



Wolters Kluwer  
Health

Lippincott  
Williams & Wilkins

# **Chapter 5**

## **Genetic Control of Cell Function and Inheritance**

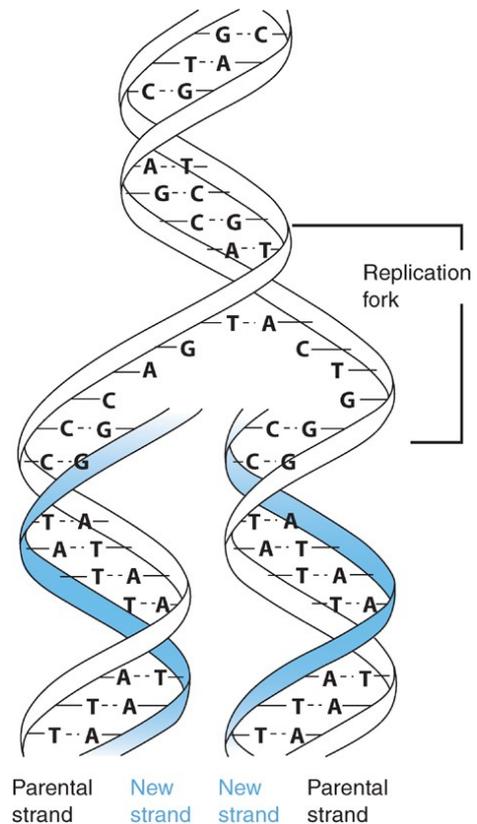


# Genes

- Sequences of DNA that contain the instructions for making a protein
  - Each set of three bases on the DNA codes for a specific amino acid.
  - The amino acids are strung together in the order specified to make the protein.



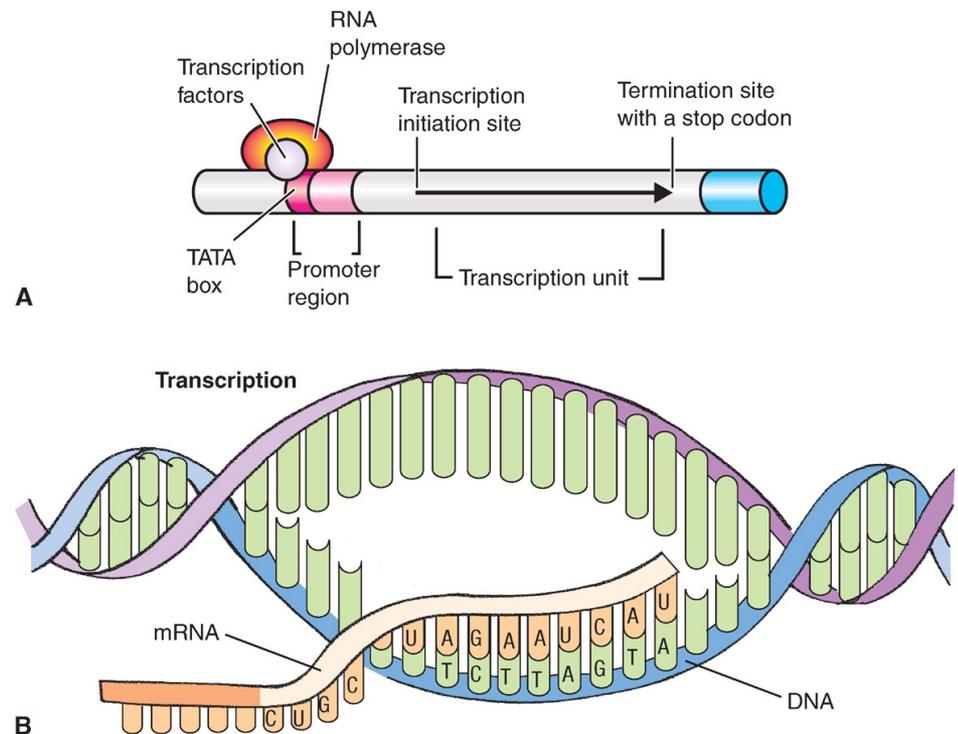
# Replicating DNA Helix





# Transcription

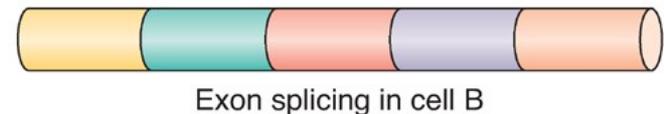
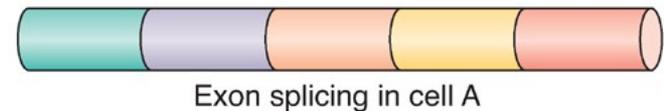
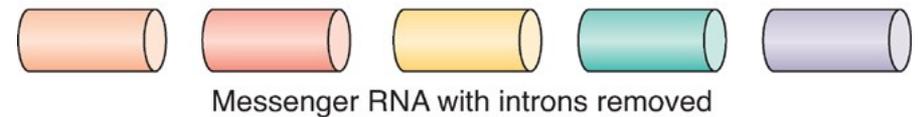
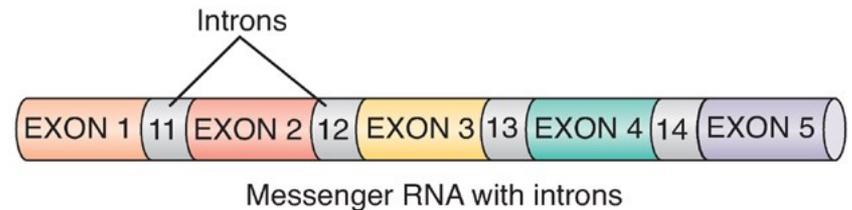
- DNA never leaves the nucleus.
- A messenger RNA copy of the gene is sent out to the cytoplasm.





# Processing mRNA

- One gene in nucleus
- Many different mRNAs
- Many different proteins





# Translation

- In the cytoplasm:
  - The mRNA acts as a pattern telling the cell how to line up amino acids to form a protein
  - Amino acids are carried into position by transfer RNA molecules
  - Ribosomes made of ribosomal RNA fasten the amino acids together to make a protein





## Ribosomal RNA

- Moves along the **messenger RNA**, moving **transfer RNAs** into position
- Connects **amino acids** that the **tRNAs** have carried into position



## Question

Which type of RNA moves from the nucleus into the cytoplasm, carrying the genetic code?

- a. Messenger RNA (mRNA)
- b. Transfer RNA (tRNA)
- c. Ribosomal RNA (rRNA)
- d. All of the above can move between the nucleus and the cytoplasm.



## Answer

### a. Messenger RNA (mRNA)

Messenger RNA is the only RNA that moves between the nucleus and the cytoplasm. Both tRNA and rRNA are relegated to the cytoplasm, while DNA never leaves the nucleus.



## Rank These Problems from Least Serious to Most Serious

- A serious error in the mRNA processing for a gene
- A serious mutation in the gene for the transfer RNA with anticodon AAA
- A serious mutation in the gene for ribosomal RNA



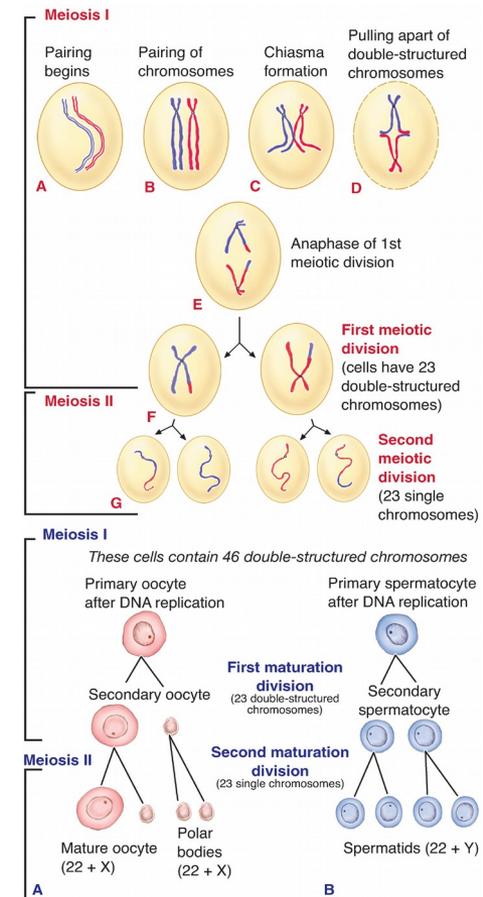
# Cell Division Requires Duplicating the DNA

- Telomeres: DNA sequences at the ends of the chromosomes
  - The enzymes that duplicate DNA attach here
  - The end of the telomere does not get duplicated
  - What will happen to the telomere as the cell continues dividing?
- A man has a mutation that causes some of his cells to rebuild their telomeres after every division; is this a good thing or a bad thing? Why?



# Meiosis

- Chromosomes duplicate
- One pair goes to each daughter cell on the first division
- One chromosome of each pair goes to the daughter cell on the second division
- Produces daughter cells (gametes) with only one copy of each chromosome





## Question

Tell whether the following statement is true or false:

Mitosis results in the formation of gametes (reproductive cells).



## Answer

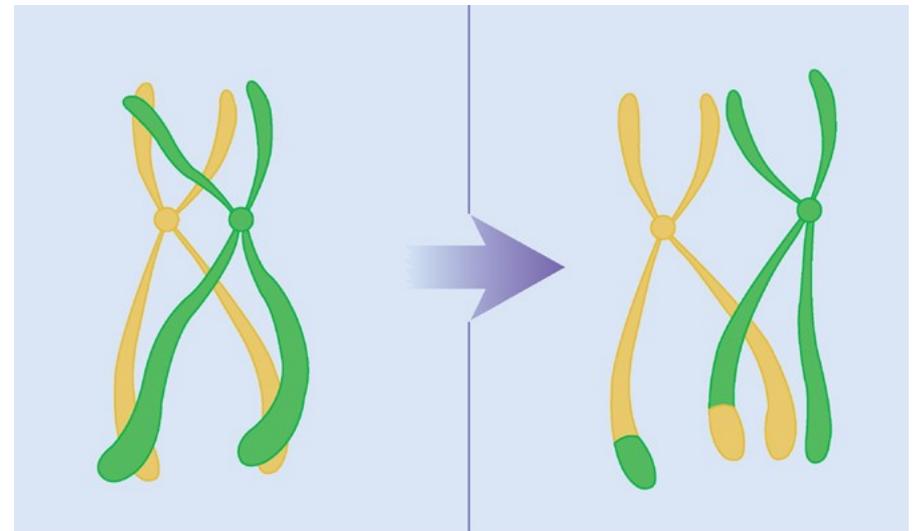
False

Mitosis replicates nongerm cells, like red blood cells and epithelial cells. It occurs during growth, replacement, or repair. Cell division that forms gametes is termed meiosis and occurs only once in a cell line.



## Crossing-Over

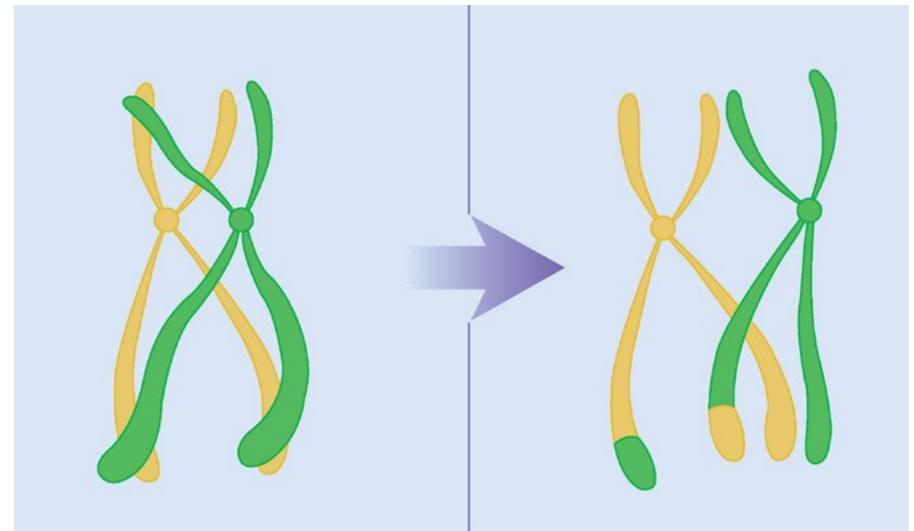
- When chromosome pairs line up during meiosis, they can exchange ends
- Each of the four resulting gametes will have a different combination of genes





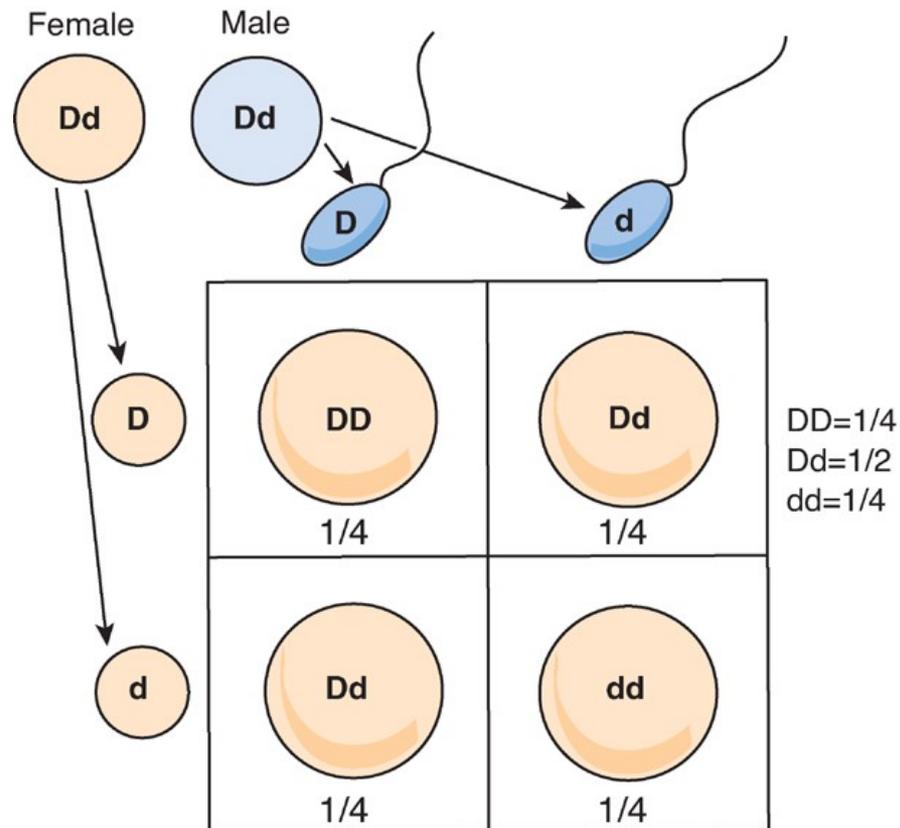
## Linkage

- Two genes that are close together on the chromosome are called “linked”
- Linked genes are rarely separated by crossing-over, and therefore are usually inherited together





# Punnett Square Summarizes Genetic Inheritance Process





## Alleles Are Copies of a Gene

- If all your copies of a gene are alike, you are **homozygous**
- If they differ, you are **heterozygous**
  - If you are heterozygous for a recessive trait and do not show it, you are a **carrier**
- If you have only one copy of a gene, you are **hemizygous**



## Genotype vs Phenotype

- Genotype: a person's genetic material
- Phenotype: a person's physical characteristics

Discussion:

If two people's genotypes are different, will their phenotypes be different also?



## Question

Tell whether the following statement is true or false:  
bb represents the phenotype for blue eyes.



## Answer

False

bb represents a genotype (arrangement of alleles). The physical trait that results from a certain genotype is termed phenotype. An easy way to remember this is the first two letters of the term and its description: phenotype/physical trait.



# Gene Expression—Is the Protein It Codes for Actually Produced?

- Genes “turn on” and “turn off”
- Induction: something turns a gene on
- Repression: something turns a gene off



## Question

Tell whether the following statement is true or false:

If a gene is induced where it should be repressed, the result can be injury to the tissue.



## Answer

True

While each chromosome contains the same genetic material, the same genes are not activated in every cell. For example, if a gene responsible for a digestive enzyme were to be induced in the lung, the result would be digestion of lung tissue, which would result in significant tissue/organ damage.



# Gene Expressivity—If the Protein Is Made, Does It Change a Person's Phenotype?

- No: It is **recessive**
- Yes: It is **dominant**
- Sometimes: It has intermediate **penetrance**



## Gene Interactions

- Many genes could affect one trait: **polygenic**
- Both multiple genes and the environment could affect one trait: **multifactorial**
- One gene could mask the effect of another: **epistasis**
- One gene might depend on another: **complementary**
- Two genes together might create a new phenotype: **collaborative**