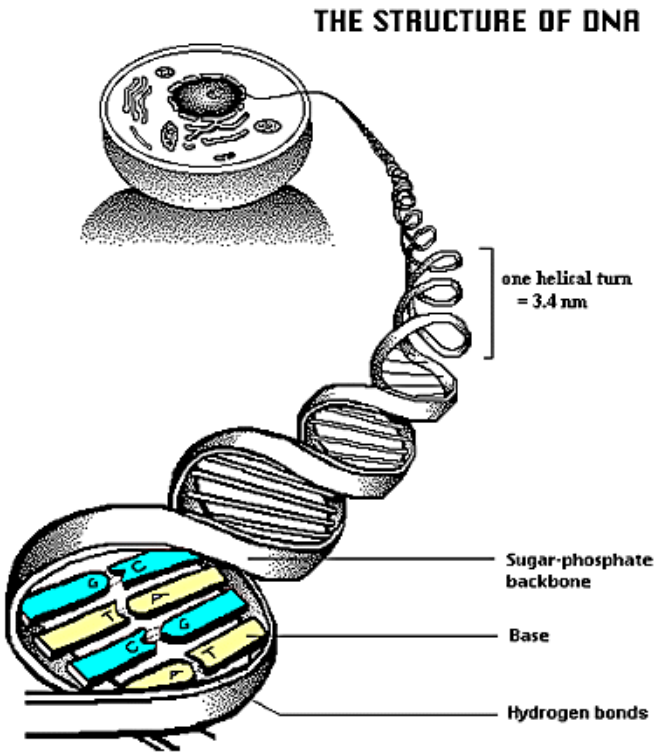
Forms a helix structure (a twisted ladder).

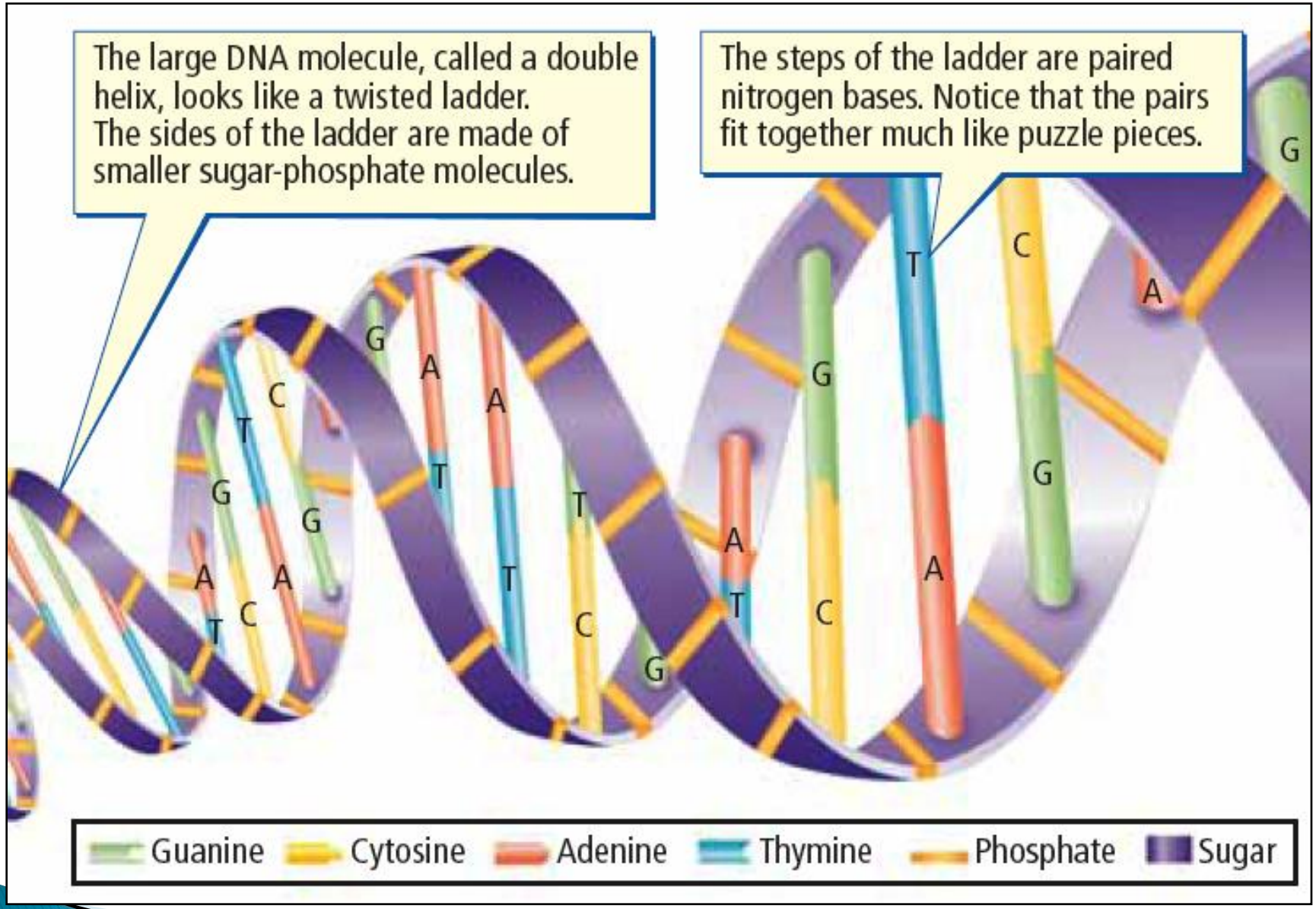
Contains ALL the instructions necessary for ALL life on earth.



Structure of DNA

- The sides of the DNA ladder are made of sugar and phosphate.
- The steps are made up of four nitrogen bases.
- 1. **adenine (A)**
- 2. **guanine (G)**
- 3. **cytosine (C)**
- 4. **thymine (T)**

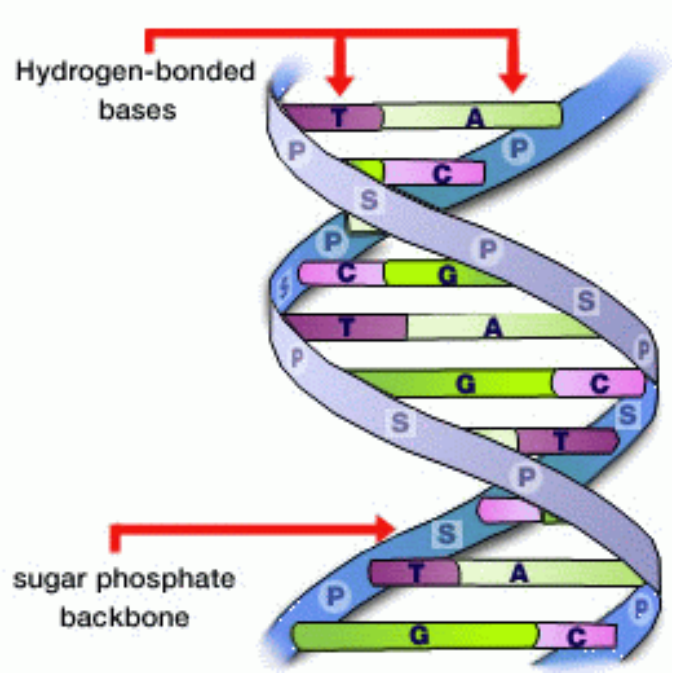



The large DNA molecule, called a double helix, looks like a twisted ladder. The sides of the ladder are made of smaller sugar-phosphate molecules.
The steps of the ladder are paired nitrogen bases. Notice that the pairs fit together much like puzzle pieces.
Guanine
Cytosine
Adenine
Thymine
Phosphate
Sugar

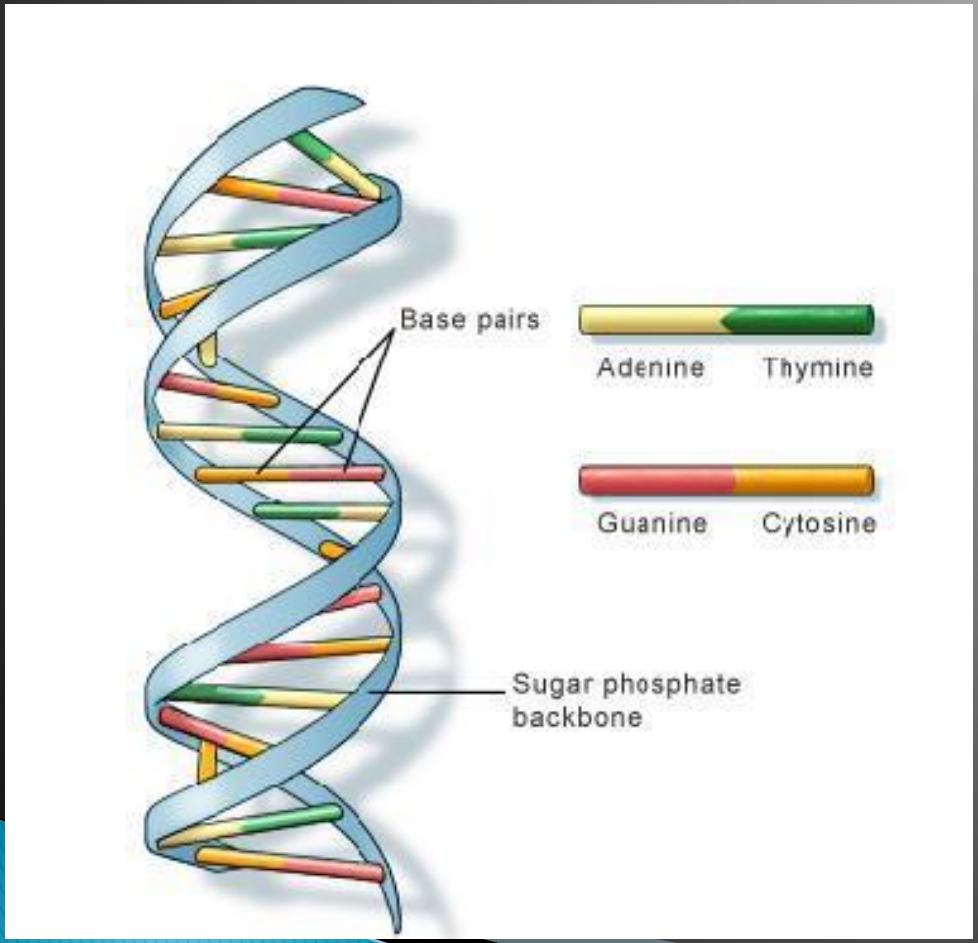
Base Pairing Rules

- The bases in a DNA molecule always join in a specific way:
  - A always joins with T
  - G always joins with C

- This is called Chargaff's Rule



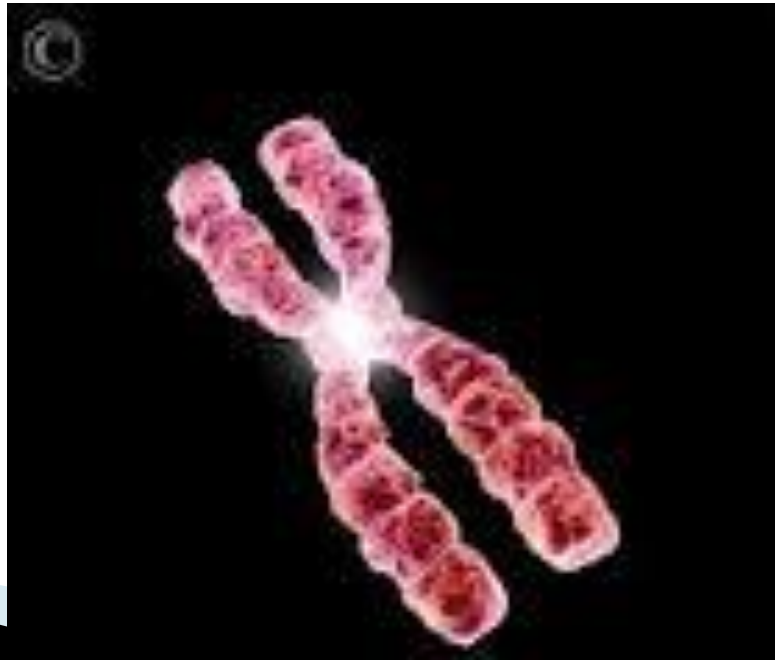
Base Pairing Rules cont…



- Q: What would one side of the DNA molecule read if the other side was:
- A T C C G G A T A C G C

Chromosomes

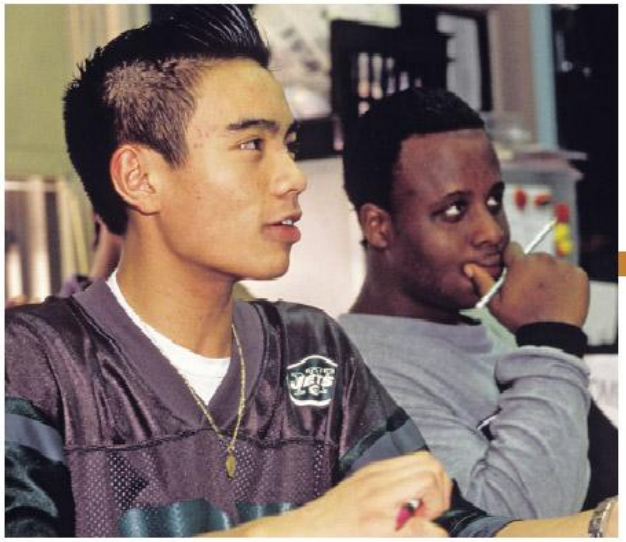
- DNA is found in structures call **chromosomes**.
- When a cell is ready to divide, each strand of loosely coiled DNA folds up further into a compact, X-shaped structure called a chromosome.

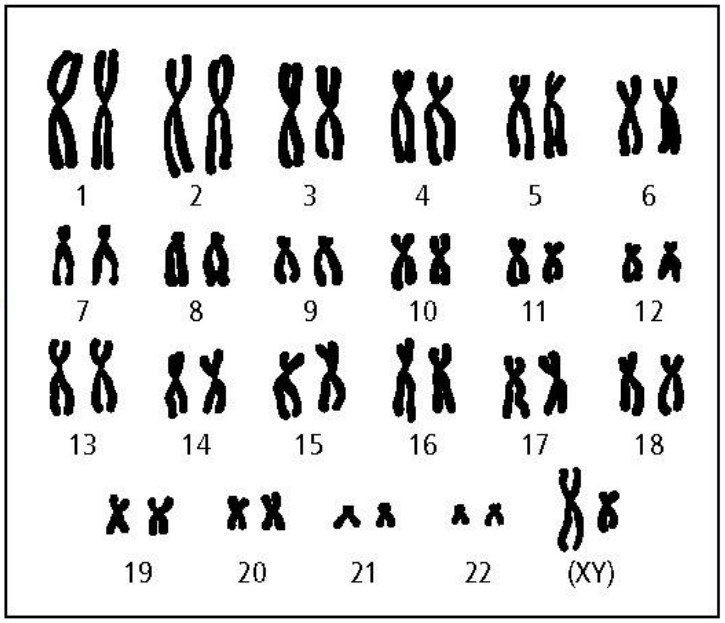


Chromosomes cont…

- Chromosomes within the nucleus are found in pairs.
- Most humans have 23 pairs of chromosomes including one pair that determines gender.
- Q: What is the total number of chromosomes in a human cell?
- Q: Would you expect a butterfly to have more of less chromosomes than a human?

Human vs. Drosophila





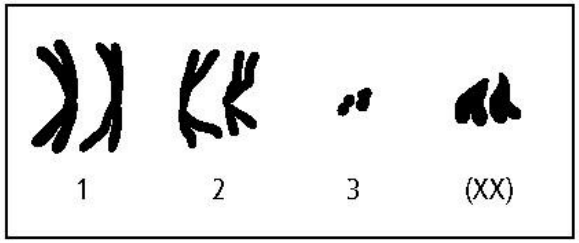


Figure 4.8 The chromosomes of a human cell compared with the chromosomes of a fruit fly cell

Genes

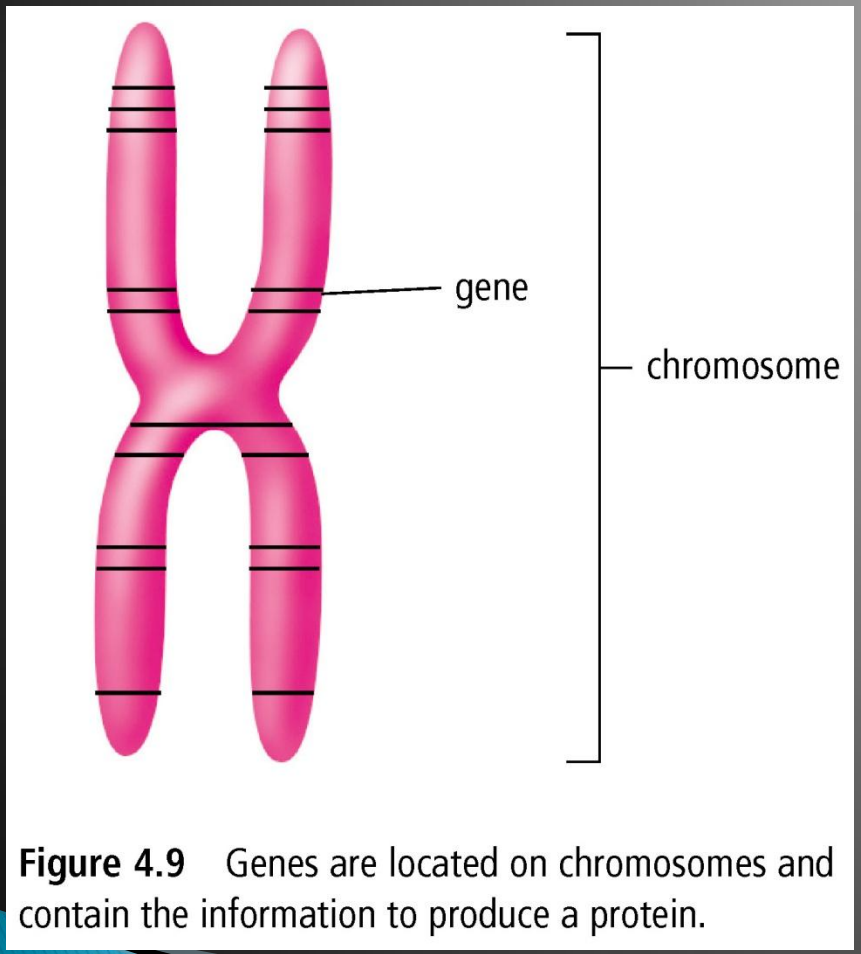


Figure 4.9 Genes are located on chromosomes and contain the information to produce a protein.

- found on chromosomes.
- small segments of DNA located at specific places on a chromosome.
- store information needed to produce proteins used by body cells.
- How many genes would fit along a chromosome?

Genes cont…

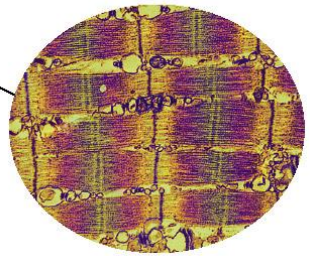
- Genes can vary in length from hundreds to thousands of bases.
- The arrangement of bases will determine the protein produced.
- Each chromosome contains thousands of genes.

From gene to protein

- Proteins determine what body cells will become and how they will function.
- Specialized cells will form tissues; tissues will form organs.

Cells in the retina of the eye produce proteins so this skier can see.

Cells in the stomach produce proteins so this skier can digest food.

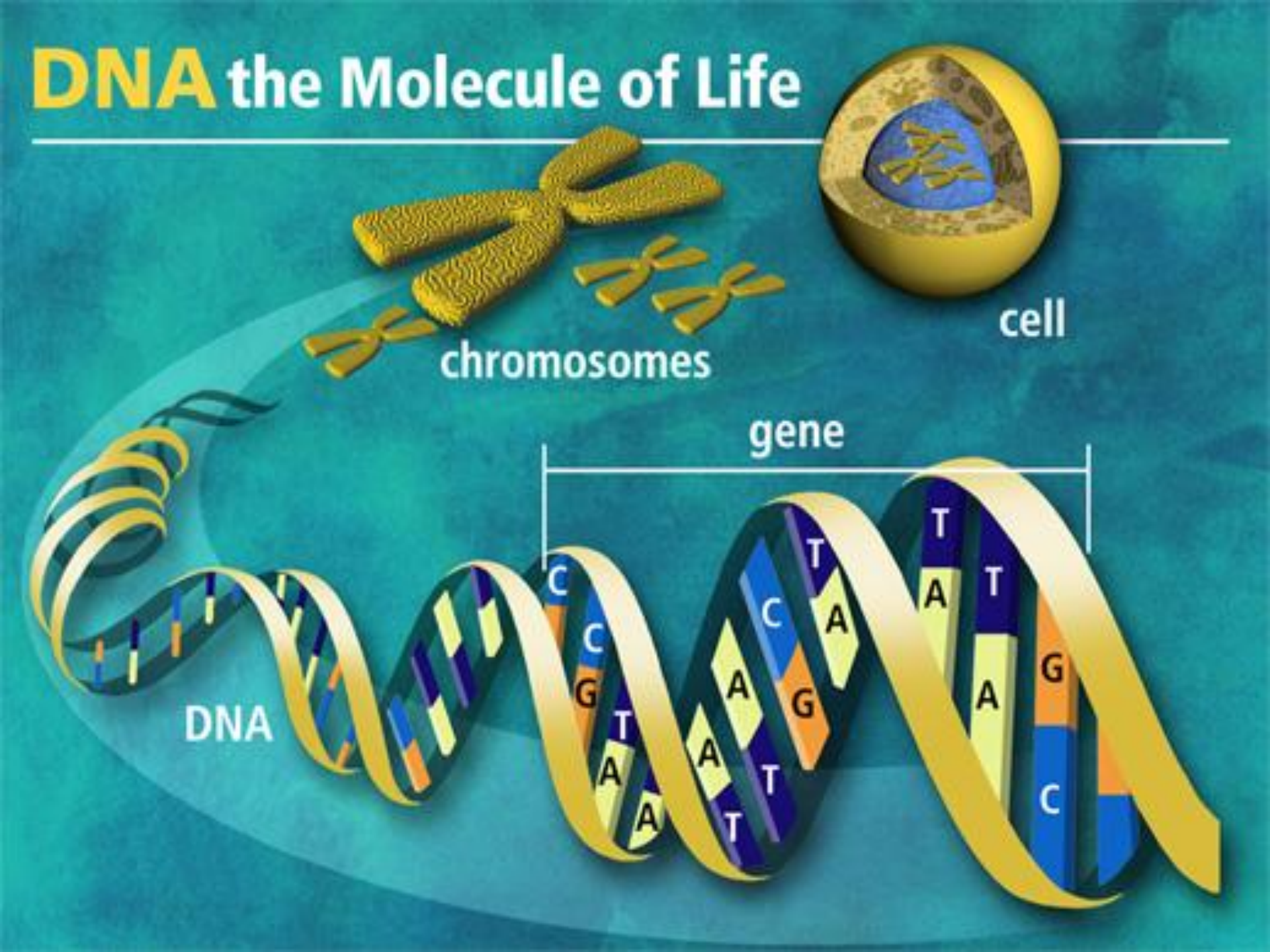


Cells in the muscles of this skier's legs prod proteins so she can ski.

Figure 4.11 Although every cell in your body contains the same genes, only certain genes will be read to produce specific proteins, as shown in the three examples on the right.

What is the difference between a gene and a chromosome?

- Genes can be composed of hundreds or thousands nitrogen bases.
- Produces a particular trait.
- Each **chromosome** is made up of thousands of genes.
- Therefore, can produce thousands of traits.


DNA the Molecule of Life
chromosomes
cell
gene
DNA
C
C
G
T
A
A
A
T
A
G
C
T
T
A
T
A
T
G
A
C

Section 3- Gene Mutation

Gene Mutation

- A gene mutation is a change in the specific order of the bases that make up a particular gene.
- A base may be:
  - Added
  - Deleted
  - Substituted for another

A Drastic Visual Mutation

- Do you think this mutation will affect the mutated bear's chances of survival.

Figure 4.12 This white kermode bear is an example of a mutation in the gene for coat colour.

Effects of Mutations

- 1. Positive Mutation
  - Benefits an individual
    - Ex. Resistance to disease

Figure 4.14 The plant on the far left has a positive mutation, which protects it from getting the disease affecting the other three plants.

- 2. Negative Mutation
  - Harms the individual
  - Reduce the probability that the individual will produce offspring or survive in their environment.

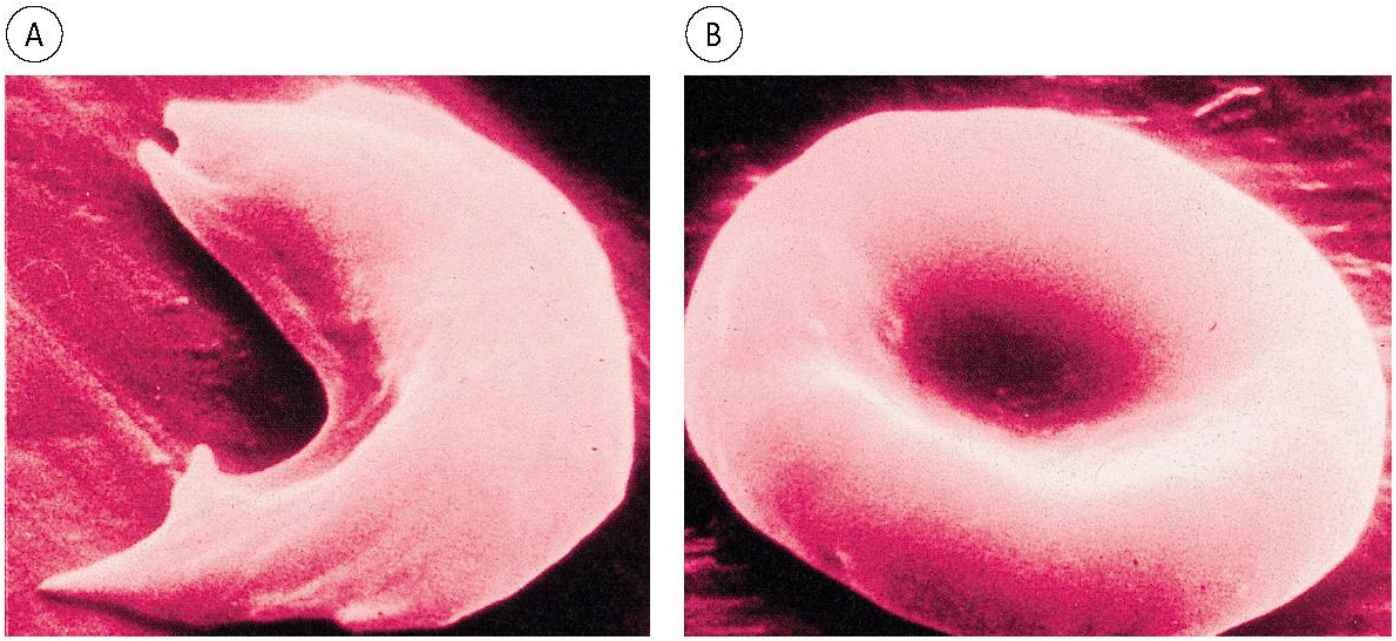


Figure 4.15 People who carry the sickle cell gene have red blood cells that are C-shaped (A). Normal red blood cells are disc-shaped (B).

- 3) Neutral Mutation
  - Does not affect the individual
    - Ex. Coat Color

Mutagens

- Substances or factors that can cause mutations in DNA.
  - Ex. Cigarette smoke, X-rays, pollutants
- Nature
  - Ex. Solar radiation
  - Radioactive gases
- Human Activity
  - Ex. Chemicals
  - Nuclear Radiation

Mutagens & Mutation Repair

- Mutagens are substances or factors that cause mutations

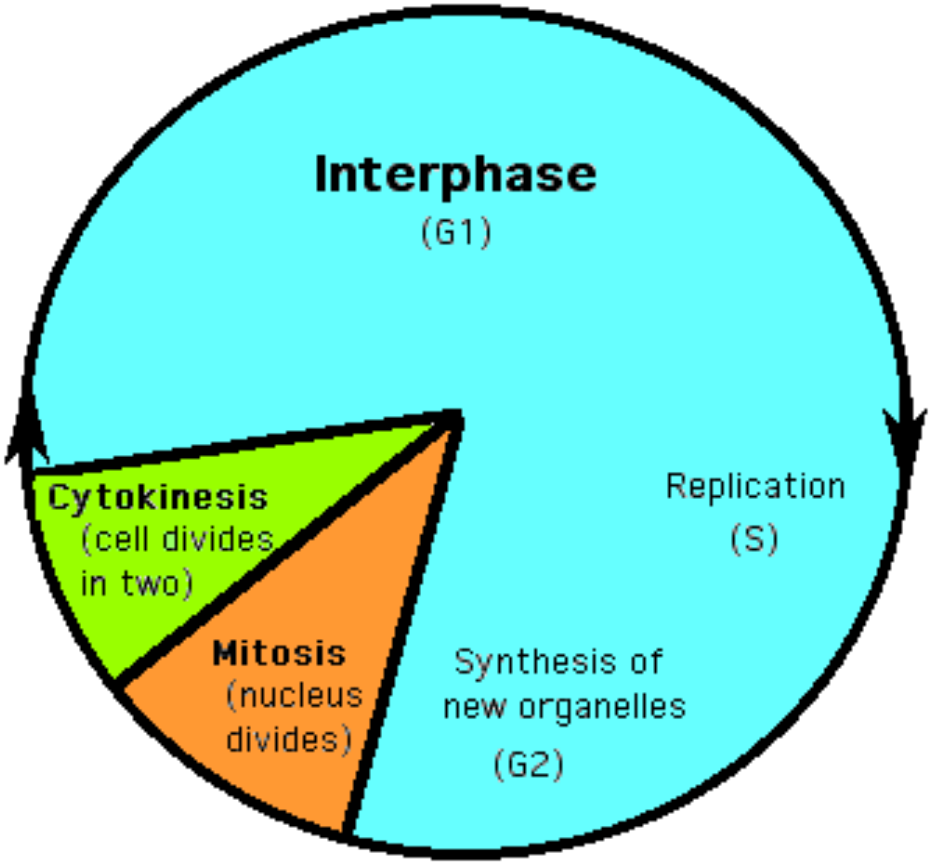
- Environmental mutagens such as mercury, cigarette smoke, X-ray and UV radiation, and certain viruses can cause mutations

- Correcting mutations is difficult, but new techniques such as **gene therapy** offer hope.

Section 4- The Cell Cycle

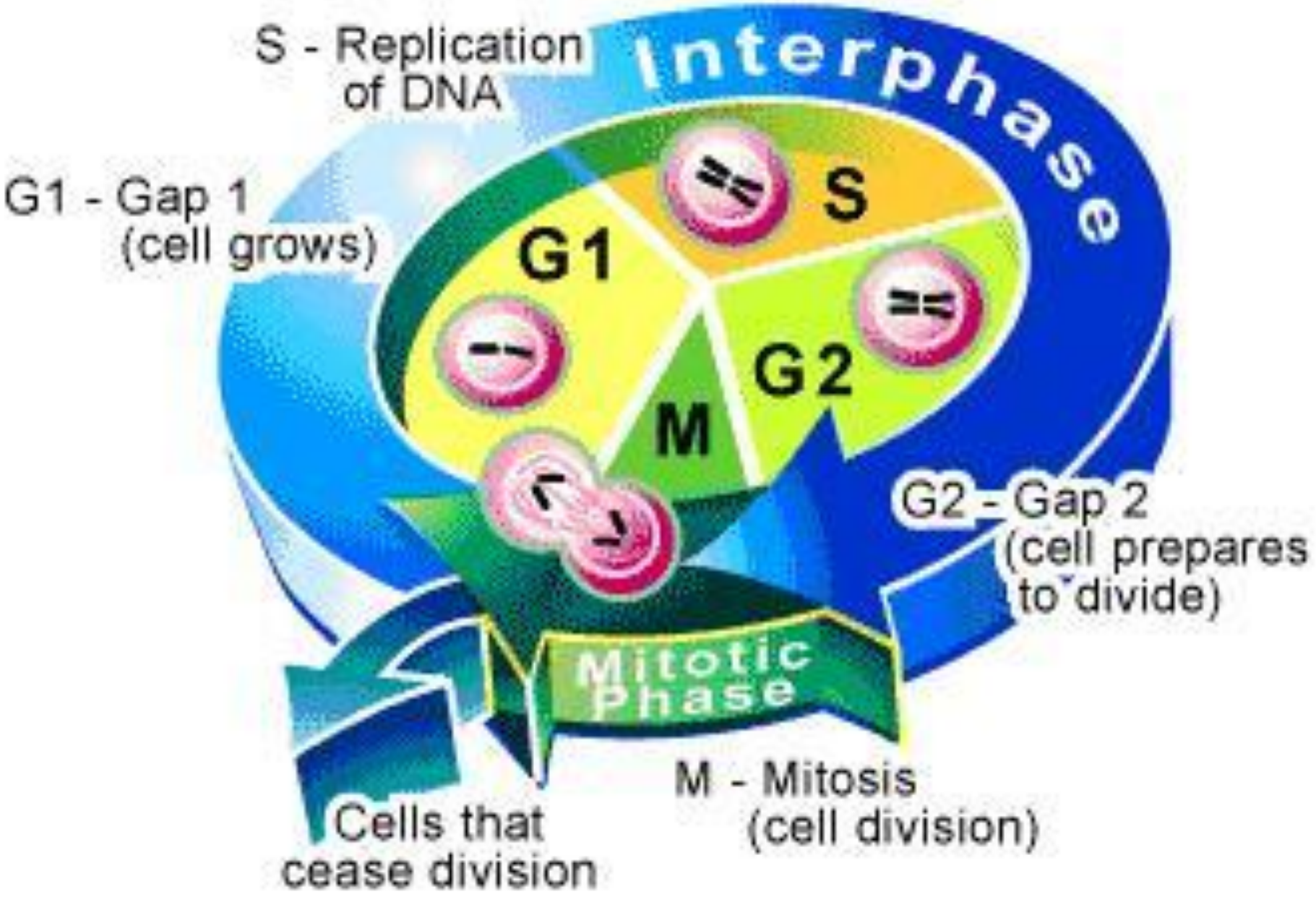
Cell Cycle

- Divided into three stages
  - Interphase
  - Mitosis
  - Cytokinesis



Interphase

- Longest stage of the cell cycle
- Carries out its functions
  - Example: stomach cells are making enzymes needed to digest food
- 3 phases
  1. G1 –Growth and Preparation
  2. S– Replication
  3. G2–Continued Growth and Preparation

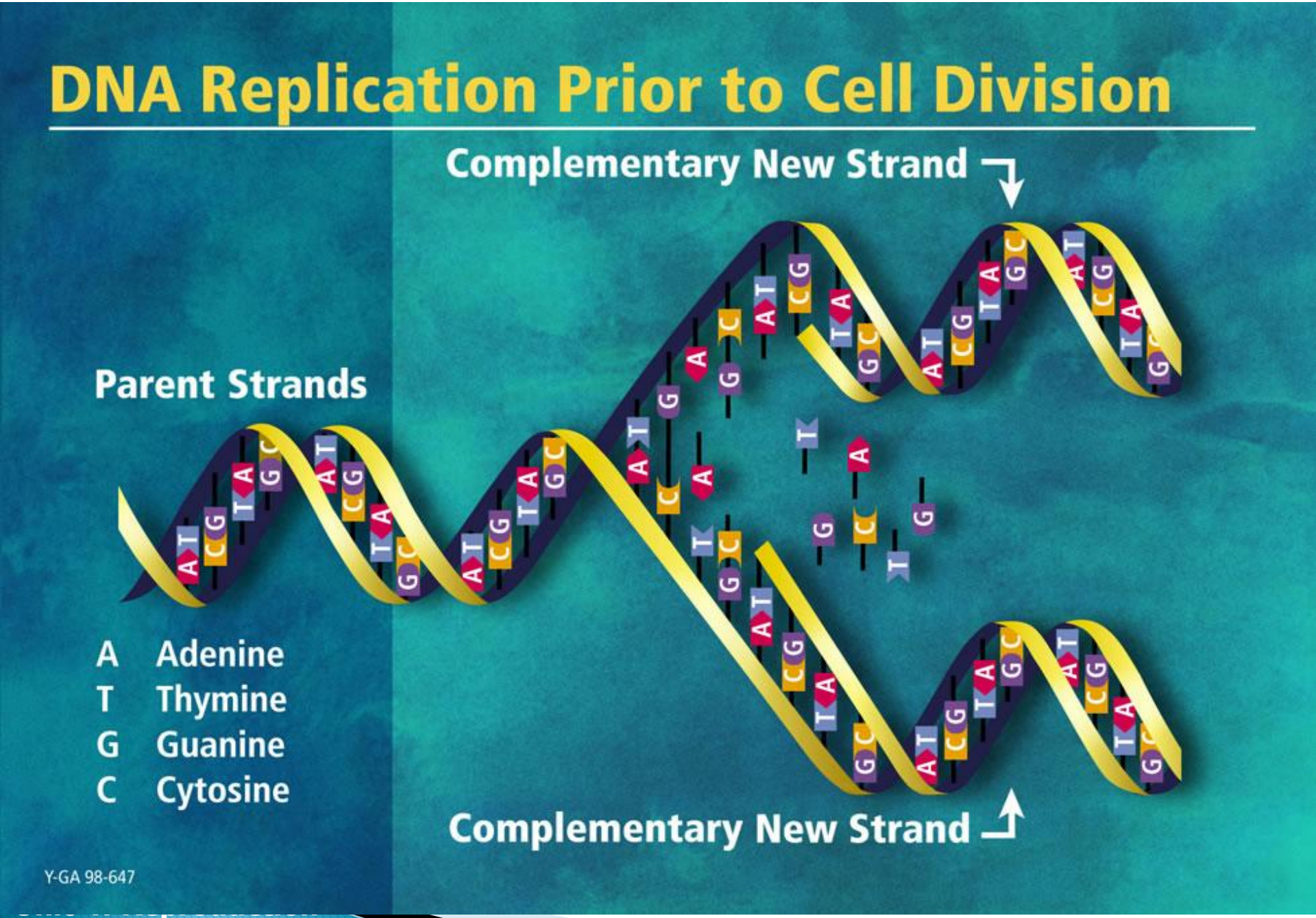

S - Replication
of DNA
Interphase
G1 - Gap 1
(cell grows)
G1
S
G2
M
G2 - Gap 2
(cell prepares
to divide)
Mitotic
Phase
M - Mitosis
(cell division)
Cells that
cease division

Interphase

- Cell increases in size
- Makes the proteins and molecules needed for the cell to function

Interphase

- DNA copies itself
- Cell temporarily has two sets of DNA
- To replicate itself the DNA molecule unwinds and the steps of the ladder break apart.

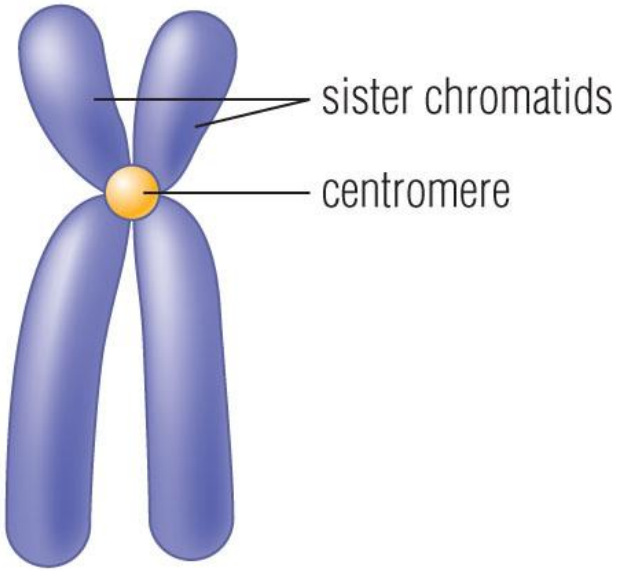

DNA Replication Prior to Cell Division
Complementary New Strand
Parent Strands
A Adenine
T Thymine
G Guanine
C Cytosine
Complementary New Strand
Y-GA 98-647

Interphase

- Cell continues to grow and prepare for mitosis.
- DNA is in a loosely coiled form
- Organelles such as mitochondria and chloroplasts will be duplicated

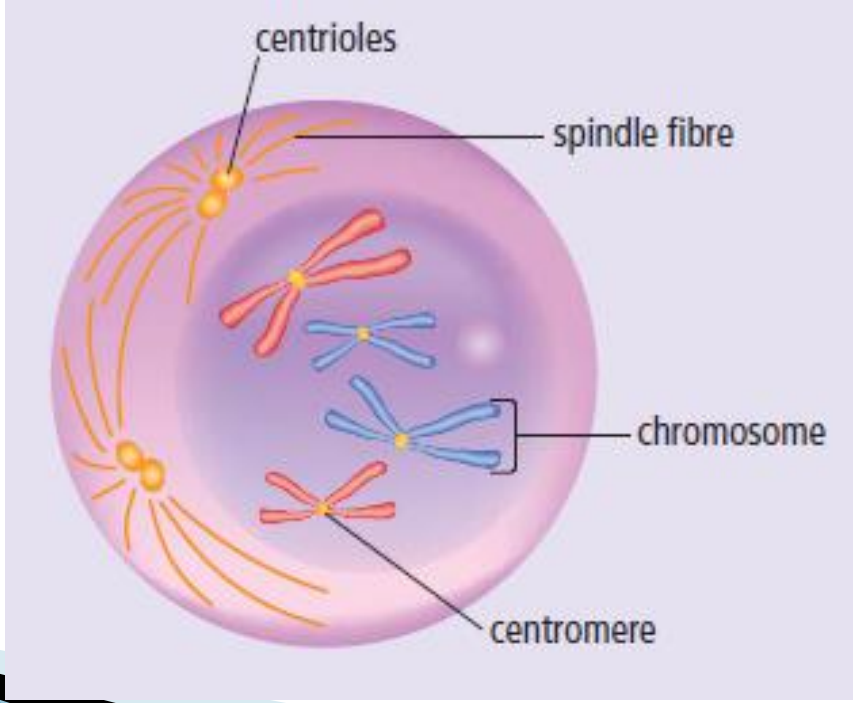
Mitosis

- Second Stage of the cell cycle
- Usually the shortest stage
- Process when the contents of a cell's nucleus divide.
- Division results in two daughter cells identical to the parent cell.



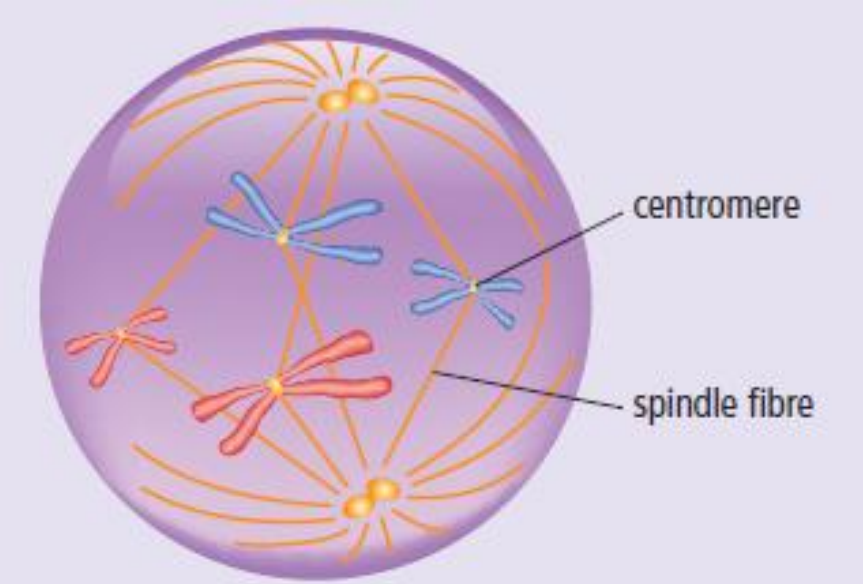
Mitosis

- Chromosomes pair up into X shaped structures. Protein fibers known as spindle fibers begin to form.



Mitosis

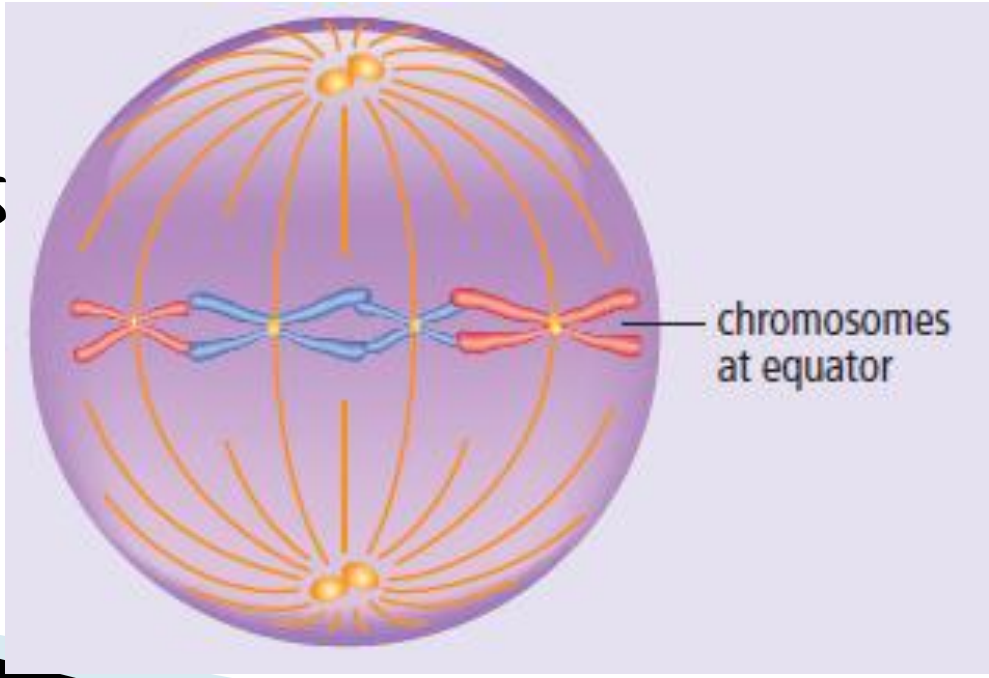
- Protein fibers complete forming
- Attach to the chromosomes at a point called the centromere
- Nuclear membrane breaks down



Mitosis

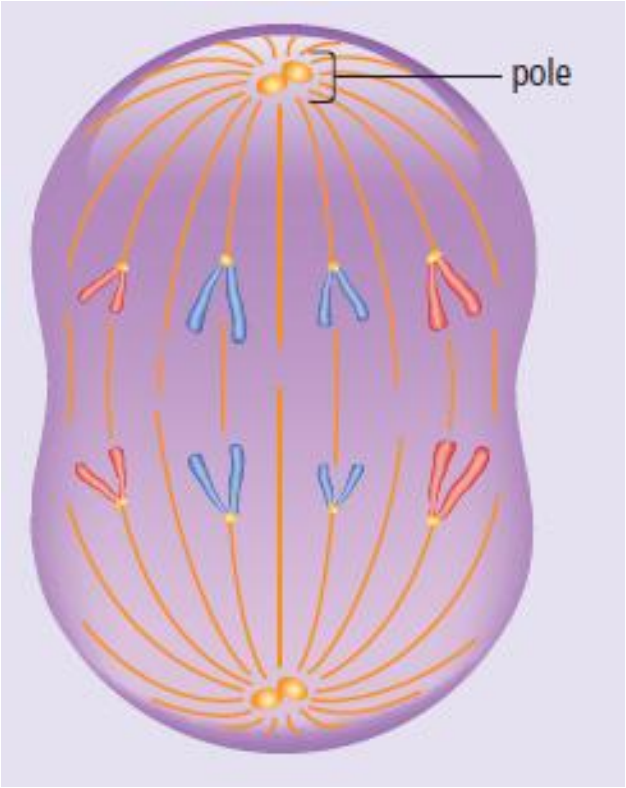
- Chromosomes are pulled to the middle (equator) of the cell.

Chromosomes line ∪



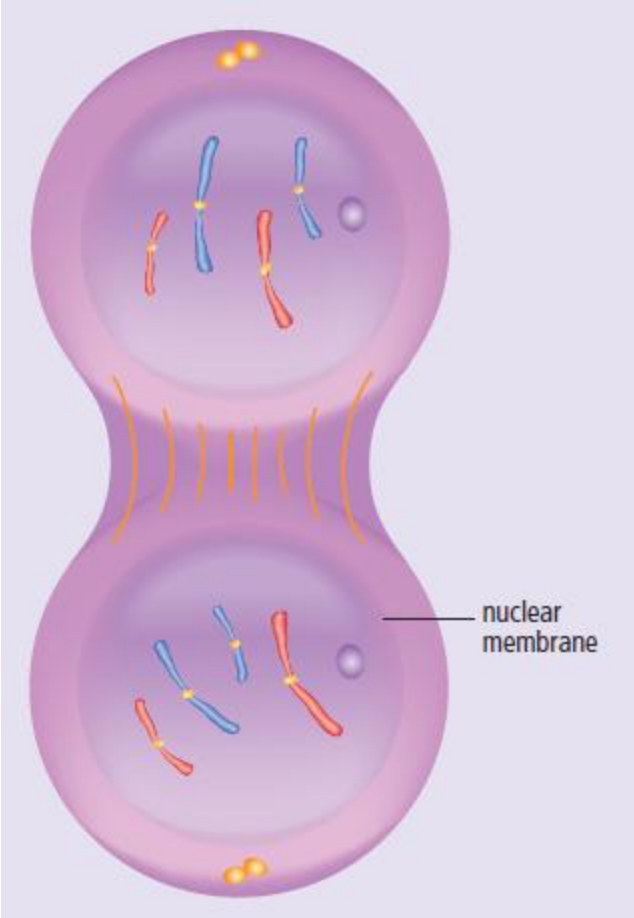
Mitosis

- Protein fibers contract and pull the chromatids to opposite poles of the cell.



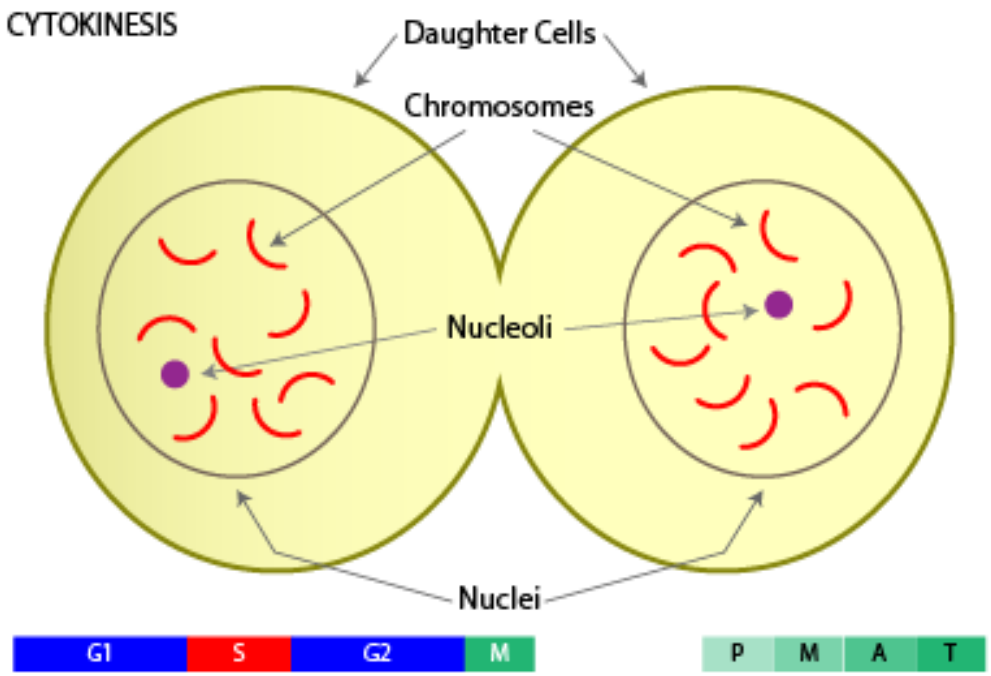
Mitosis

- One complete set of chromosomes is now at each pole of the cell
- Nuclear membrane forms around each set of chromosomes.
- Now there are two nuclei in one cell



Cytokinesis

- Final stage of the cell cycle
- Cell membrane pinches together to divide the cell's cytoplasm and organelles.



Checkpoints

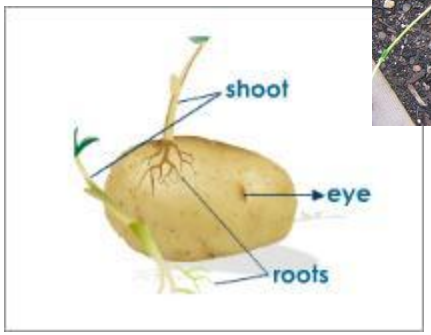
- Checkpoints in the cell cycle monitor cell activities and instructs the cell whether or not to divide.
- Cells will not divide if:
  - There are not enough nutrients to support cell growth.
  - DNA within the nucleus has not been replicated
  - DNA is damaged.

Section 5- Asexual Reproduction

Asexual Reproduction

- Only one parent is required to produce offspring.
- Offspring look identical to the parent
  - Can you name some organisms which reproduce through asexual reproduction?

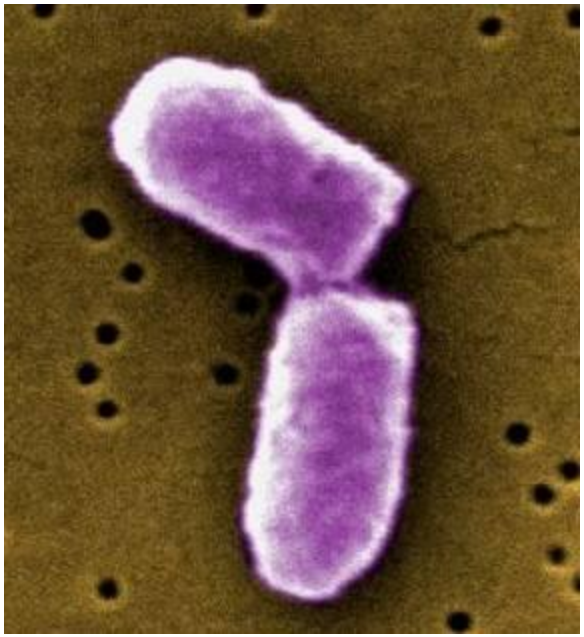
•Bread Mould
•Trees
•Potatoes
•Tulip bulbs



Types of Asexual Reproduction

- **1) Binary fission**
- A single parent cell reproduces itself and divides into two equal parts
  - Example: Amoeba and Bacteria

E Coli Bacteria



Types of Asexual Reproduction

- **2)Budding**
- Occurs when part of the cell pushes outward to form a growth or bud.
- Pinches off from the parent cell to form a new organism identical to the parent.
  - Example: yeast, hydra, sponges

Types of Asexual Reproduction

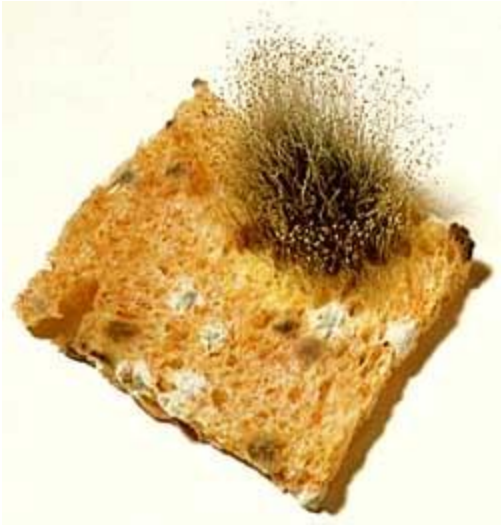
- **3)Fragmentation**
  - Some animals can reproduce asexually from fragments
  - Example: Starfish, Japanese Knotweed

Types of Asexual Reproduction

- **4) Vegetative Reproduction**
- Occurs when special cells, usually in the stems and roots divide repeatedly to form structures that will develop into a new plant.

Types of Asexual Reproduction

- **5) Spore Formation**
- A spore is a reproductive cell that grows into a new individual by mitosis. Ex: Bread Mould
- Spores are lightweight and rely on wind and water to carry the spores away from the parent.
  - Why is it important to carry the spores away from the parent?



Section 6- Meiosis is the basis of sexual reproduction

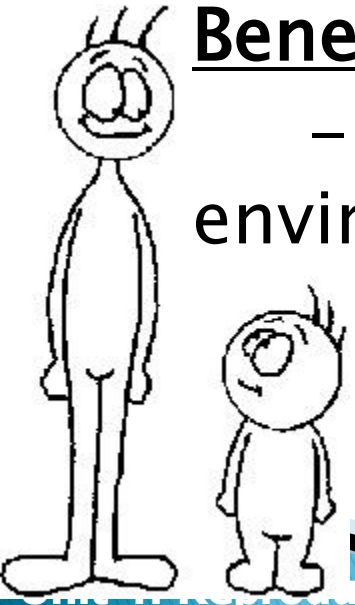
Sexual Reproduction

In chapter 5 you have learned that through *asexual reproduction* one parent can produce genetically identical offspring.

Sexual reproduction – Requires two parents and produces genetically different offspring. This results in *genetic diversity* within the species.

Genetic Diversity

- Offspring's DNA slightly different than parents because of the combination of genes received from each parent during sexual reproduction.



Benefits:

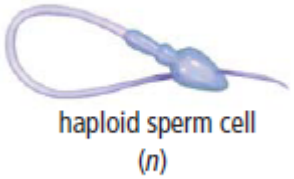
- better equipped to adapt to changes in environment

- One organism may gain an advantage over another organism in the same species.

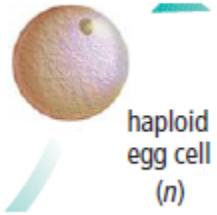
What are Gametes ????

- Specialized cells necessary for reproduction

– In animals:
  - Male gametes: Sperm



  - Female gametes: egg



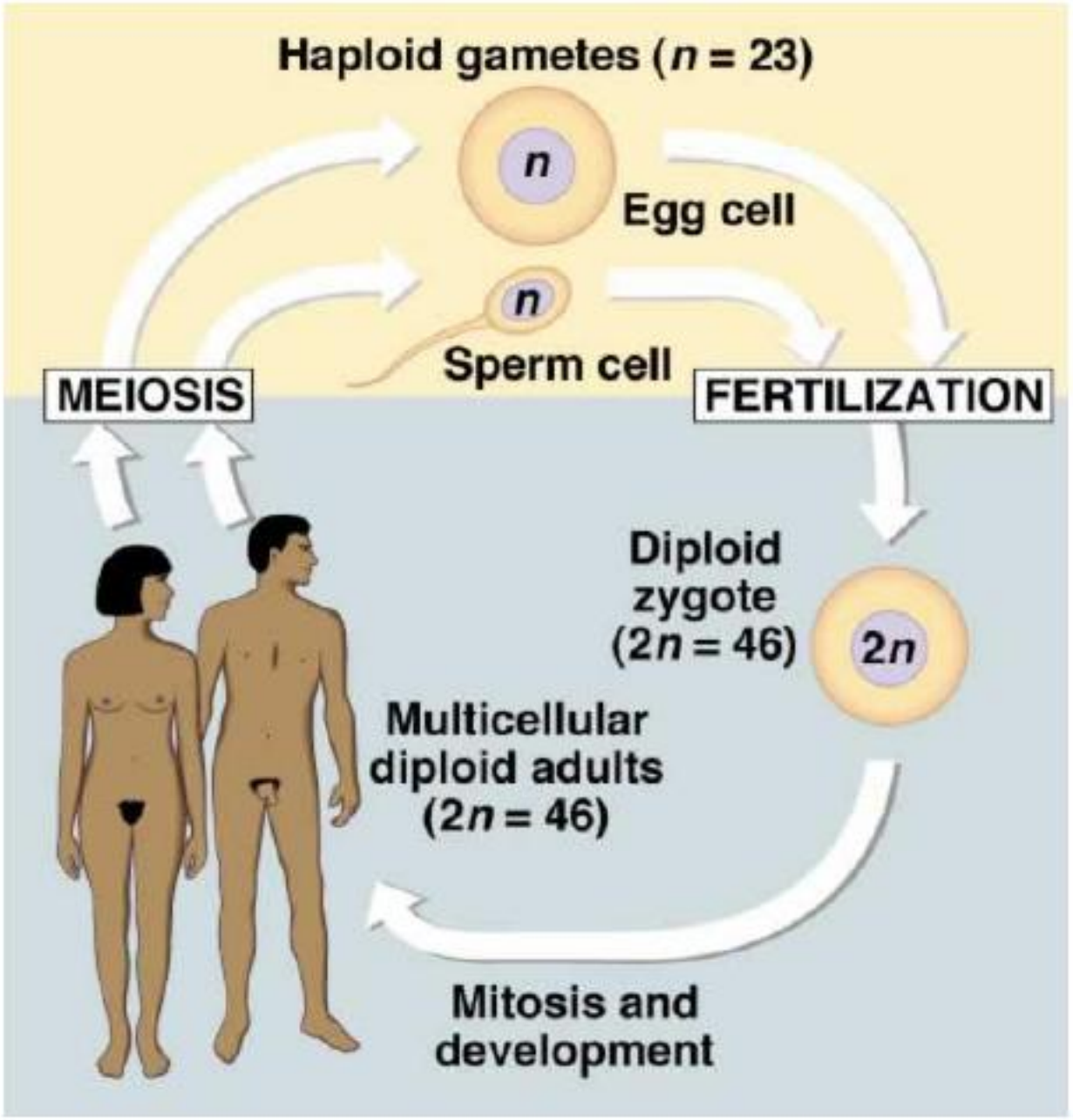
Haploid vs: Diploid

- **Haploid (n)** = half the genetic content
  - (example: sperm has 23 chromosomes, egg has 23 chromosomes)

- **Diploid (2n)** = genetic content equal to the parent
  - (example: Through ***fertilization***, haploid sperm (23 chromosomes)+ haploid egg (23 chromosomes)= diploid ***zygote*** (46 chromosomes, the same amount of chromosomes as the parents)

  - See next slide (warning: contains graphic content!!)

WARNING
SCIENCE
IN
PROGRESS



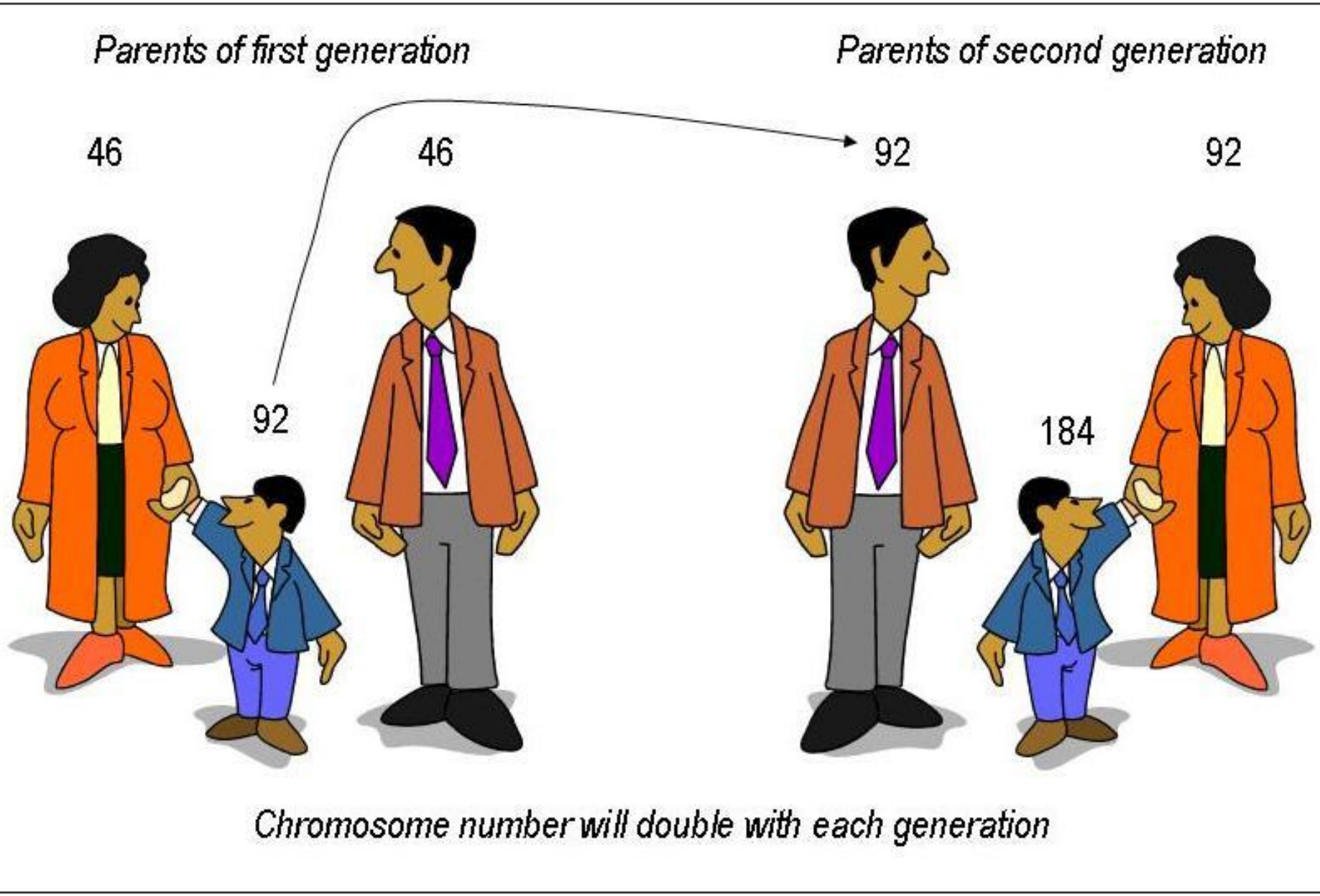
Meiosis

- The process that occurs in the sex cells and produces half the number of chromosomes as body cells.

Question?????

Why is it important to produce gametes with only half the number chromosomes as the parent????

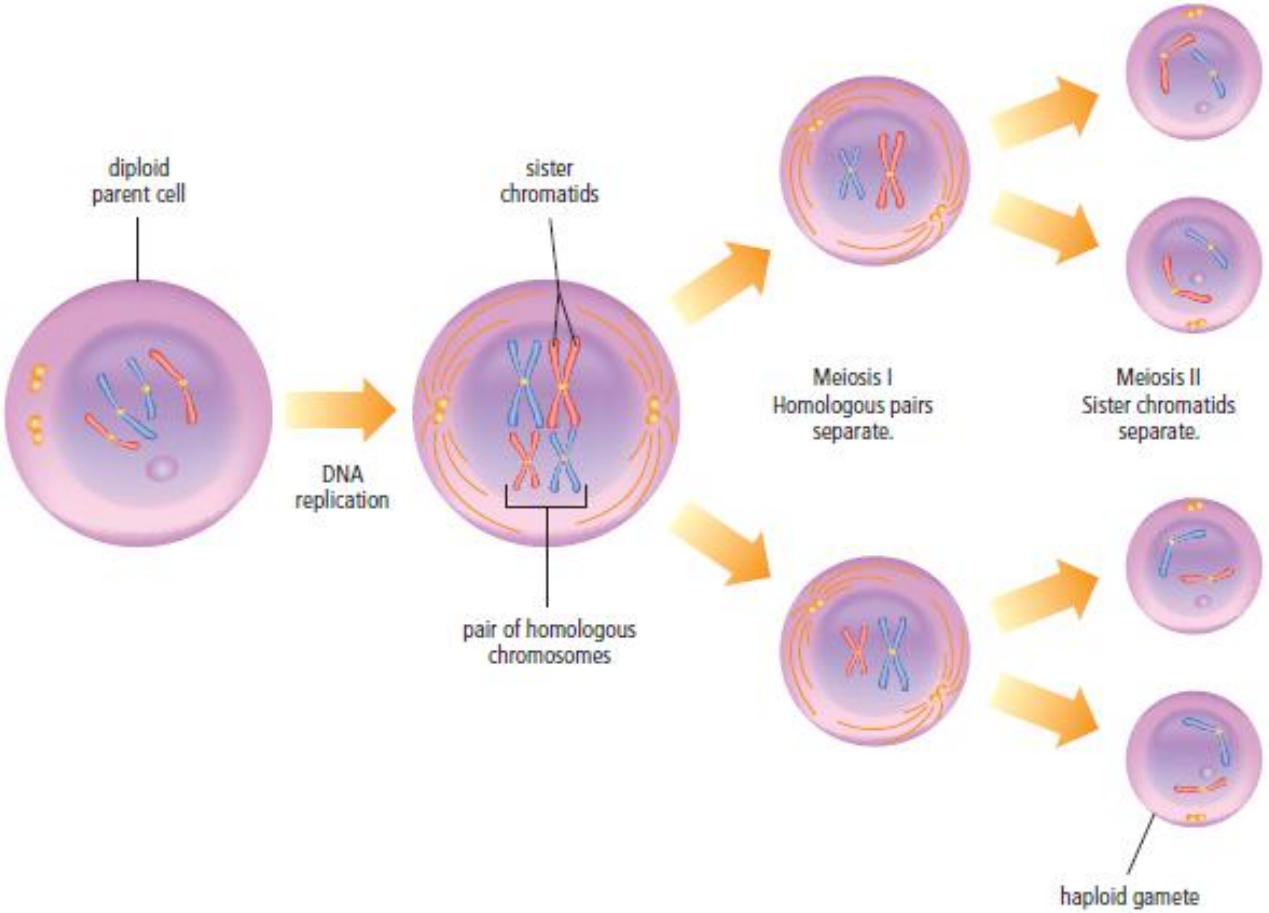
ANSWER (see next slide)


Parents of first generation
Parents of second generation
46
46
92
92
92
184
Chromosome number will double with each generation

How does Meiosis reduce the Chromosome Number???

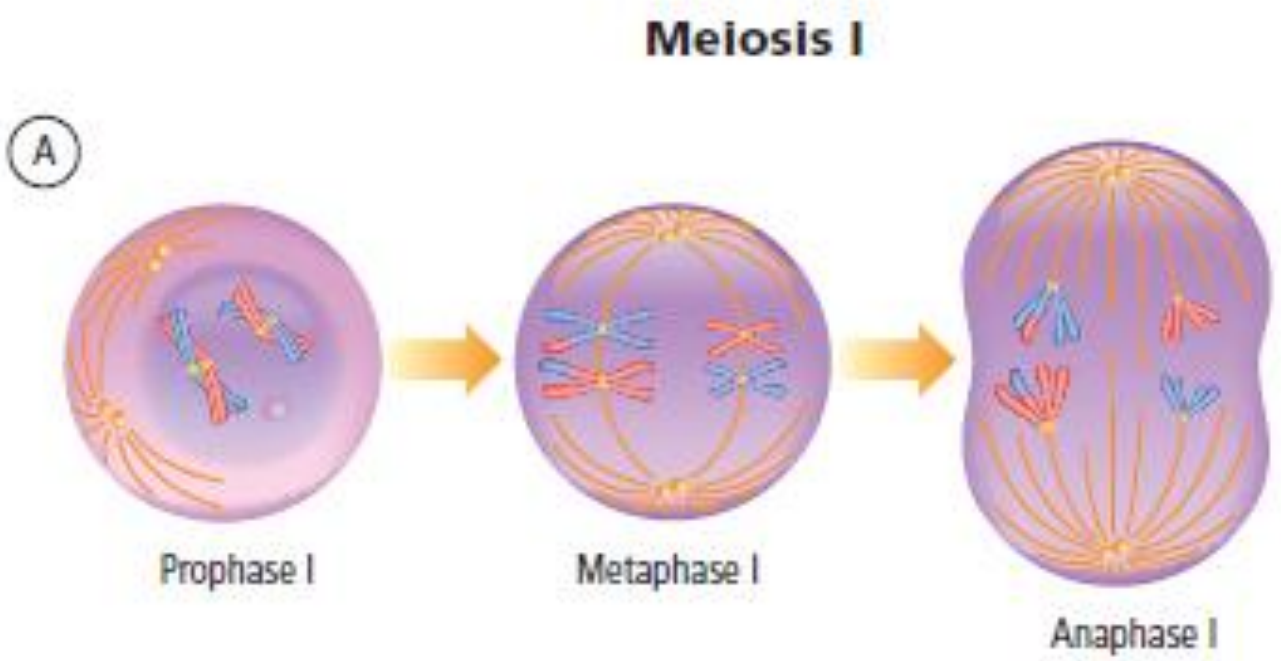
Note:
DNA only replicates once, in interphase, before meiosis begins.

Two complete cell divisions occur, once after <u>meiosis I</u> and once after <u>meiosis II</u>



Meiosis I

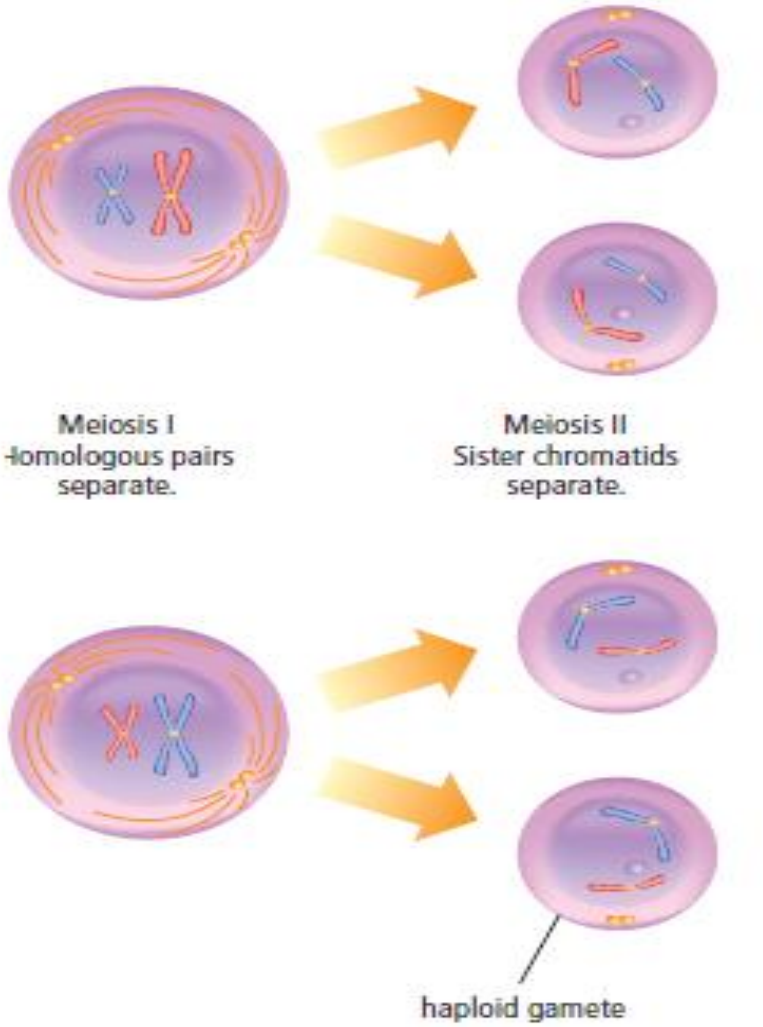
- Meiosis I separates homologous chromosomes, producing two daughter cells



Meiosis II

- Results is four haploid cells, each with half the number of chromosomes.

- *NOTE*: DNA is **not** replicated again before meiosis II begins!!



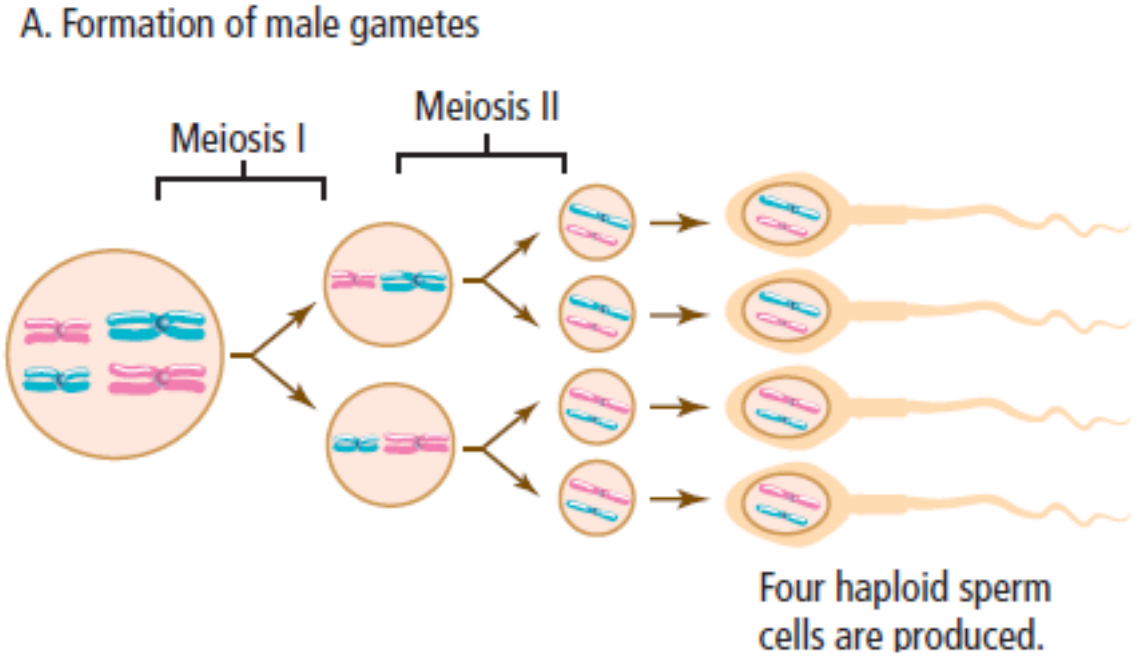
Gamete Formation

- Meiosis is the same for males and females, however, gamete formation is different!
  - Through meiosis males produce 4 sperm cells, but females only produce 1 egg!!!

- WHY?

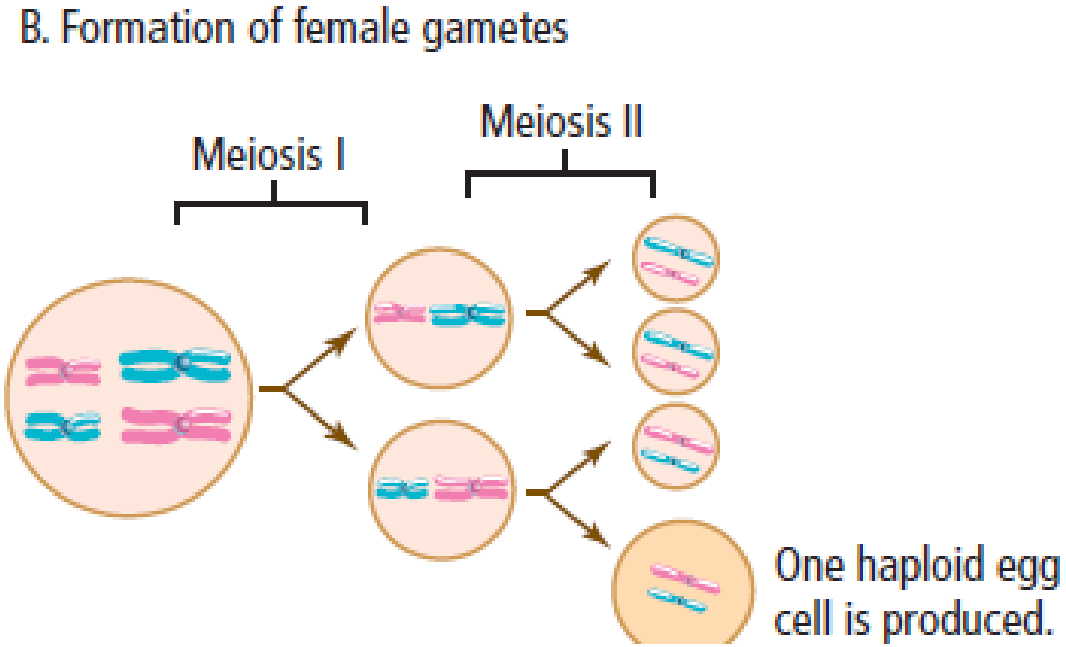
Male Gamete Formation

- Meiosis I produces two cells, this is immediately followed by meiosis II which results in four haploid cells which are capable of becoming sperm cells



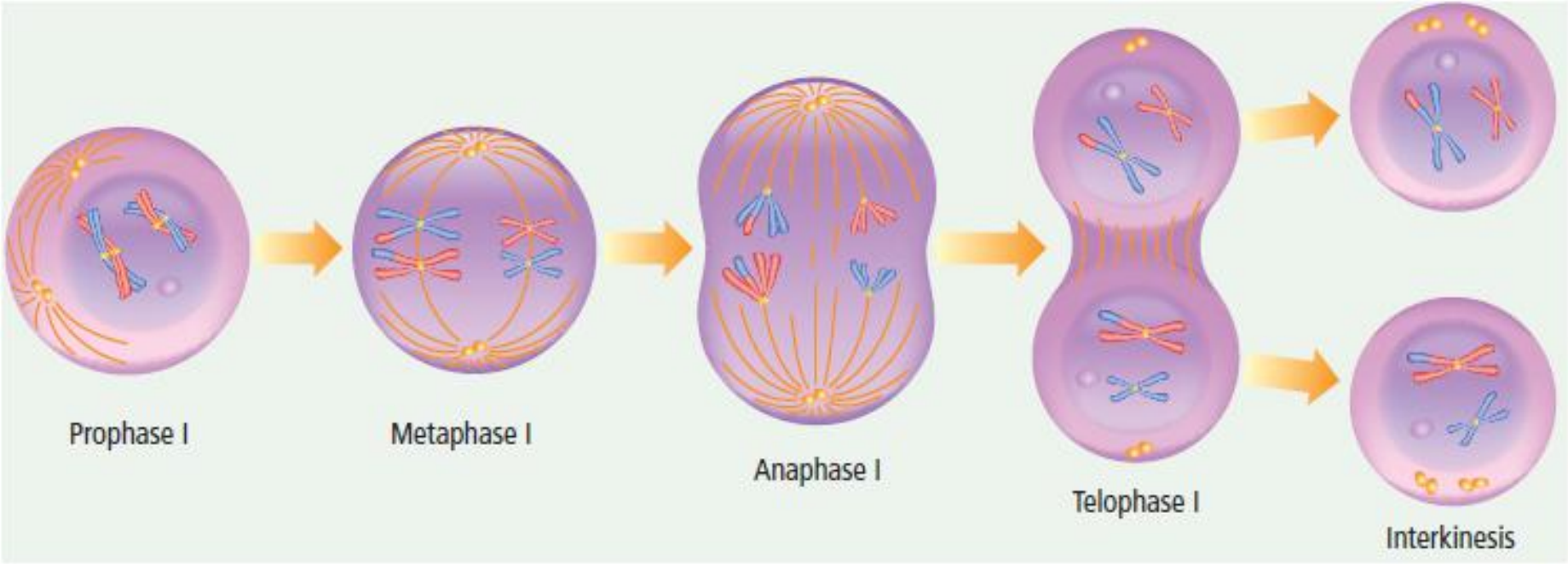
Female Gamete Formation

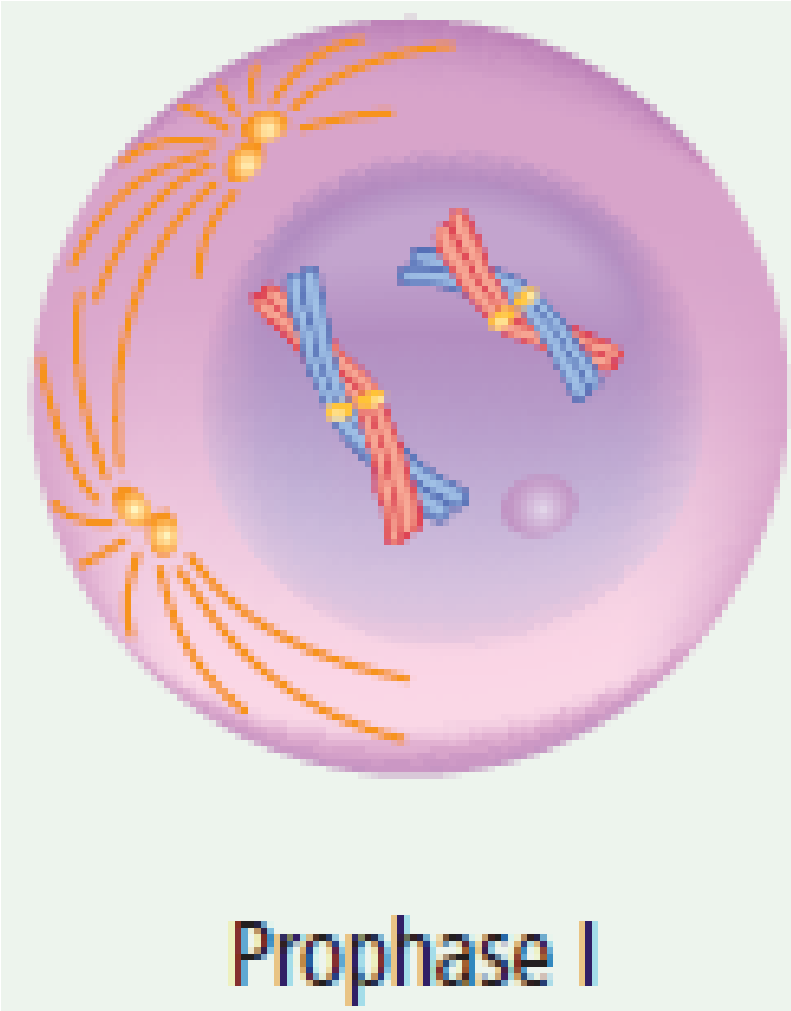
- Meiosis I produces two egg cells, this is followed by meiosis II which results in 4 haploid cells.
- Only **one** of these 4 haploid cells has enough of the cytoplasm and organells to develop into an egg. The other three will disintegrate…



Meiosis Explained

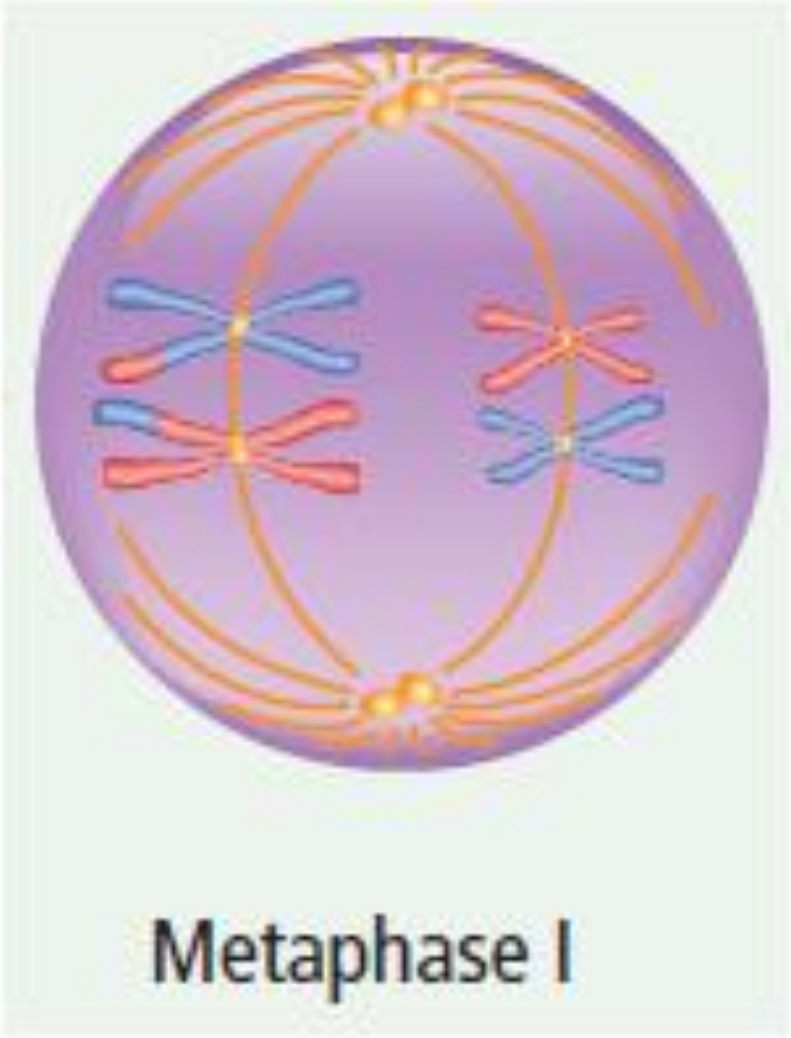
Meiosis I begins





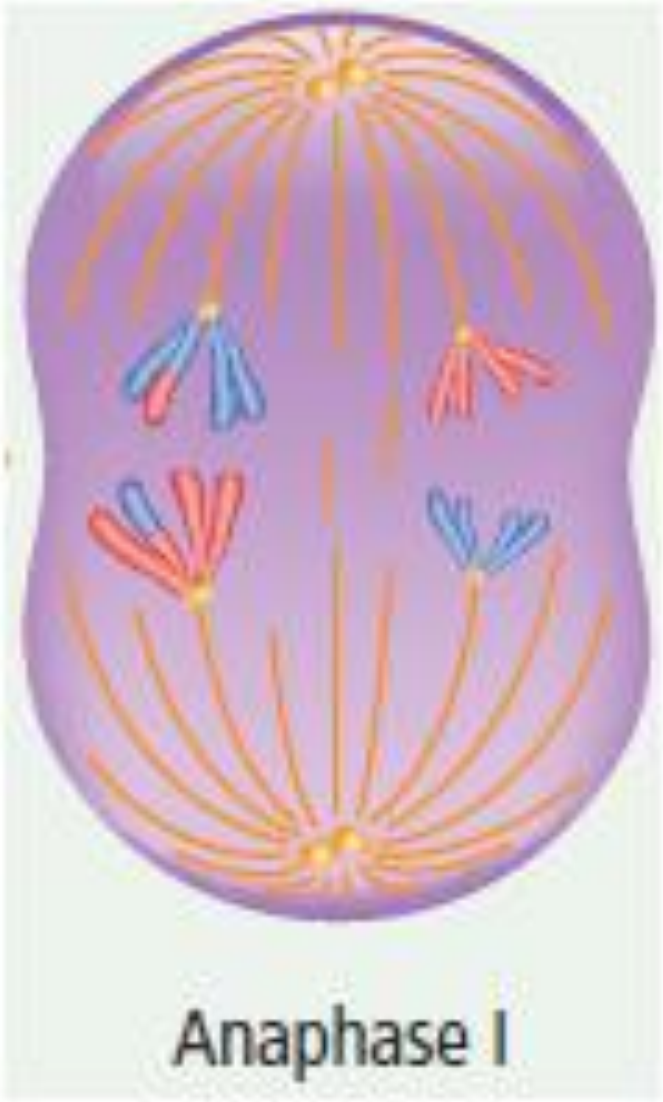
Prophase I

Homologous chromosomes pair up



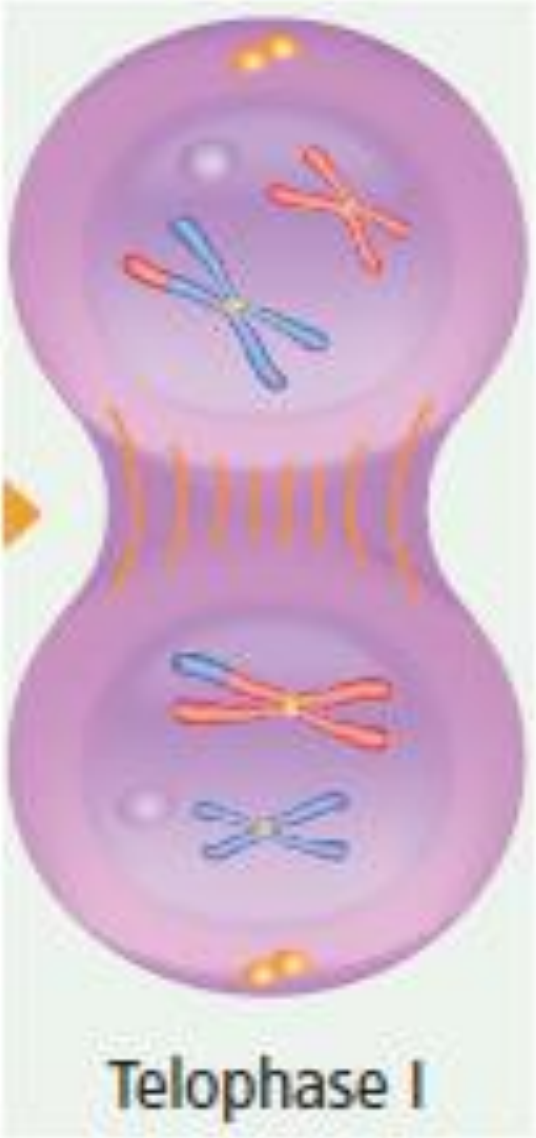
Metaphase I

Homologous chromosomes pair up at the equator



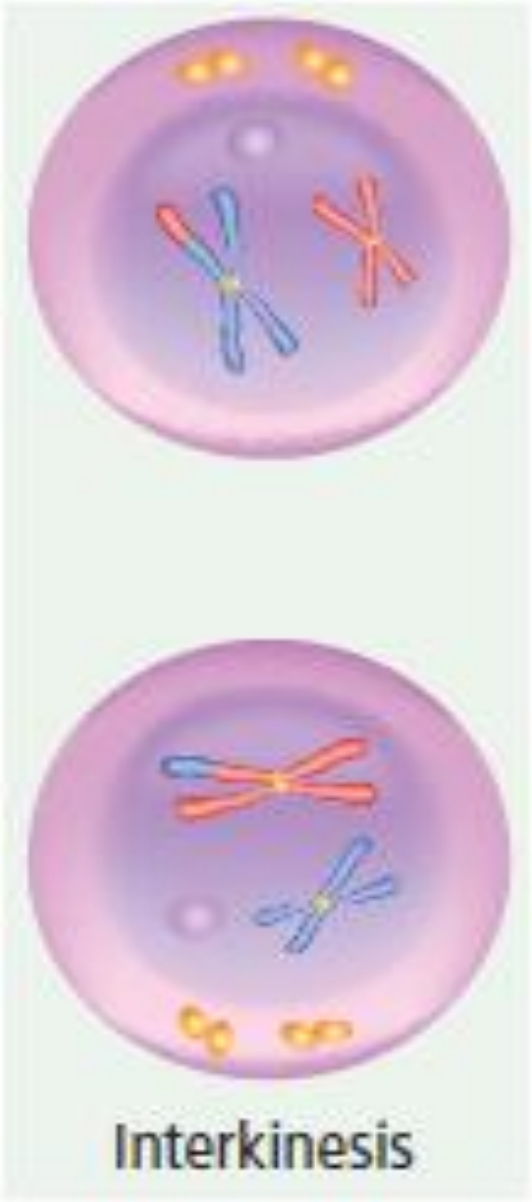
Anaphase I

Homologous chromosomes separate and are pulled to opposite poles



Telophase I

One chromosome from each homologous pair is at each pole of the cell

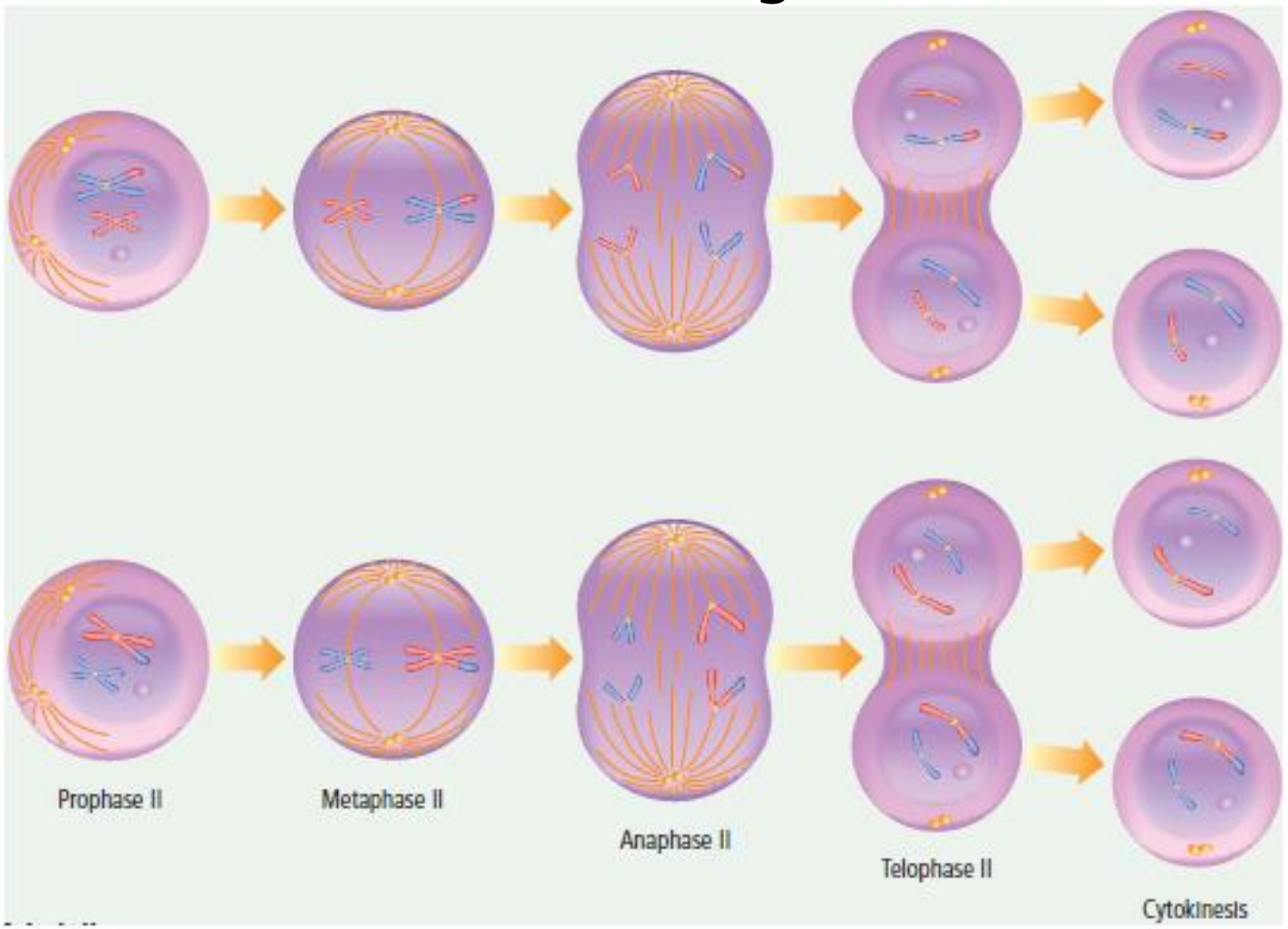


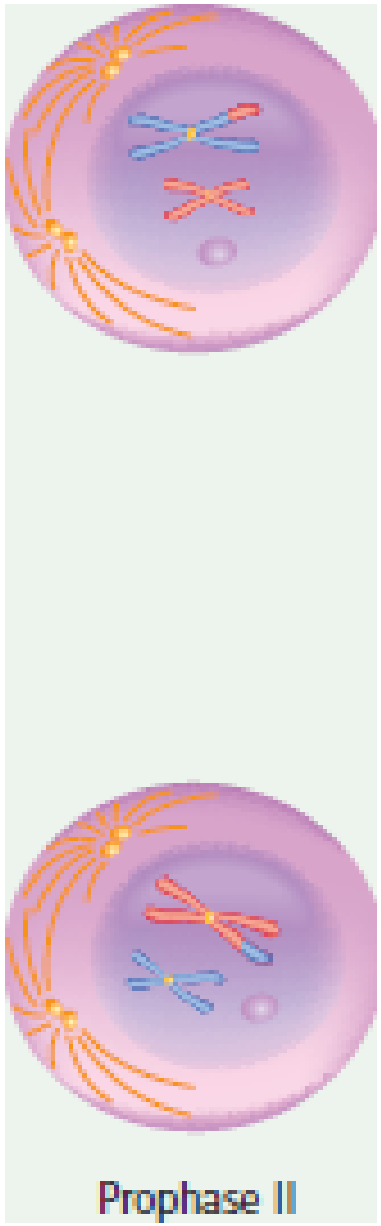
Interkenisis

Interkinesis is the stage between cell divisions. During this time, the cell will grow and make proteins as in interphase of mitosis. **Unlike interphase in mitosis, there is no replication of DNA during this stage**

Meiosis Explained

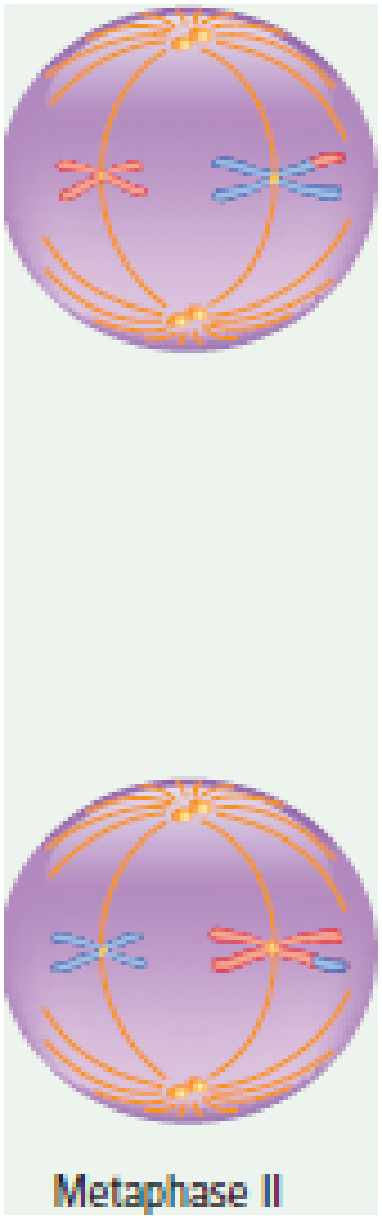
Meiosis II begins





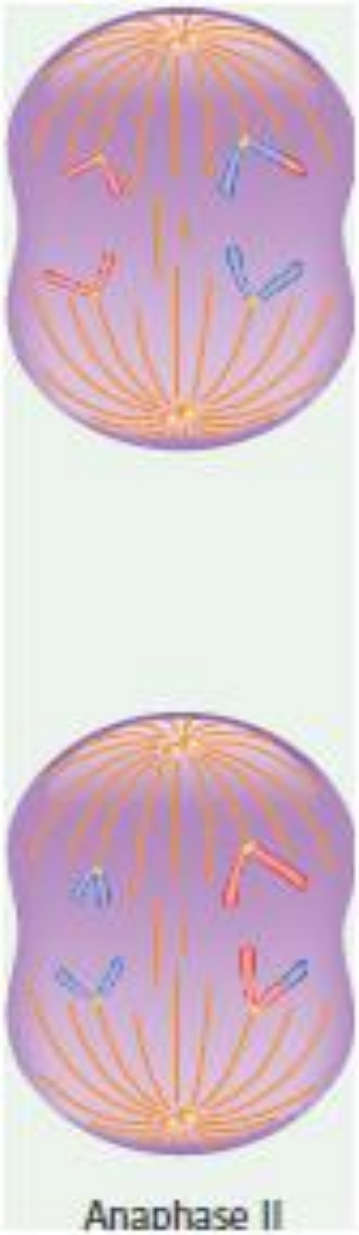
Prophase II

There is one chromosome of the homologous pair in each cell



Metaphase II

The X-shaped chromosomes form a single line across the middle of the cell.

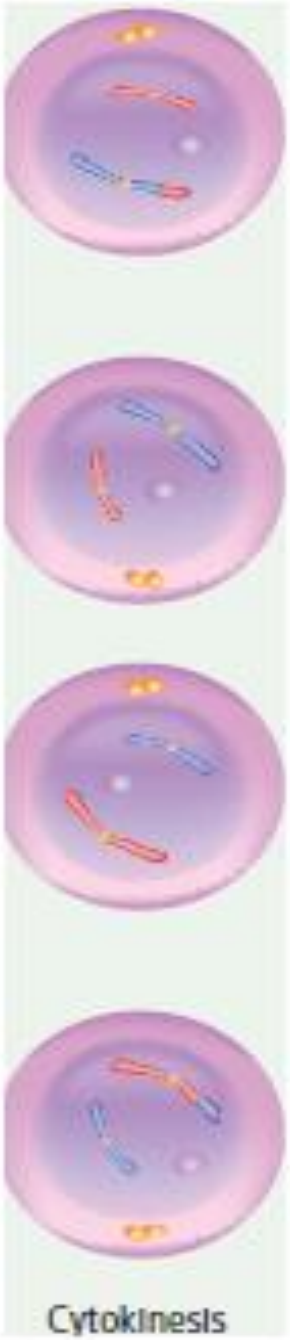


Anaphase II

Sister chromatids move to opposite poles of the cell. Once they separate, each sister chromatid is considered to be a chromosome

Telophase II

A nuclear membrane forms around each set of chromosomes



Sexual Reproduction

Cytokinesis

In cytokinesis, the two daughter cells are separated

Section 7:Meiosis is the basis of sexual reproduction

Methods of Fertilization

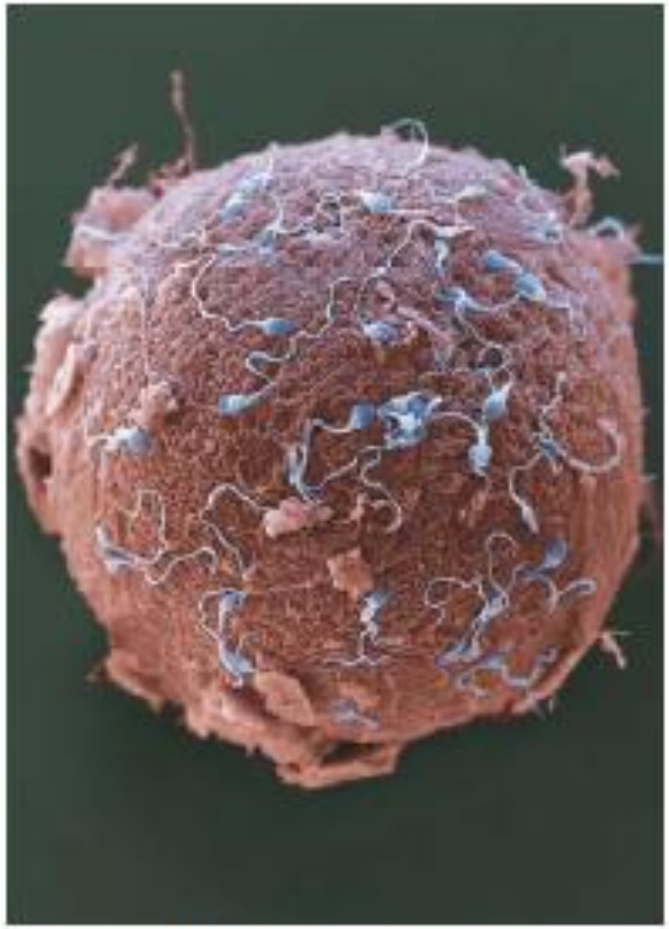
- Sperm and Egg cell unite outside of the bodies of the parents.
- If a sperm cell comes in contact with an egg cell of the species, fertilization may occur.
- Fertilized eggs not protected

External

- Sperm cells are deposited inside the females body where they meet the egg.
- Embryo develops and is nourished inside the mothers body.
- Fertilized embryo protected from dangers

Internal

INTERNAL FERTILIZATION



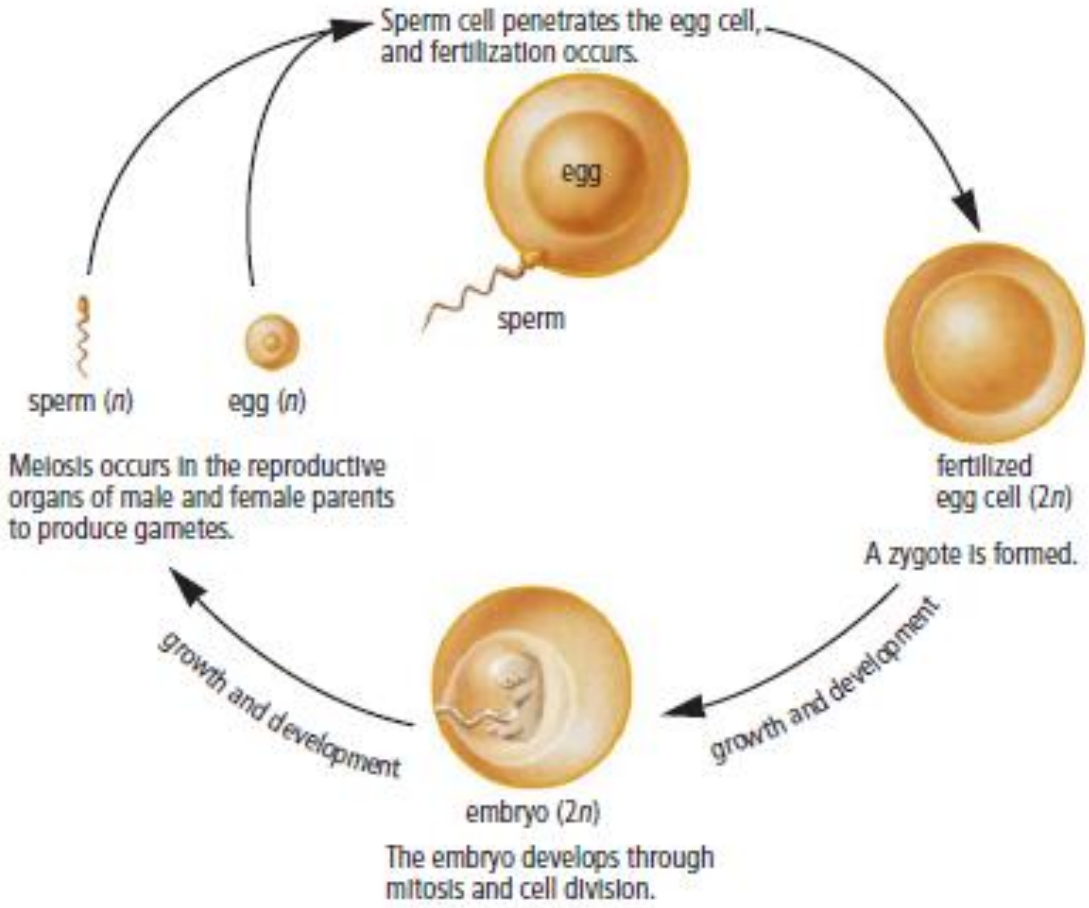


Figure 6.15 In internal fertilization, gametes meet inside the female's body. Only one sperm cell will fertilize the egg cell.

Class Debate!!

INTERNAL FERTILIZATION

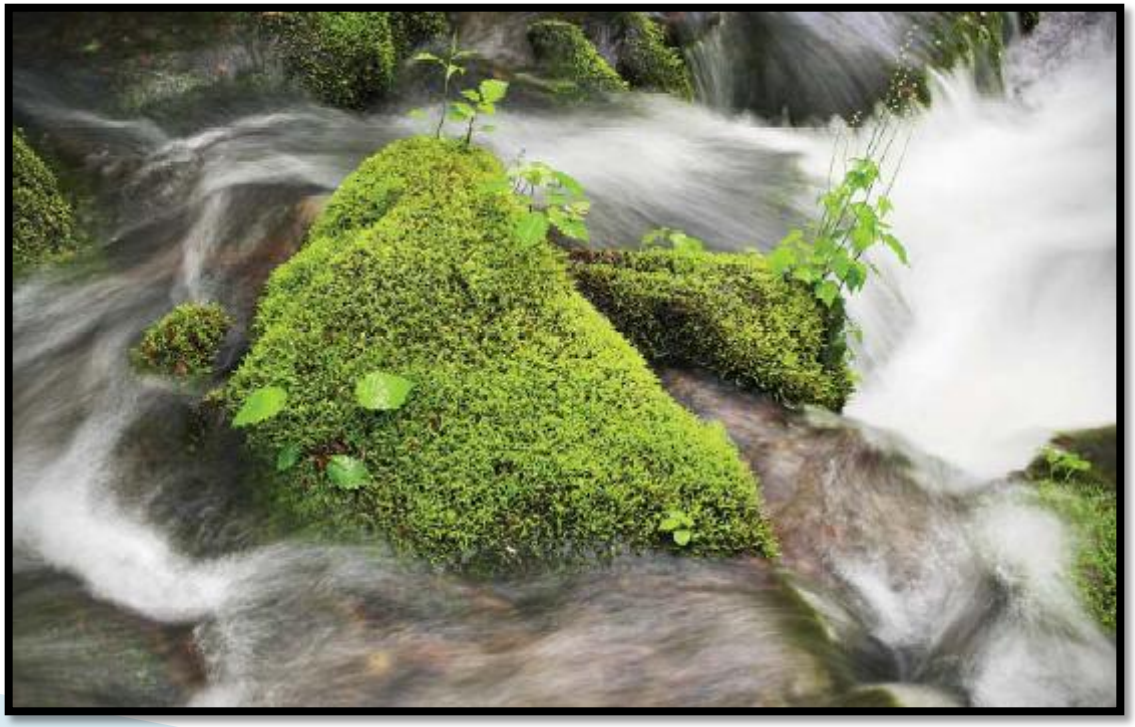
VS:

External Fertilization

Advantages and

Sexual Reproduction in…

- 1. **Mosses**
  - External Fertilization
  - Water allows the sperm and egg cells to meet
  - Reproduces <u>BOTH</u> ***sexually*** and ***asexually***



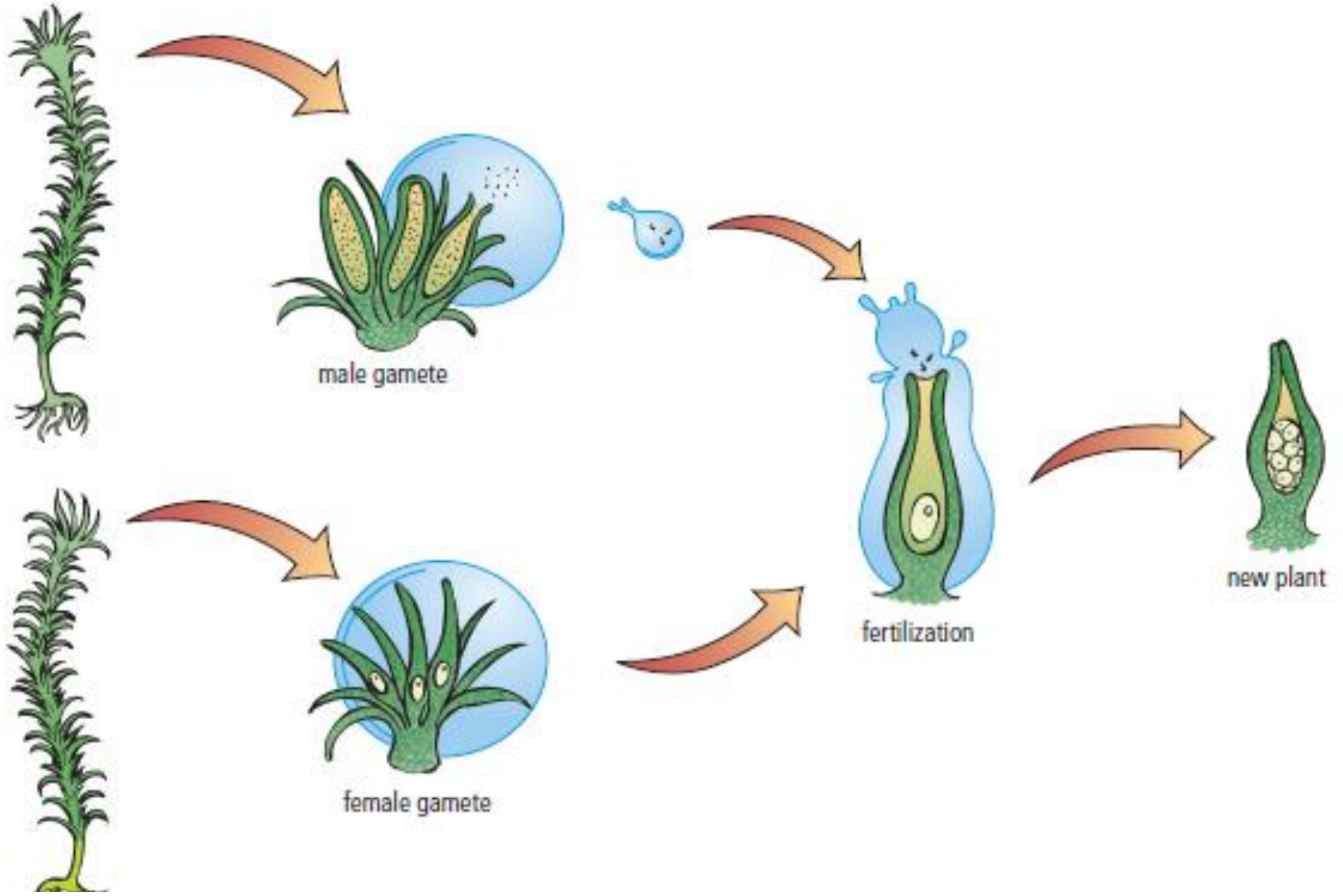
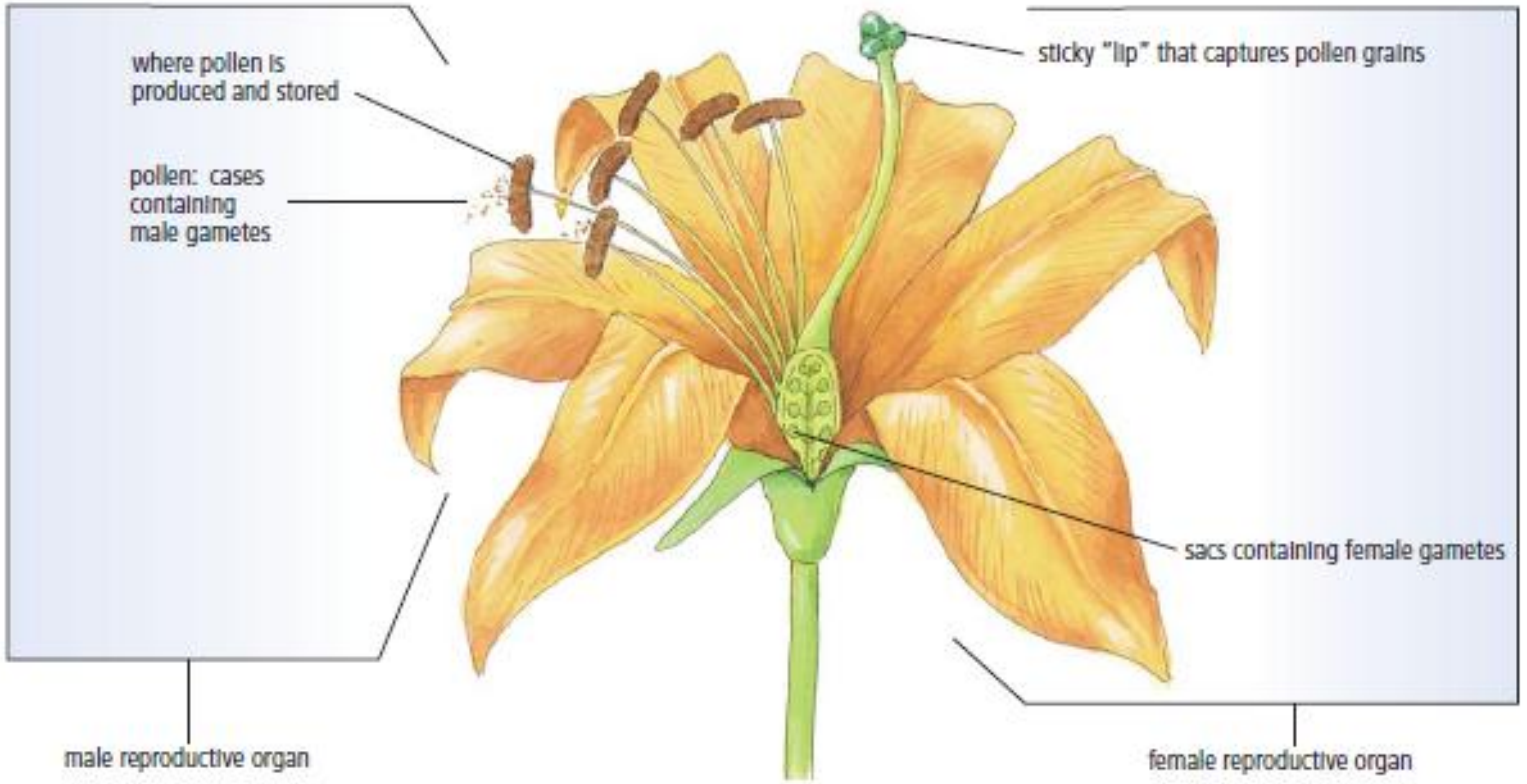
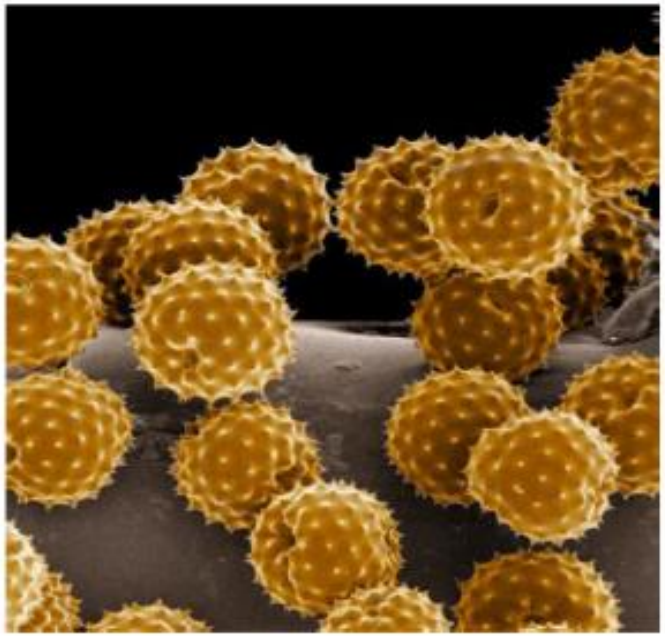


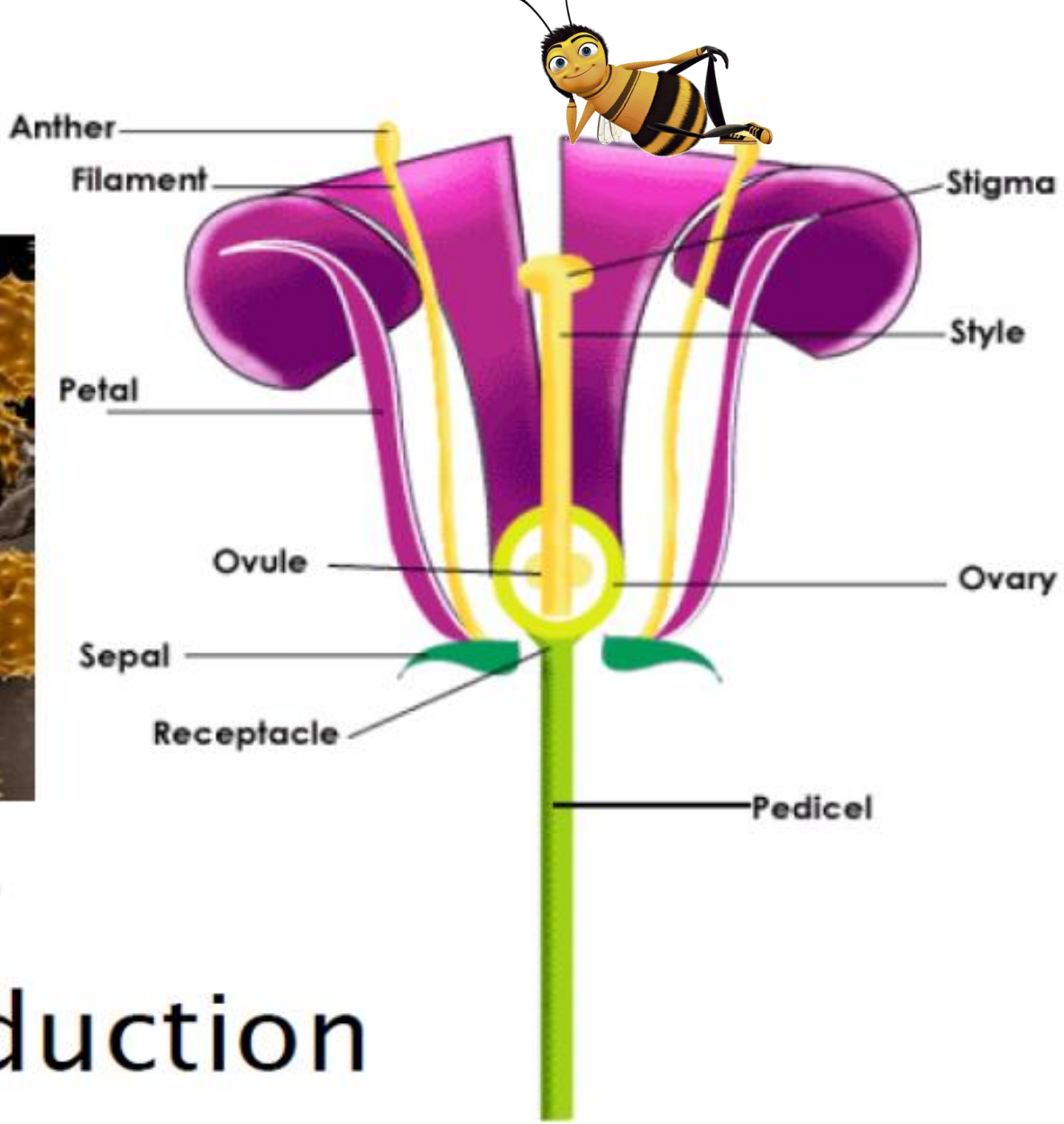
Figure 6.14 In one part of its life cycle, moss uses male and female gametes to reproduce sexually. Water helps the male gametes connect with female gametes for fertilization.

Sexual Reproduction in…

- **2. Flowering Plants**
  - Pollination
  - Male Gametes called **pollen** are transferred from the male structure to the female structure of the plant



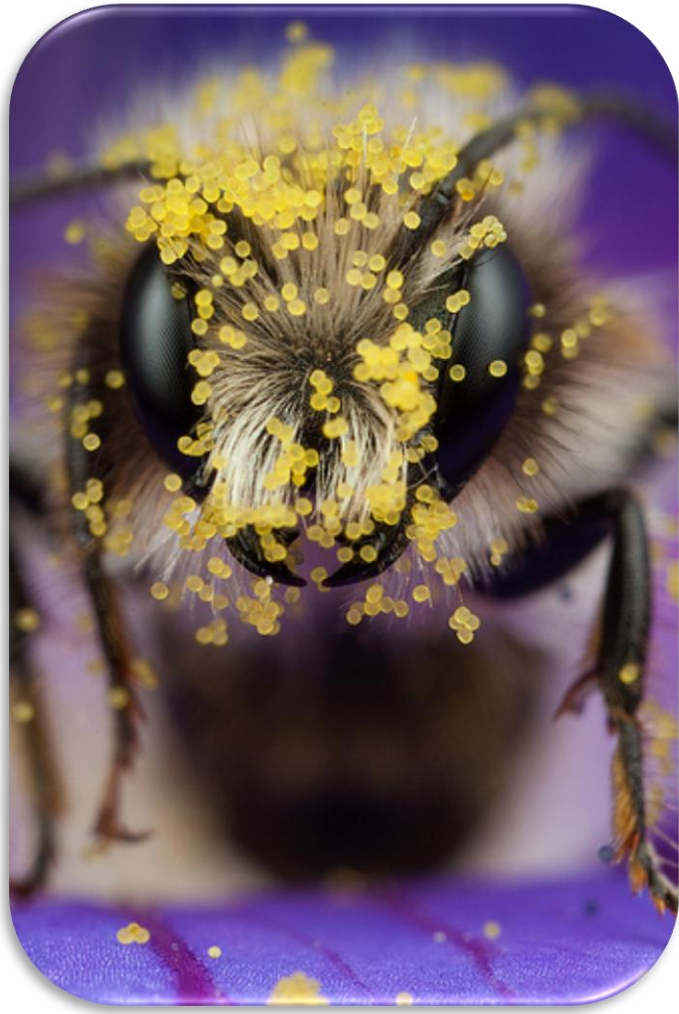




Flower Reproduction

Sexual Reproduction in…

- Flowering Plants Cont…
  - How is pollen transported??
    - Pollinators such as:
      - Insects (example: bees)
      - Other animals (example: fruit bats)
    - Air
    - Water



Sexual Reproduction in…

- After fertilization seeds are often protected in seeds or cones.
- Seeds contain the plant embryos!

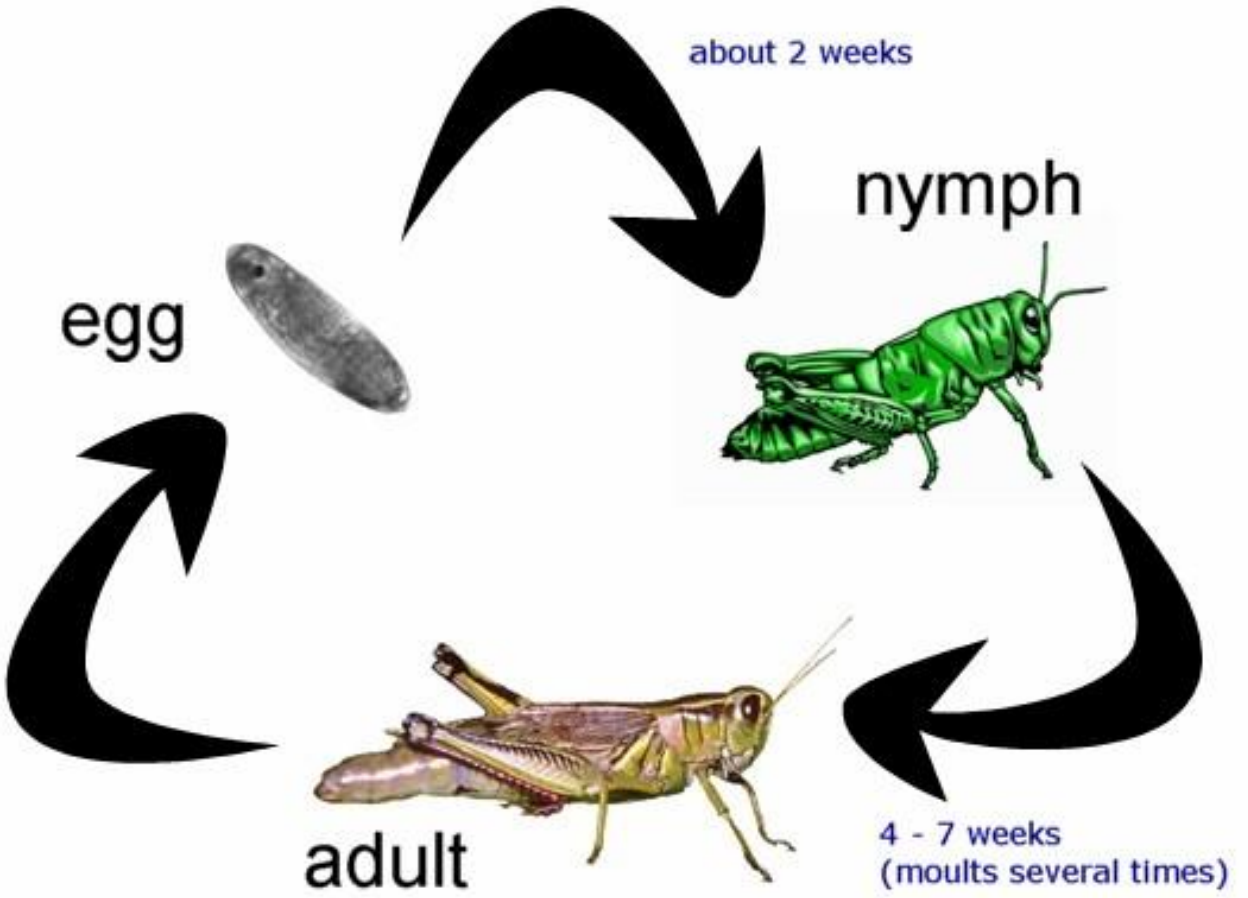
Figure 6.23 Bears love blueberries. The seeds remain undigested when eaten and may be deposited far from the

Figure 6.24 The female cones of a black (bog) spruce tree are small and purplish. Pollen is released from the dark red male cones.

Sexual Reproduction in…

- **3. Insects**
  - Male usually deposits a package of sperm inside the female.
  - Insects often change a great deal between hatching and adulthood.
    - This change in form is called **metamorphosis**

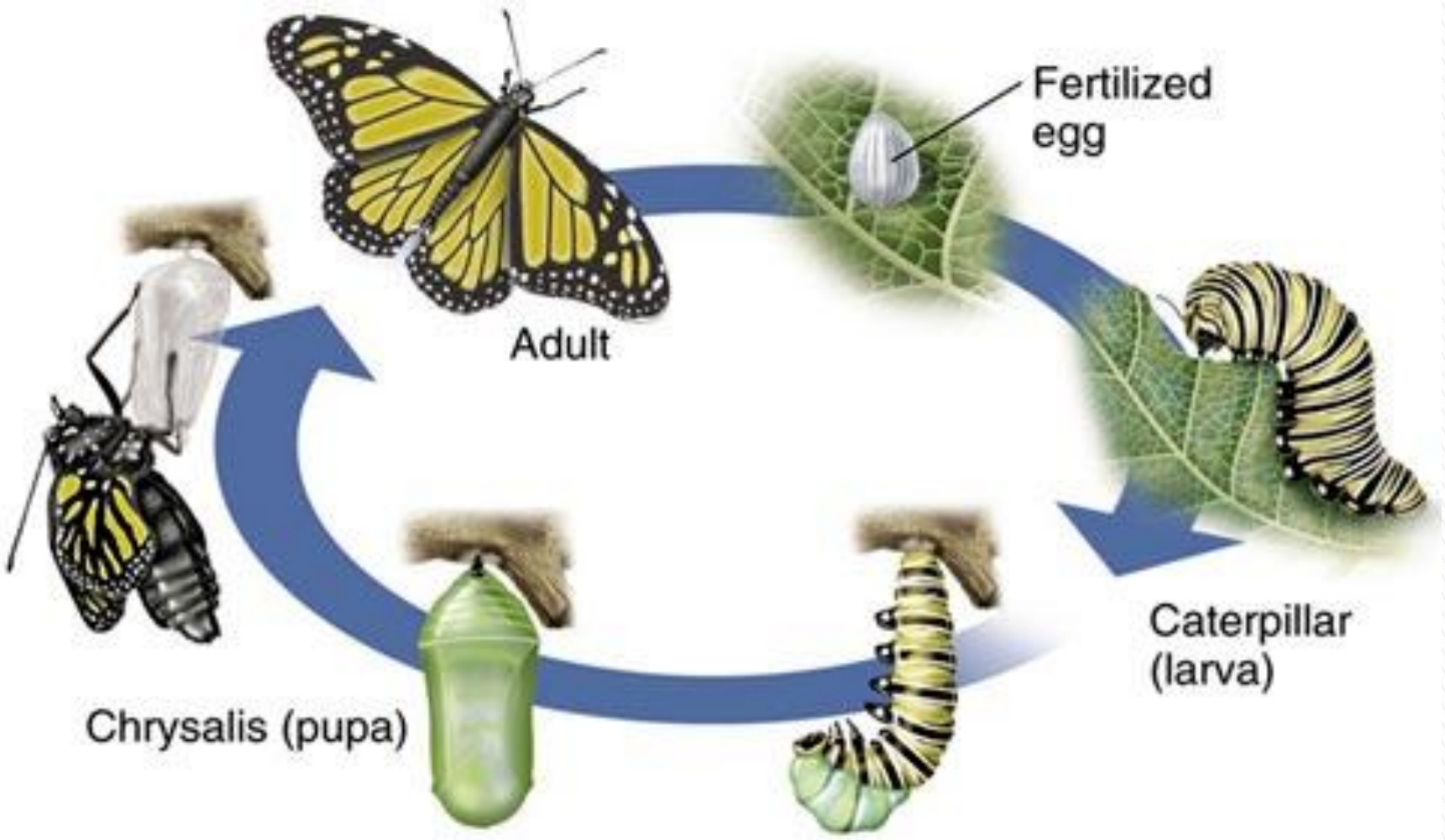
Metamorphosis can be complete or incomplete!!!



Incomplete Metamorphosis

Subtle changes through three life stages: egg, nymph, and adult.

The nymph stage resembles a smaller version of adult.



Complete Metamorphosis

Has four life stages: Egg, Larvae, Pupa, Adult

Asexual VS: Sexual Reproduction

Asexual

- 1 parent cell
- No gametes: cell divides
- Little variation in offspring
- Little energy required
- Less parental care

Sexual

- 2 parent cells
- 2 sex cells unite to forma zygote
- Greater variation in offspring
- Greater energy required
- Greater parental care

Advantages and Disadvantages of Sexual Reproduction

Advantages

- Very little energy required to find a mate
- Greater numbers of offspring can repopulate an area after a disaster (external fertilization)
- More protection is given to the embryo and more parental care is given to offspring (internal fertilization)
- Offspring are genetically different from their parents, so they may survive new diseases or other threats that appear in a population

Disadvantages

- More energy is generally required to find a mate (internal fertilization)
- Fewer offspring are produced, so if the number of predators increases a population will decline (internal fertilization)
- Gametes, embryos, and offspring are unprotected and are often preyed upon (external fertilization)
- Some beneficial traits may not be passed on from parents to offspring

SECTION 7 – Human Reproduction system

Male Human Reproductive System

- Testes
- Scrotum
- Urethra
- Vas Deferens
- Penis

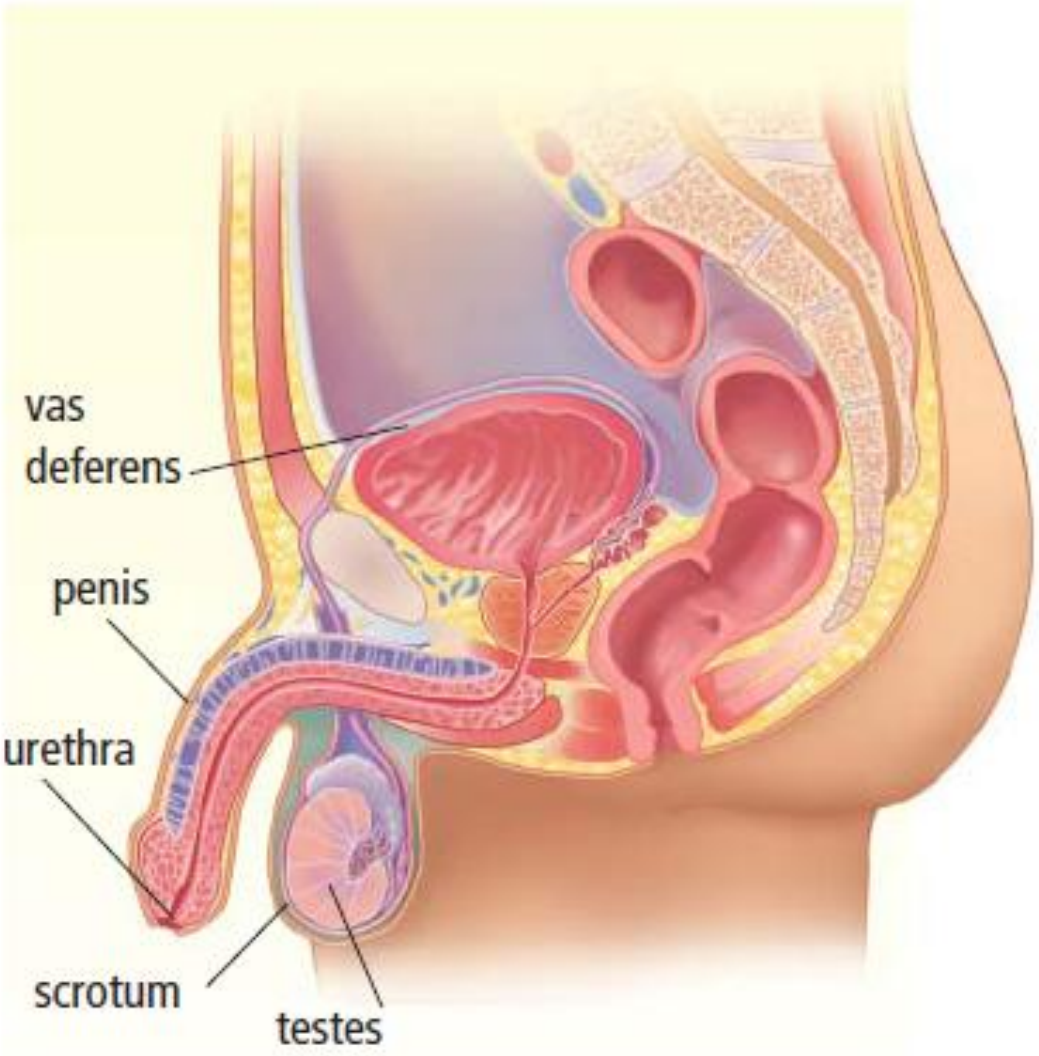


Table 6.2 Function of Structures in the Male Reproductive System

Structure	Function
Testes	Produce sperm (male gametes) by meiosis and release hormones.
Scrotum	Protects the testes, maintaining them at a cooler temperature than the body core.
Vas deferens	Muscular tubes in which sperm mix with fluids to form semen as the sperm are moved from the testes to the urethra. Can house sperm for several months.
Urethra	Opening through which sperm leave the body.
Penis	Contains the urethra for delivery of sperm.

Female Reproductive System

- Ovaries
- Oviducts / Fallopian Tubes
- Uterus
- Cervix
- Vagina

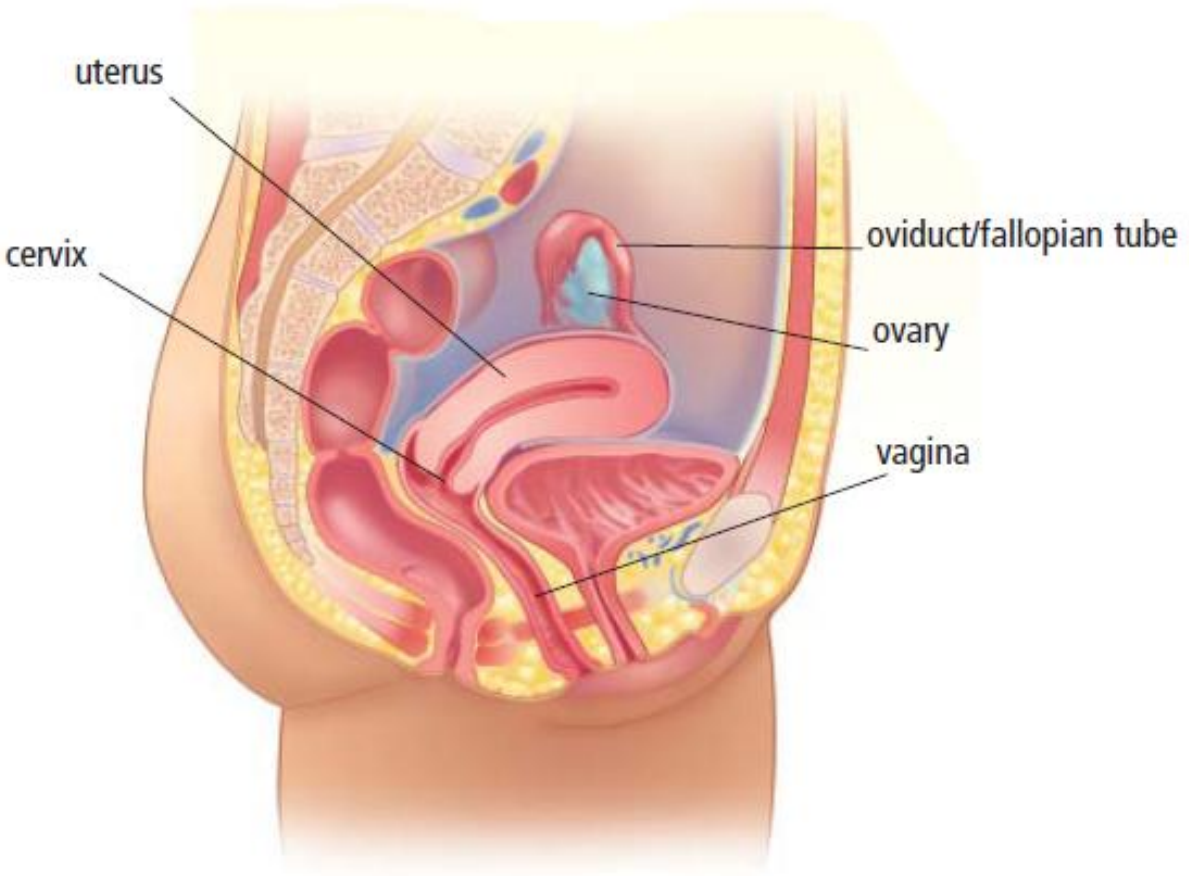


Table 6.3 Function of Structures in the Female Reproductive System

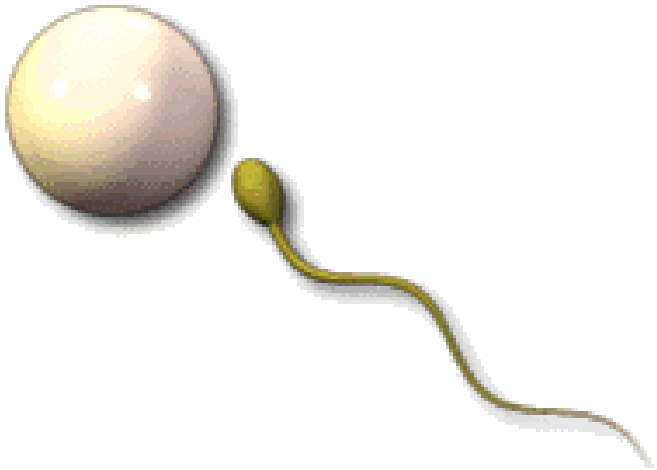
Structure	Function
Ovaries	Produce eggs (female gametes) by meiosis and release hormones.
Oviducts/ fallopian tubes	Location of fertilization. Connect the ovaries to the uterus, although the oviducts are not physically connected to the ovaries.
Uterus	Protects and nourishes the zygote during development. Connects the oviducts to the cervix.
Cervix	Sperm travel through this opening on the way to the uterus. Dilates (opens) to allow the baby to leave the body during childbirth.
Vagina	Sperm are deposited here, their first stop on the way to the egg. Opening through which the baby leaves the body, or through which unfertilized eggs leave the body.

Stages in Human Development

- 1. Fertilization
- 2. First Trimester
- 3. Second Trimester
- 4. Third Trimester

1. Fertilization

- Occurs in the Oviducts/Fallopian Tubes
- Egg and Sperm unite to form a zygote



2. First Trimester

- All organ systems begin to develop
- Zygote is called an embryo
- Placenta and amniotic sac form
- At 4 weeks, the brain and spinal cord are forming
- At 8 weeks, the embryo is now called a **fetus**
- At 12 weeks, all major organs are formed

Figure 6.29A The embryo at 4 weeks

Figure 6.29B The fetus at 8 weeks

Figure 6.29C The fetus at 12 weeks

3. Second Trimester

- Rapid Growth
- Skeleton forms
- Fetus will grow rapidly between 12 to 16 weeks
- Mother will feel movement by 20 weeks
- Growth slows between 20 and 24 weeks

Figure 6.30 The fetus at 16 weeks

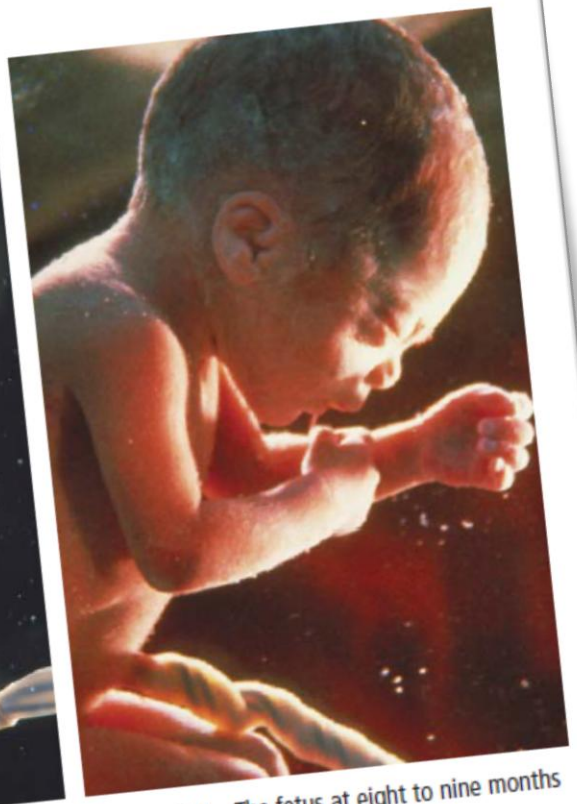
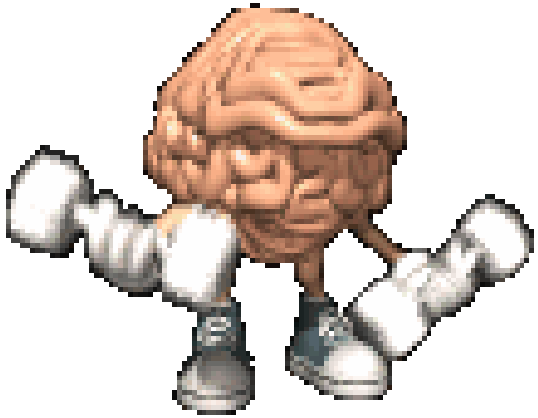


Figure 6.31 The fetus at eight to nine months

4. Third Trimester

- Growth in preparation for birth
- Significant growth in the brain
- Immune system develops
- Fat is deposited under the skin to aid in warmth after birth



Signs of Pregnancy

- Menstruation stops
- Hips will become slightly larger
- Breasts become larger
- Weight gain and abdomen will bulge
- Nausea and Dizziness
- Cravings