# CHAPTER 8

## CELL REPRODUCTION

# REMEMBER:

- 5 FEATURES ALL LIVING THINGS HAVE IN COMMON:
  - Must be made up of one or more cells.
  - Must be able to reproduce.
  - Must be able to adapt to changes in the environment.
  - Must be able to grow and develop.
  - Must be able to use energy.

# REPRODUCTION

- Reproduction is the process by which an organism produces others of the same kind.
- Reproduction is important to the growth and survival of all living things.

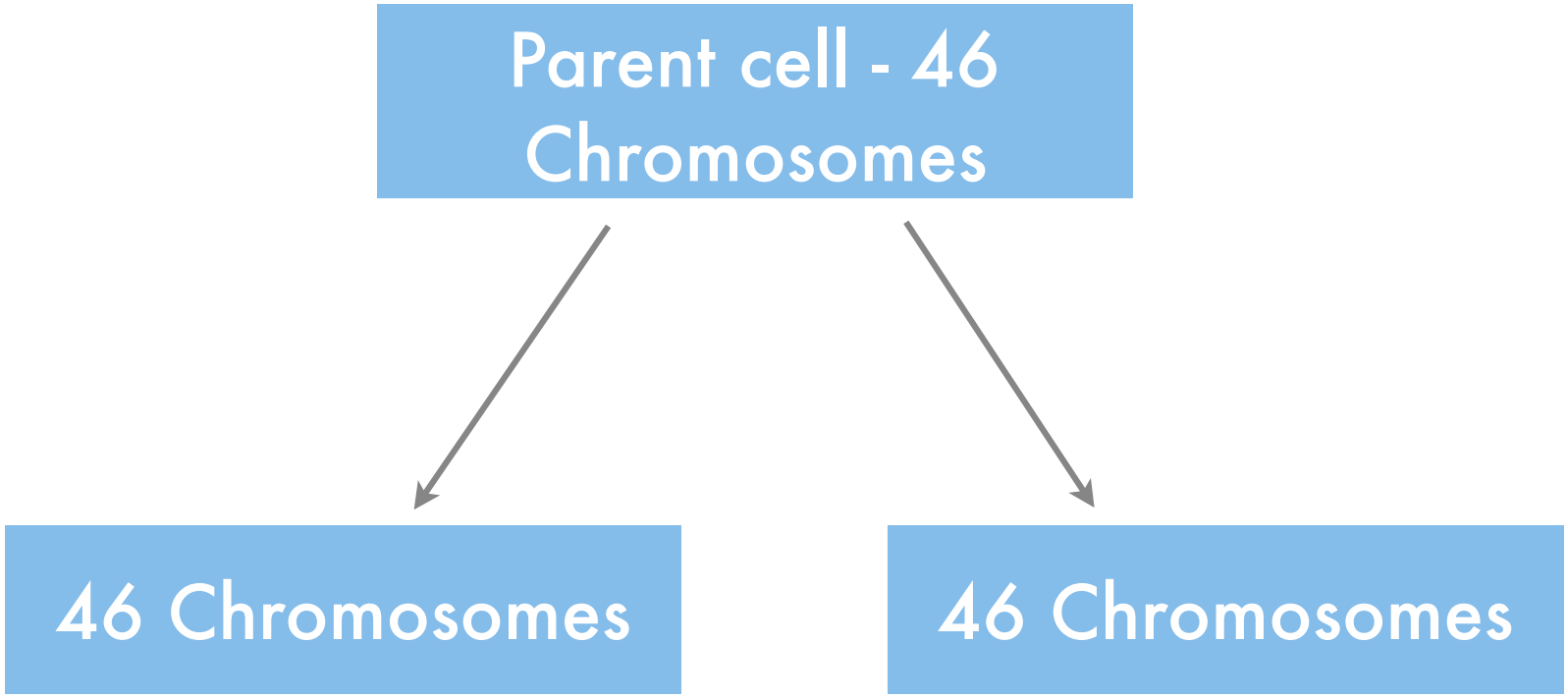
# CELL DIVISION - Growth & Development

- Why is cell division important?
  - Cell division is the means by which multicellular organisms **GROW** and **REPAIR** themselves.
  - Growth happens because the number of cells in your body increases and some of your cells become larger through metabolism.
  - Single-celled organisms use cell division for reproduction.
  - Organisms go through stages, or life cycles, while they are alive. Ex. birth, growth, development, death Cells in your body also go through cycles.

# MITOSIS

- Mitosis is the process in which the nucleus divides to form two identical nuclei. Each new nucleus is identical to the original nucleus.
- There are 5 steps in mitosis: (interphase), prophase, metaphase, anaphase, and telophase.
- Two basic things happen in mitosis:
  1.Nucleus of the cell divides then
- 2. the cytoplasm divides.

# MITOSIS




When the cell divides the chromosomes in the nucleus play the most important part. REMEMBER: Chromosomes hold the DNA.

# STAGES OF MITOSIS

- Interphase
- Prophase
- Metaphase
- Anaphase
- Telophase

# INTERPHASE

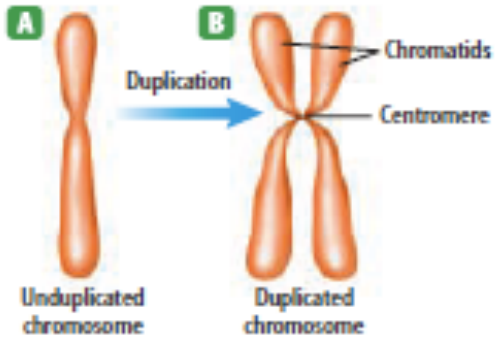
- Most of the life of an eukaryotic cell (cell with a nucleus) is spent in a period of growth and development called interphase.
- During interphase:
  - Chromatin begins to shorten and thicken and become visible (chromosomes)
  - Chromosomes begin to copy themselves near the end of interphase - actively duplicating. Pair up with their copies (chromatids). These chromatids are held together by a structure know as the centromere.
- **Nerve cells** & **muscle cells** are always in interphase - they don't divide or multiply. Red blood cells circulating in the blood do not divide - live about 90 days & then are replaced by new red blood cells.

# INTERPHASE (cont.)

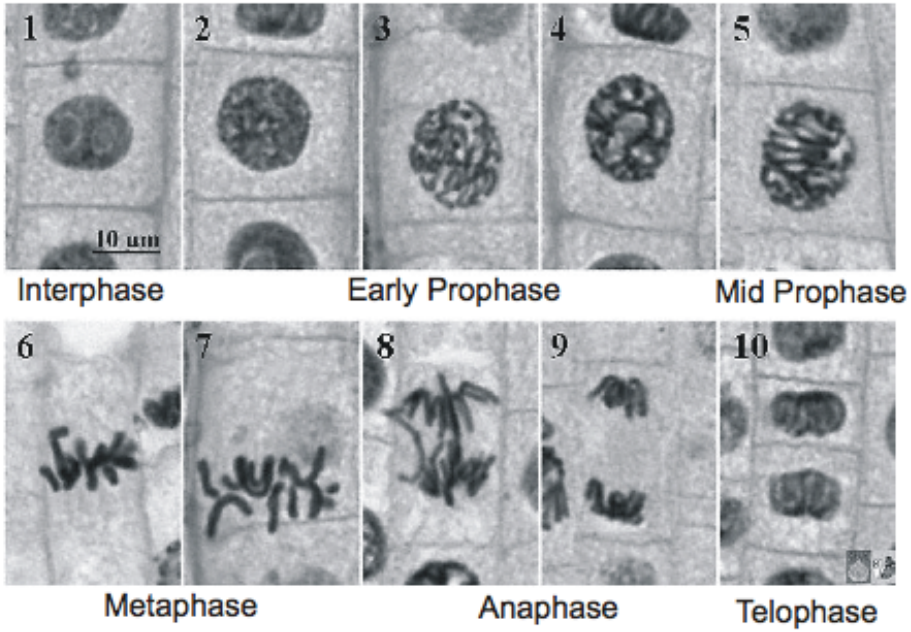
- Before a cell divides a copy of the heredity material must be made so that each of the two new cells will get a complete copy of the heredity material (DNA). These terms are all given to chromosomes at different stages.
- A chromosome is a structure in the nucleus that contains hereditary material (DNA).
- It's called chromatin when these strands of DNA are stretched out and difficult to see.
- chromatid is the name given to the chromosomes after duplication -- double-stranded chromosome, joined by a centromere after they have duplicated.

# INTERPHASE (cont.)

- During interphase, each chromosome duplicates. When the nucleus is ready to divide, each duplicated chromosome coils tightly into two thickened, identical strands, called chromatids.



# Onion Root Tip - Mitosis

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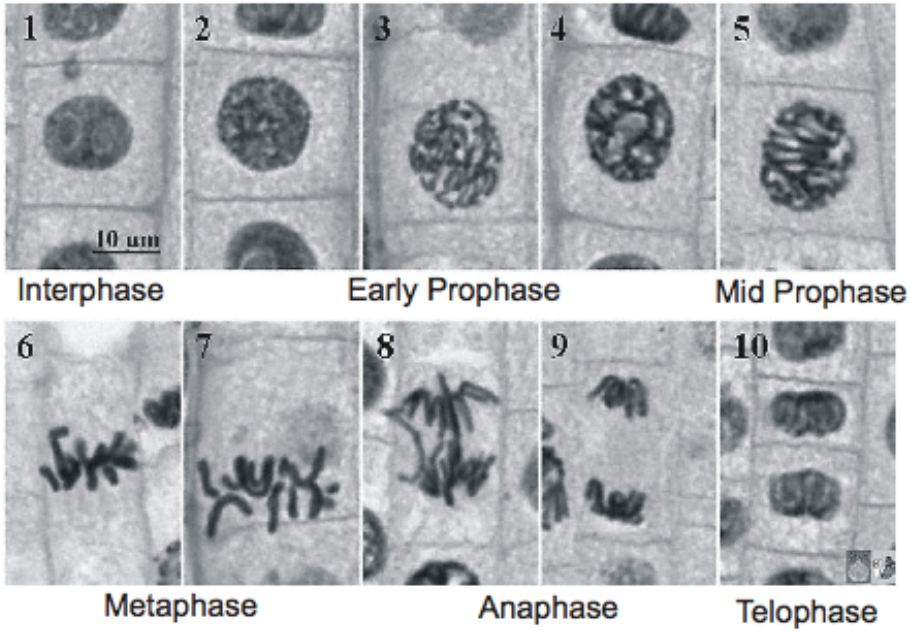
# PROPHASE

- The pairs of chromatids are fully visible when viewed under the microscope.
- The nucleolus and the nuclear membrane disintegrate.
- Two small structures called centrioles move to opposite ends (poles) of the cell.
- Between the centrioles, threadlike spindle fibers begin to stretch across the cell. Plant cells also form spindle fibers, but do NOT have centrioles.

# Onion Root Tip - Mitosis

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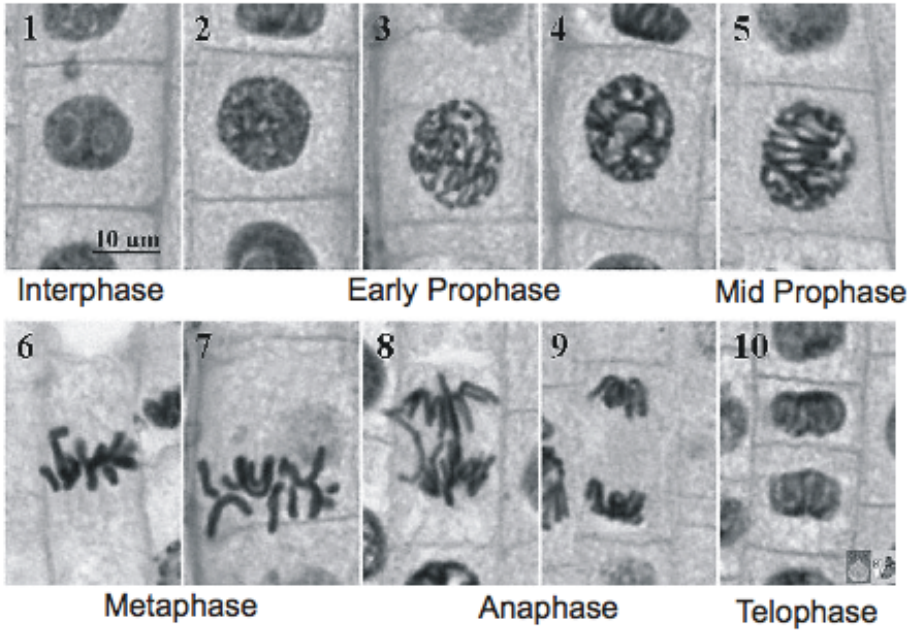
# METAPHASE

- The chromatids line up across the center (middle) of the cell.
- Each centromere becomes attached to two spindle fibers - one from each side of the cell. (The cell is preparing to sort the chromatids into two complete sets of chromosomes.)

# Onion Root Tip - Mitosis

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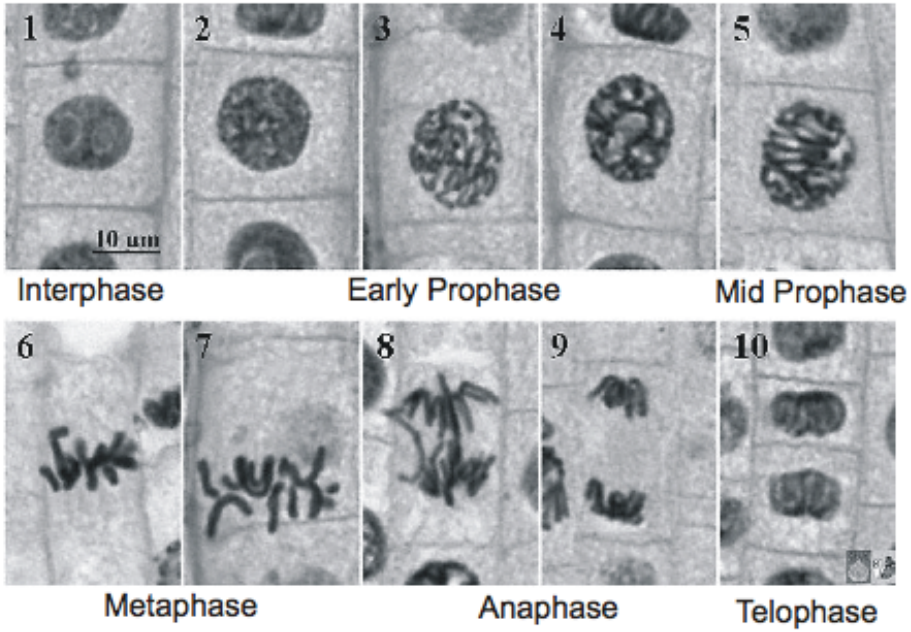
# ANAPHASE

- Each centromere divides.
- Spindle fibers shorten.
- Separated strands (chromatids) begin to move away from each other to opposite ends (poles) of the cell. The separated chromatids are now called chromosomes.

# Onion Root Tip - Mitosis

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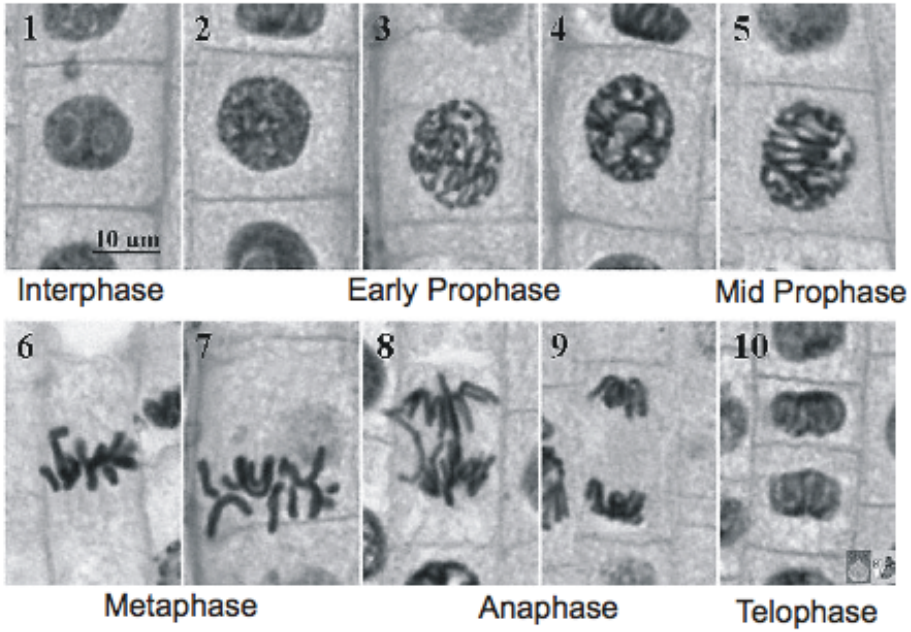
# TELOPHASE

- Centrioles and spindle fibers start to disappear.
- Chromosomes stretch out and become harder to see (chromatin).
- A new nuclear membrane forms around each mass of chromosomes and a new nucleolus appears in each new nucleus.
- In animal cells, the cell membrane pinches in the middle and the cytoplasm divides, forming two new cells identical to the parent (original) cell.
- In plant cells, a cell plate forms down the middle of the cell. This divides the cytoplasm. New cells walls will be formed on each side of this plate and cell membranes develop inside the cell walls. This forms two new plant cells identical to the original cell.

# Onion Root Tip - Mitosis

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# MITOSIS

**REMEMBER:

1)Mitosis is the division of the nucleus to form two new identical nuclei.

2)Mitosis produces two new nuclei that have the same number and type of chromosomes as the original cell.

3Through BODY cell division, organisms grow, replace worn-out or damaged cells, and produce new organisms.

# REPRODUCTION

- Reproduction is the process by which an organism produces others of the same kind.
- TWO TYPES OF REPRODUCTION:
- 1. Asexual Reproduction
- 2. Sexual Reproduction

# ASEXUAL REPRODUCTION

- Asexual reproduction - A new organism is produced from one parent. The new organism will have hereditary material (DNA) identical to the hereditary material (DNA) of the parent organism.
- The offspring produced during asexual reproduction is identical to the parent organism.

# Types of Asexual Reproduction

- Fission - division of an organism into two equal parts having identical genetic material. Ex. Bacteria
- Budding - a new organism grows from the body of its parent. When the bud on the adult becomes large enough, it breaks away to live on its own. Ex. Hydra
- Regeneration - a whole new organism grows from just a part of the parent organism. Ex. sea star, sponge
- ★ Regeneration may also be used to replace damaged or lost body parts. Ex. Crayfish may lose a cheliped in a fight and grow a new one to replace the lost appendage.

**Figure 8**
Some organisms use cell division for budding and regeneration.

A Hydra, a freshwater animal, can reproduce asexually by budding. The bud is a small exact copy of the adult.

# SEXUAL REPRODUCTION

- Sexual reproduction is a type of reproduction in which a new organism is produced by combining sex cells (gametes), from two parents. The female (♀) is the egg and the male  gamete is the sperm.

# Sexual Reproduction

- During fertilization, the egg and sperm fuse to form a new cell called a zygote. This zygote gets half of its chromosomes (DNA) from the sperm and half of its chromosomes (DNA) from the egg. It is a combination of both parents and is not exactly like either one.

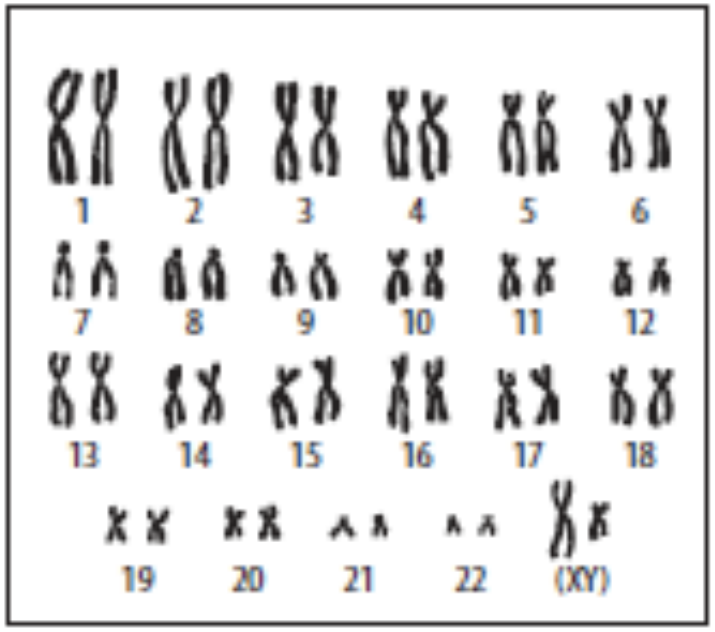
Egg ♀ + Sperm ♂ → fertilization → Zygote

# Cells in Your Body

- BODY CELLS - contain 46 chromosomes (23 pair). Formed during mitosis. These cells are diploid - cell that have pairs of similar chromosomes.
- SEX CELLS (gametes) - contain 23 chromosomes. Produced in the reproductive organs of the body. These are haploid because they do not have pairs of chromosomes. They only have half the number of chromosomes as body cells.

# CHROMOSOMES

- Humans have 23 pair - 46 chromosomes total in each normal bod



# Why are gametes haploid?

- Why do gametes only have 23 chromosomes instead of 46????
- GAMETES MUST BE HAPLOID because during fertilization a gamete from each parent combines to form a new organism. If they are not haploid the new organism would not have the correct number of chromosomes. They would have 92 instead of 46 -- this normal. If both gametes are haploid, have 23 chromosomes, when they combine you get a normal number of 46 for the new cell (zygote).

# MEIOSIS - Gamete Formation

- Meiosis is the process by which haploid sex cells are produced. (23 chromosomes)
- Takes place in the reproductive organs of an organism.
- Ensures that the offspring will have the same diploid number of chromosomes as its parent.

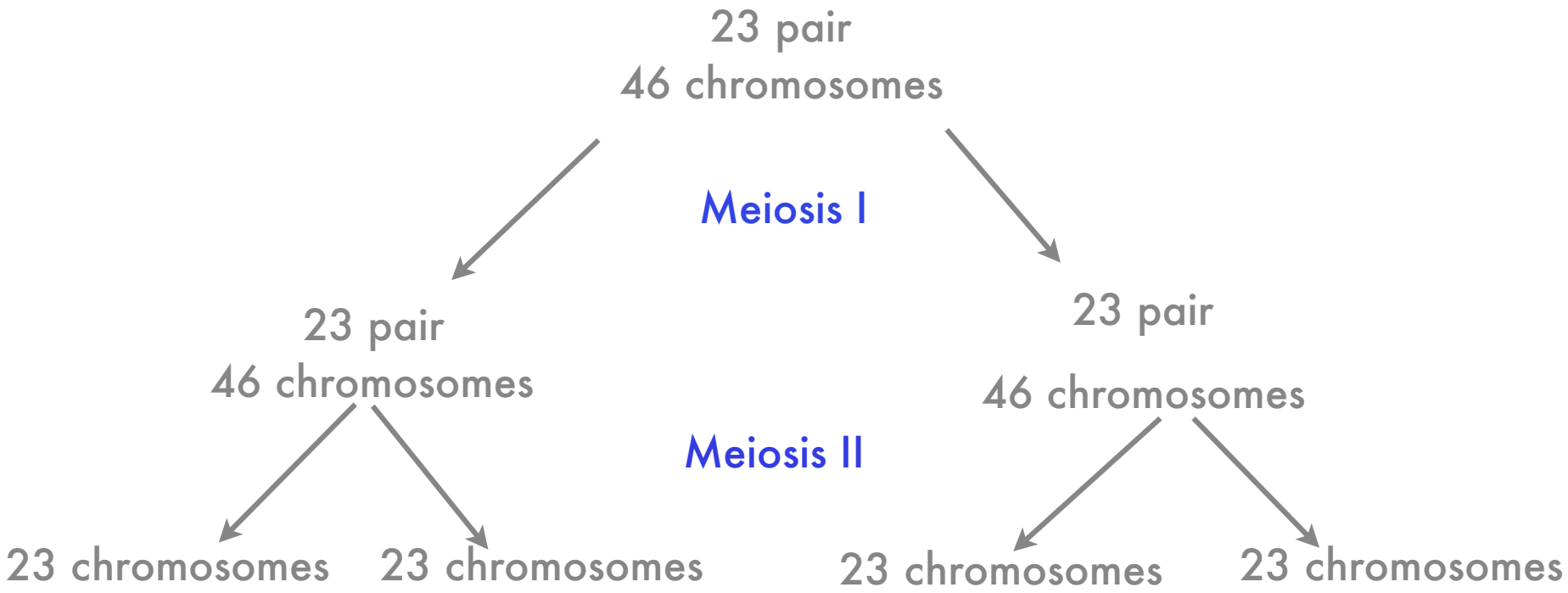
# MEIOSIS

- In Meiosis, there are two divisions of the nucleus:

1. Meiosis I - Two cells form with the same number of chromosomes as the parent cell. Produces diploid cells just like mitosis, but it doesn't end here. 2 cells = 46 or 23 pair of chromosomes each

2. Meiosis II - The two cells from Meiosis I each divides again - this time without duplicating the chromosomes first. Each new cell only gets 1/2 of the chromosomes from the parent cell. End result is a total of 4 cells each only having 23 chromosomes. Four haploid cells are produced. 4 cells = 23 chromosomes each

# MEIOSIS




** End result = 4 cells (gametes) with 23 chromosomes each. Gametes are haploid.

# MEIOSIS (cont.)

- Meiosis occurs many times in the reproductive organs.
- Mistakes in plants are common and not necessarily deadly.
- Mistakes in animals are less common and often with more serious consequences.
- Sometimes zygotes produced from sex cells with too many or too few chromosomes die. If the zygote lives, every cell in that organism will have the abnormal number of chromosomes. These organisms may not grow normally.

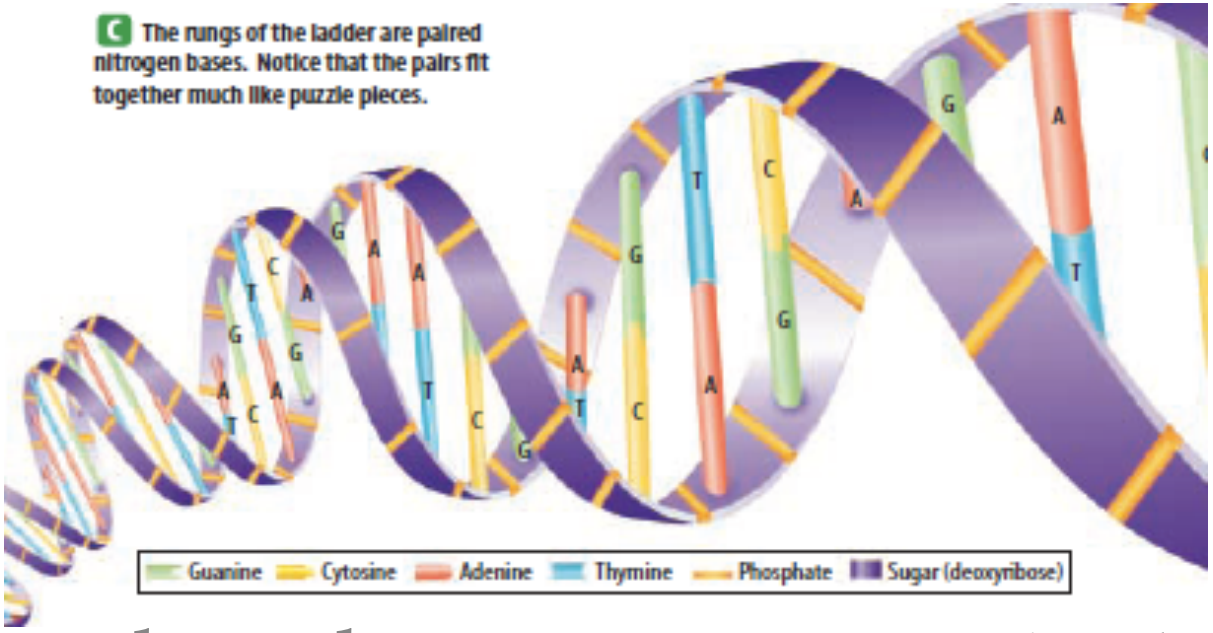
# DNA

- DNA (Deoxyribonucleic Acid) - hereditary code or genetic blueprints of the cell.
- DNA controls an organism's growth and function.
- DNA is stored in the nucleus of the cell.
- When a cell divides, the DNA code is copied and passed to new cells.
- Every cell in your body contains DNA.

# DNA STRUCTURE

- James Watson & Francis Crick, using the work of Rosalind Franklin, made a model of a DNA molecule.
- DNA is a double stranded helix. Meaning, it resembles a twisted ladder.
- Each side of the ladder is made of deoxyribose (sugar) and phosphate groups.
- The rungs of the ladder are made up of 4 nitrogen bases held together in the center by a hydrogen bond. The four nitrogen bases in DNA are adenine (A), thymine (T), guanine (G), and cytosine (C)
- Adenine (A) always pairs with thymine (T).
- Cytosine (C) always pairs with guanine (G)

# DNA STRUCTURE




- When chromosomes are duplicated before mitosis & meiosis, the amount of DNA is the nucleus is doubled.

# DNA REPLICATION

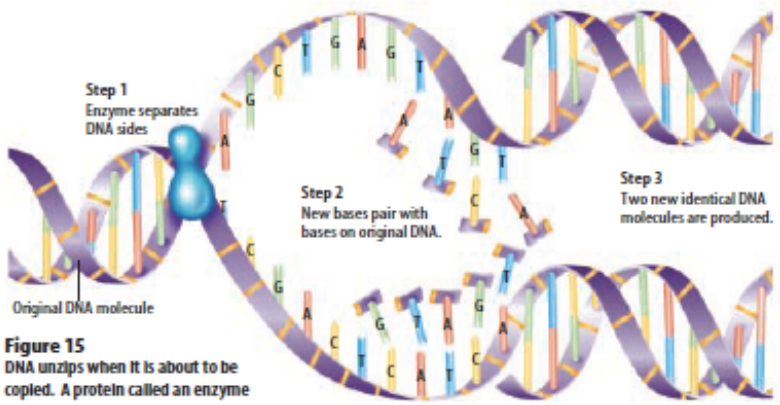
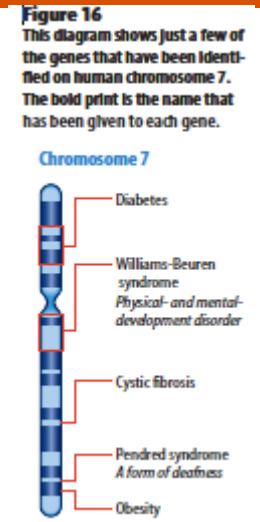



**Figure 15**
**DNA unzips when it is about to be copied. A protein called an enzyme helps unzip the DNA.**

- Start with a double stranded DNA molecule.
- An enzyme breaks the hydrogen bonds between the nitrogen base pairs. The two strands of DNA separate.
- Free bases pair up with the bases on each strand of DNA. (A-T, C-G) The order of bases in each new strand of DNA will match the order of base pairs in the original. (p.226)
- Sugar and phosphate groups form the side of each new DNA strand. You now have two DNA molecules identical to each other and to the original.

# Why is DNA important??




- All of the characteristics you have are affected by the DNA that you have in your cells. These characteristics you display are called traits. *How traits appear in you depends on the kinds of proteins your cells make.*

- DNA stores the blueprints for making proteins. (The order of amino acids determines this.) The section of DNA on a chromosome that directs the making of a specific protein is called a gene.

  - **REMEMBER**: *Proteins are made on the ribosomes in the cytoplasm. DNA is in the nucleus.*

# GENES

- The characteristics you have, such as the color of your hair, your height, and even how things taste to you, are determined by the kinds of proteins your cells make.
- Proteins are made by the ribosomes in the cells and are made from amino acids linked together in a specific order. Proteins work to build new cells and tissues or work as enzymes.
- The instructions for what kind of protein is made are determined by genes. Genes are a section of DNA on a chromosome. (p.226)
- Each chromosome contains hundreds of genes. These genes determine the order of the amino acids for a specific protein.
- What might occur if an important protein couldn't be made or if the wrong protein was made in your cells? Cystic fibrosis is on example. It is caused by an incorrect protein as a result of a bad gene.

# GENES

- REMEMBER: Proteins are made on the ribosomes in the cytoplasm. Genes are found on the chromosomes (DNA) in the nucleus.
- How does the code (on DNA) in the nucleus reach the ribosomes out in the cytoplasm? RNA

# RNA

- RNA (ribonucleic acid) carries the codes from the nucleus to the ribosomes where proteins are made.
- RNA is made in the nucleus on a DNA pattern.
- RNA is single stranded, and has the nitrogen bases adenine (A), guanine (G), cytosine (C), and Uracil (U).

| DNA | RNA |
|---|---|
| Sugar = deoxyribose | Sugar = ribose |
| double stranded | single stranded |
| Adenine pairs with Thymine | Adenine pairs with uracil |

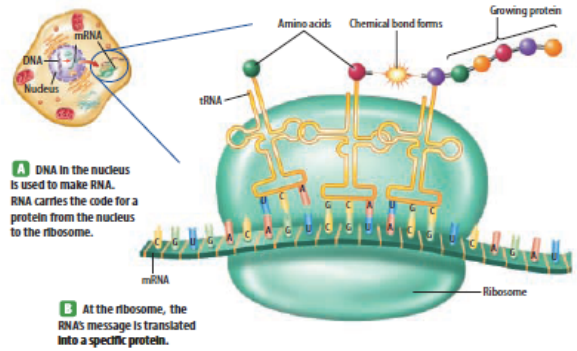
- There are 3 types of RNA - mRNA, tRNA, & rRNA

# RNA

- 3 Types of RNA:

1. rRNA (ribosomal RNA) - makes up the ribosomes
2. tRNA (transfer RNA) - collects amino acids in the cytoplasm and brings them to the ribosome.
3. mRNA (messenger RNA) - carries the code for making the specific protein from the nucleus to the ribosome. This code will direct the order in which the amino acids bond.

# PROTEIN SYNTHESIS




- Protein synthesis is the process in which proteins are produced.
- mRNA carries the code for making the specific protein.
- The code for one amino acid consists of three nitrogen bases called a codon. EX. AUG - is a codon that means "start". There is a codon for each of the 20 different amino acids. There are also codons that trigger the beginning and the end of protein synthesis.
- Cells must be able to control genes by turning some genes off and turning other genes on.
- If incorrect proteins are made by the cells, the organism cannot function properly.

# MUTATIONS

- A mutation is any permanent change in the DNA sequence of a gene or chromosome of a cell.
- Sometimes mutations include cells that receive an extra chromosome or are missing a chromosome.
- Outside factors such as X-rays, sunlight, and some chemicals have been know to cause mutations.
- If a mutation occurs in a body cell, it might or might not be life threatening to the organism. If mutations occur in a sex cell (gamete), then all the cells that are formed from that sex cell will have that mutation.
- Mutations add variety to a species when the organism reproduces. Some mutations are beneficial to the species. They provide the organism with traits that make it better suited for its environment. Many mutations will cause death in an organism.