Keystone Biology Remediation

B2: Genetics

Assessment Anchors:

- to describe and/or predict observed patterns of inheritance (i.e. dominant, recessive, co-dominance, incomplete dominance, sex-linked, polygenic, and multiple alleles) (B.2.1.1)
- to describe the processes that can alter composition or number of chromosomes (i.e. crossing-over, nondisjunction, duplication, translocation, deletion, insertion, and inversion). (B.2.1.2)
- to describe how the processes of transcription and translation are similar in all organisms (B.2.2.1)
- to describe the role of ribosomes, endoplasmic reticulum, Golgi apparatus, and the nucleus in the production of specific types of proteins (B.2.2.2)
- to describe how genetic mutations alter the DNA sequence and may or may not affect phenotype (e.g. silent, nonsense, frameshift) (B.2.3.1)
- to describe how genetic engineering has impacted the fields of medicine, forensics, and agriculture (e.g. selective breeding, gene splicing, cloning, genetically modified organisms, gene therapy) (B.2.4.1)

Unit Vocabulary:

agriculture
biotechnology
chromosomal mutation
cloning
co-dominance
crossing-over
deletion
dominant inheritance
duplication (mutation)
endoplasmic reticulum
forensics
frameshift mutation
gene expression
gene recombination
gene splicing
gene therapy
genetic engineering
genetically modified organism
genetics
genotype
Golgi apparatus
incomplete dominance
inheritance
insertion
inversion
missense mutation
multiple alleles
mutation
nondisjunction
nonsense mutation
phenotype
point mutation
polygenic trait
protein synthesis
recessive inheritance
ribosome
selective breeding
sex-linked trait
silent mutation
transcription
translation
translocation

Assessment Anchor: Describe and/or predict observed patterns of inheritance (i.e. dominant, recessive, co-dominance, incomplete dominance, sex-linked, polygenic, and multiple alleles) (B.2.1.1)

Dominant / Recessive

Description: Two alleles exist for the gene. One is dominant and the other is recessive.

Example: In pea plants, yellow seeds are dominant to green seeds. If a plant that is heterozygous for yellow seeds is crossed with one that has green seeds, what will be the genotypic and phenotypic ratios of their offspring?

Codominance

Description: Two alleles are expressed equally in the phenotype.

Example: A male brown horse in mated with a white female horse. The offspring that is produced has white and brown hairs making the horse appear light brown (roan). What offspring would you expect from the mating of a brown horse with a roan horse?

Incomplete Dominance

Description: The heterozygous condition produces a phenotype somewhere between the two extreme phenotypes.

Example: In four o'clock flowers, the allele for red flowers is incompletely dominant to the allele for white flowers. The heterozygous condition results in pink flowers. If a plant bearing red flowers is crossed with one bearing pink flowers, what will be the expected phenotypic ratio of their offspring?

Multiple Alleles

Description: More than 2 alleles exist for a particular gene. The most common example is blood type in humans.

Example: A woman with type O blood marries a man with type AB blood. What will be the phenotypic ratio of their offspring?

(Blood type is also an example of codominance because the A allele and the B allele are **codominant**.)

Polygenic Inheritance

Description: More than one pair of genes is responsible for a phenotype. (Examples are traits that exhibit a range of phenotypes like skin color, hair color and eye color.)

Example: You won't have to do a problem of this type (and I couldn't fit it in this space – it's long!)

Sex-Linked Traits

Description: The gene for a trait is carried on a sex chromosome (usually the X).

Example: In humans, color-blindness is recessive and sex-linked. Cross a normal woman whose father was color-blind and whose mother was normal with a man who is color-blind. Show the cross.

What are the chances that their children will be color-blind? What are the chances that their children will be carriers?

What are the chances that their children will be normal?

Important Vocabulary

Chromosome = structure made of DNA and protein that carry the genetic code from one generation to the next

Gene = factor that controls a trait or a segment of DNA that controls a particular trait (This term wasn't used by Mendel; it was coined later.)

Alleles = different forms of a gene

Example: There is a gene for seed color in peas. (This means that there is a section of a chromosome in pea plants that controls the color of the seeds.) There are two alleles for that gene – green and yellow.

Dominant = having the ability to cover up the effects of another allele; is always expressed when present

Recessive = able to be covered up; only expressed if no dominant allele is present

Genotype = genetic make-up of an organism **(Example: TT, Tt, tt)**

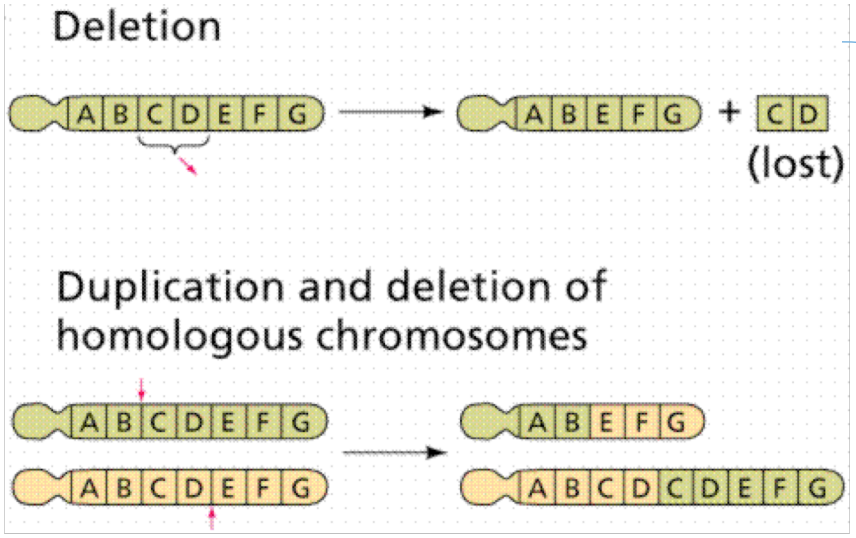
Phenotype = an organism's physical characteristics **(Example: short or tall)**

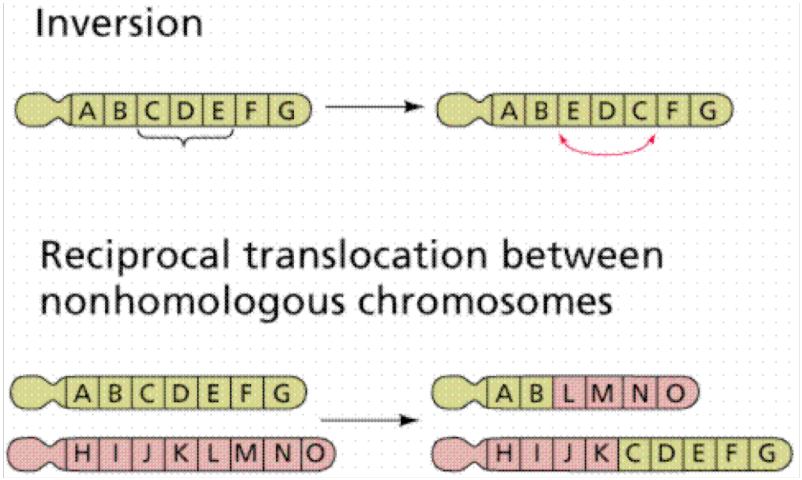
Homozygous = having two of the same alleles for a particular trait **(Example: TT or tt)**

Heterozygous = having two different alleles for a particular trait **(Example: Tt)**

Assessment Anchor: Describe the processes that can alter composition or number of chromosomes (i.e. crossing-over, nondisjunction, duplication, translocation, deletion, insertion, and inversion). (B.2.1.2)

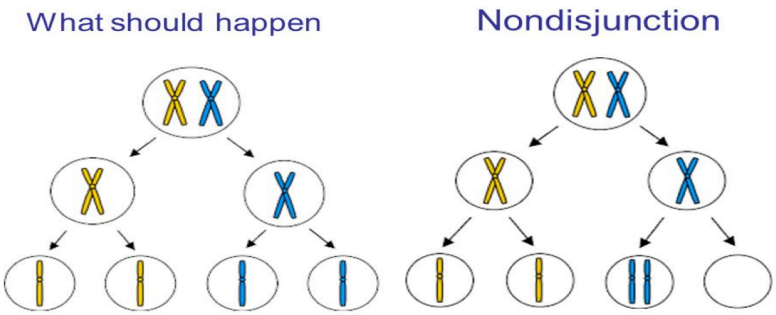
Types of Chromosome Mutations





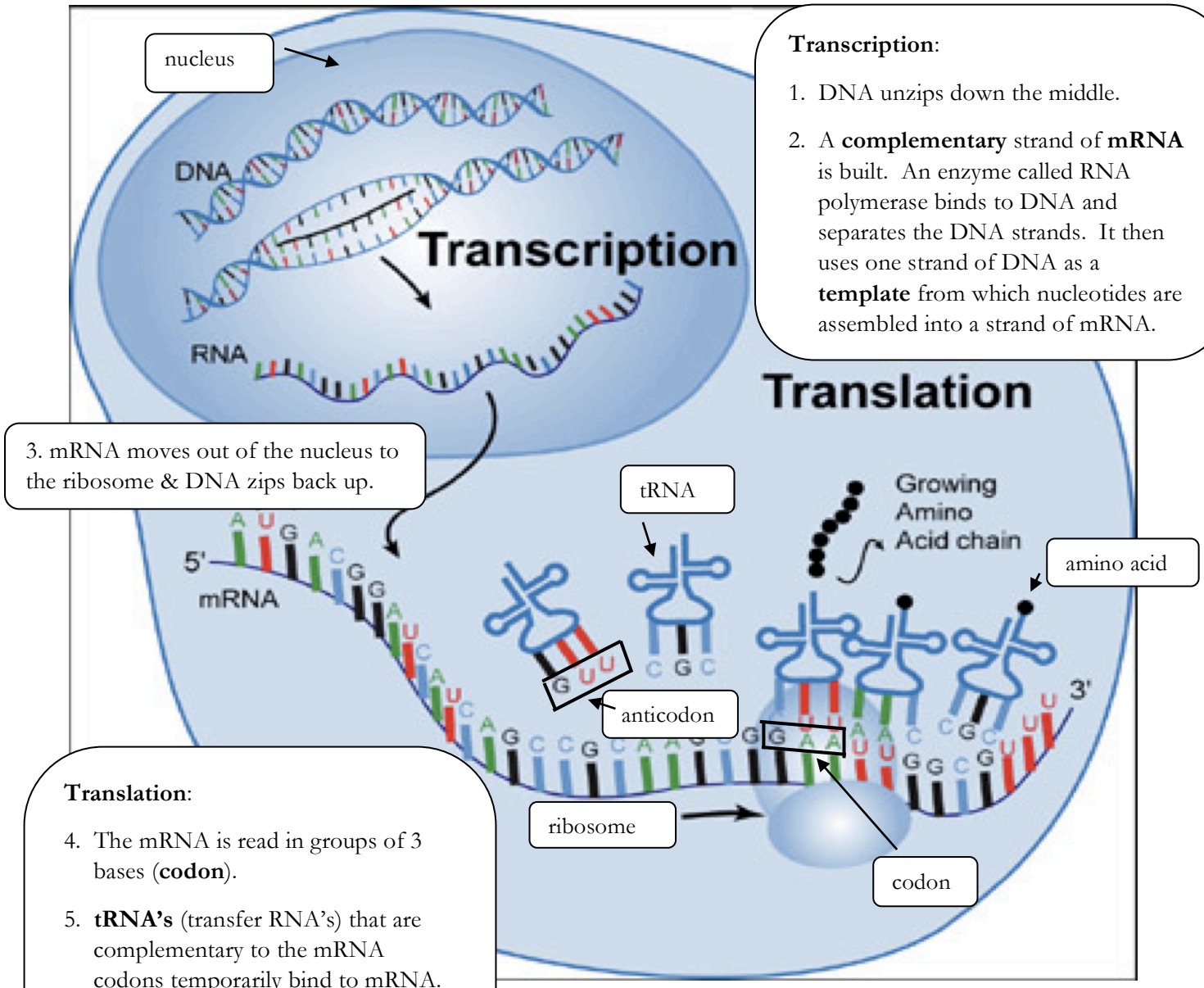
*** Each letter represents a gene on a chromosome.

Nondisjunction – the failure of homologous chromosomes to separate properly during meiosis



Assessment Anchor: Describe how the processes of transcription and translation are similar in all organisms (B.2.2.1)

OVERVIEW OF PROTEIN SYNTHESIS



Transcription:

1. DNA unzips down the middle.
2. A **complementary** strand of **mRNA** is built. An enzyme called RNA polymerase binds to DNA and separates the DNA strands. It then uses one strand of DNA as a **template** from which nucleotides are assembled into a strand of mRNA.

Translation:

4. The mRNA is read in groups of 3 bases (**codon**).
5. **tRNA's** (transfer RNA's) that are complementary to the mRNA codons temporarily bind to mRNA.
6. Each tRNA carries an amino acid on one end & has a group of three bases as the other (**anticodon** = "opposite" of codon).
7. **Peptide bonds** are formed between the amino acids creating a protein.
8. After it has dropped off its amino acid, the tRNA returns to the cytoplasm and picks up another amino acid.

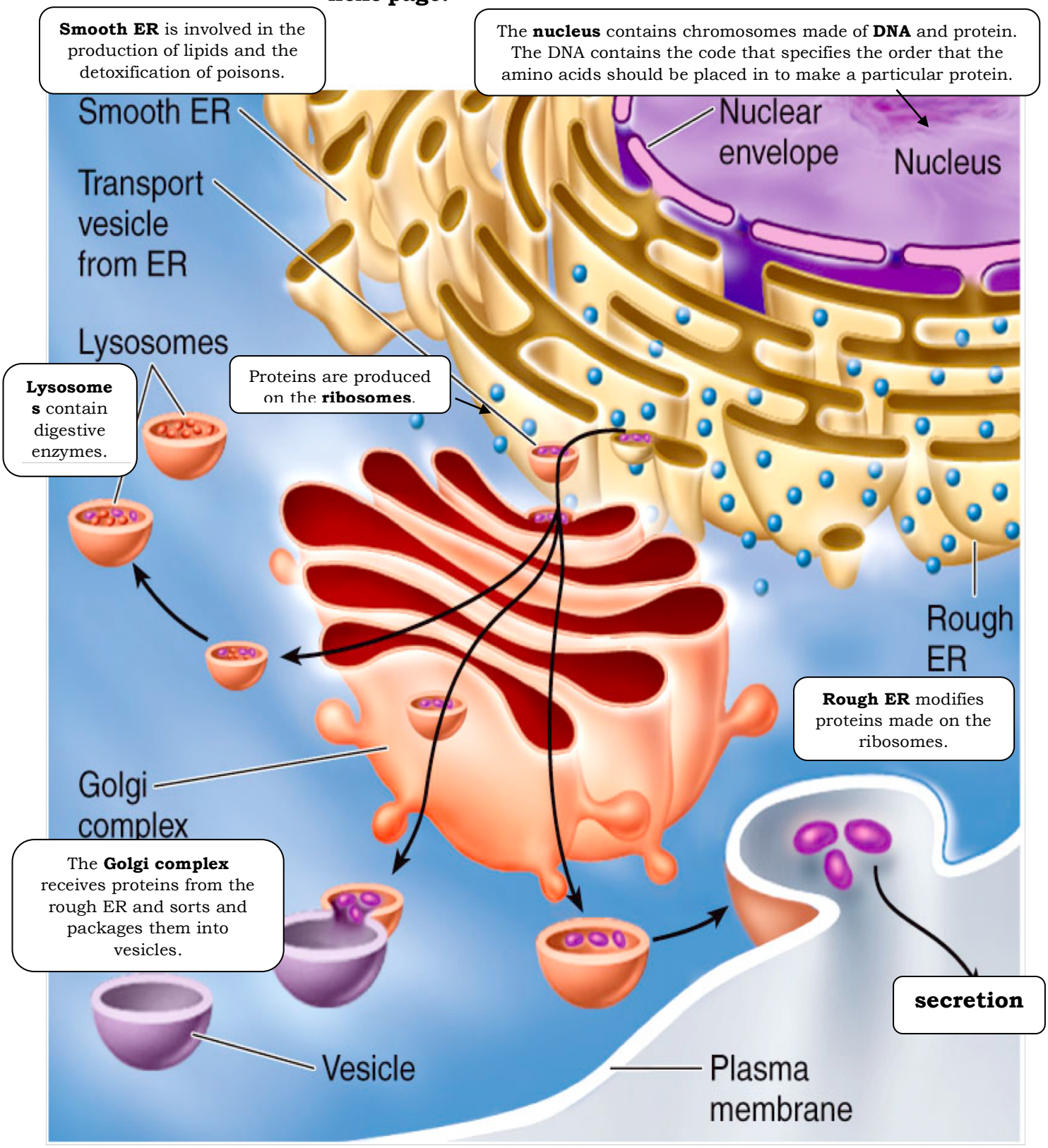
Translation (the building of proteins by joining amino acids) is the same in prokaryotes and eukaryotes.

Transcription (the copying of the code in DNA into an mRNA molecule) is the same in both prokaryotes and eukaryotes, except it doesn't occur in the nucleus in prokaryotes because prokaryotes don't have a nucleus.

Assessment Anchor: Describe the role of ribosomes, endoplasmic reticulum, Golgi apparatus, and the nucleus in the production of specific types of proteins (B.2.2.2)

ENDOMEMBRANE SYSTEM

Production of Proteins – study the diagram below to accompany the flow chart on the next page.



The code for the production of a particular protein is found in the chromosomes which are located in the **nucleus**.

↓

Proteins are produced on the **ribosomes**.

↓ Proteins are transported in **vesicles**.

The proteins are sent for further processing to the **rough endoplasmic reticulum**.

↓ Proteins are transported in **vesicles**.

The proteins are then packaged for their final destination in the **Golgi complex**.

Some proteins will speed up chemical reactions within the cell. These are called **enzymes**.

Some proteins will be incorporated into the plasma membrane.

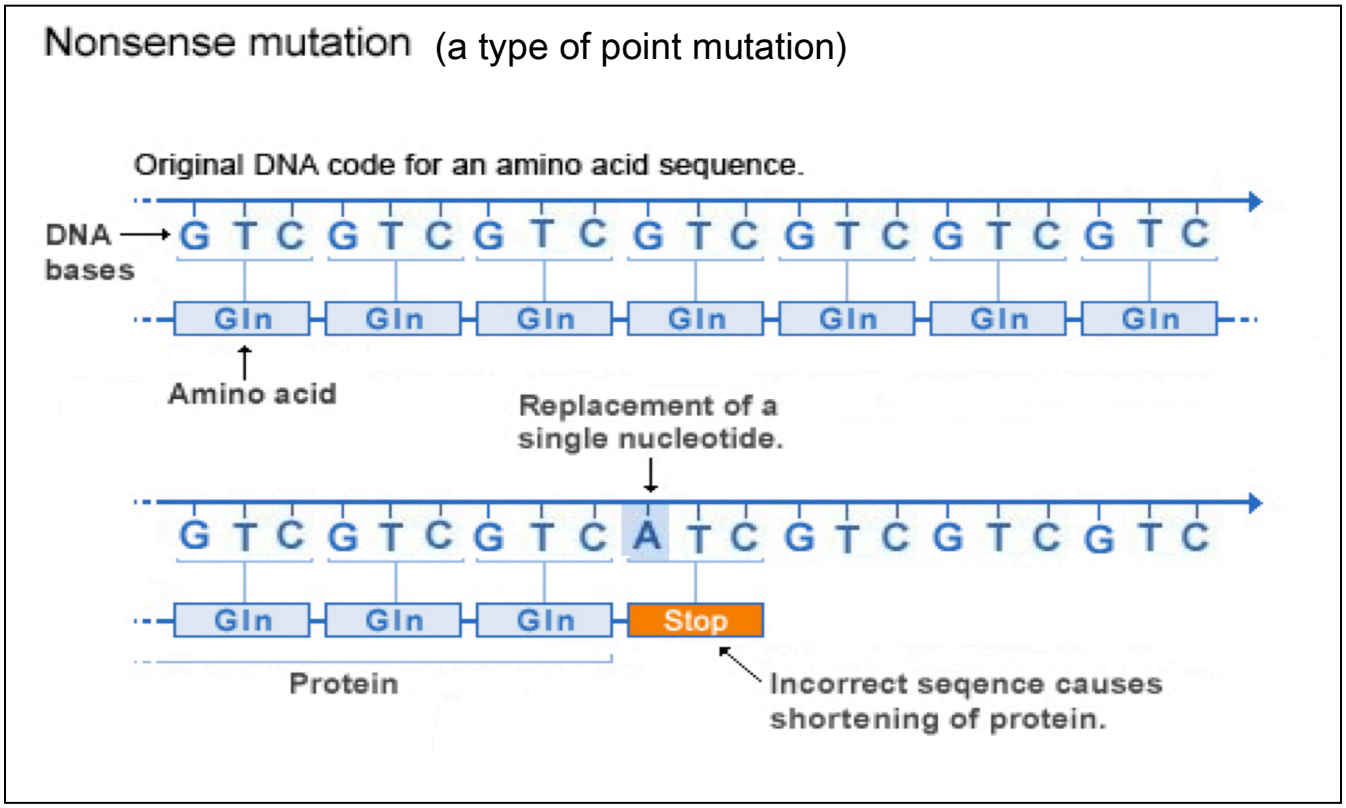
Examples are:

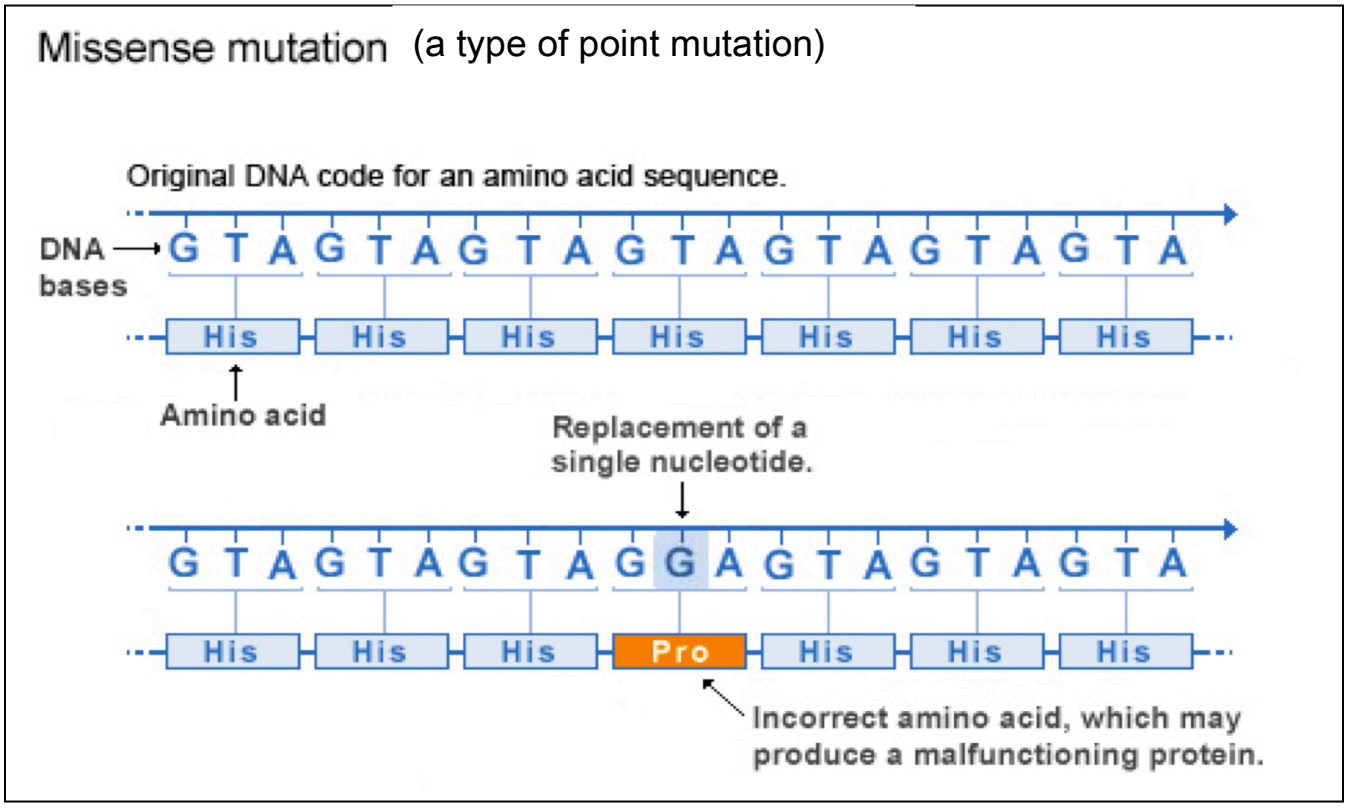
- **marker proteins**
- **channel proteins**
- **transport proteins (pumps)**

If the proteins are to be **secreted** from the cell (such as hormones), the vesicle must fuse with the **plasma membrane**.

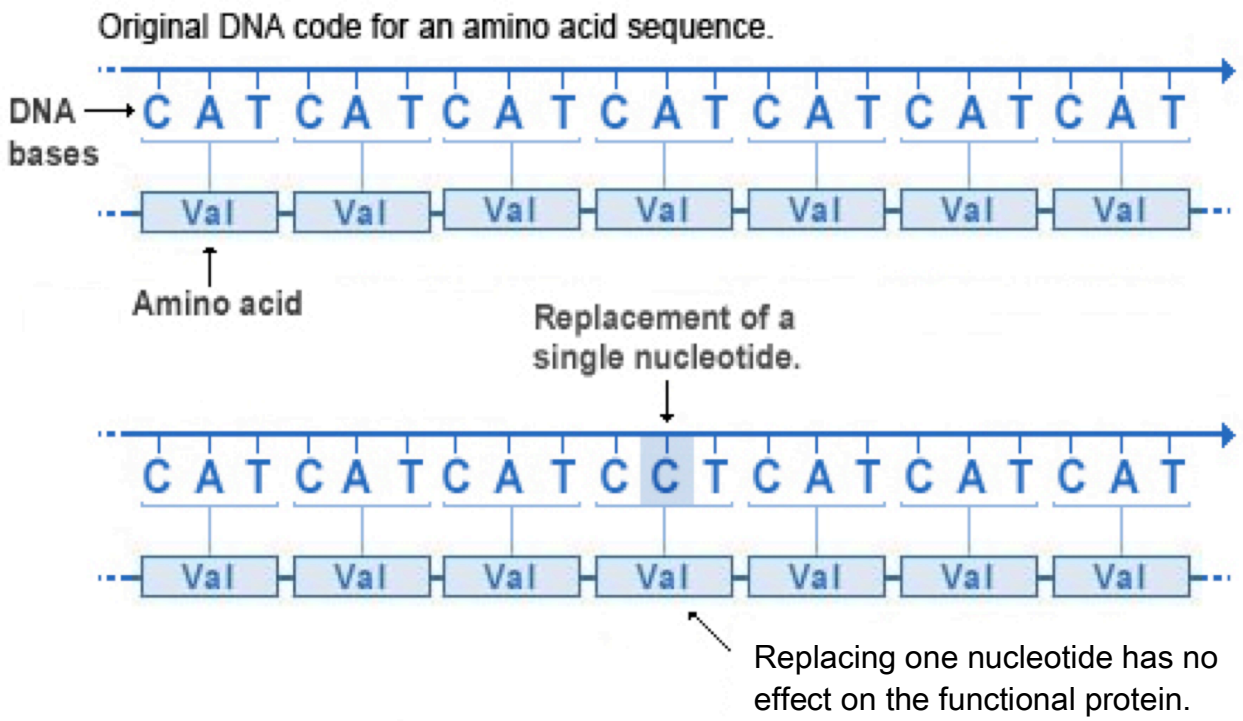
Some vesicles develop into organelles used for digestion within the cell and are called **lysosomes**.

Assessment Anchor: Describe how genetic mutations alter the DNA sequence and may or may not affect phenotype (e.g. silent, nonsense, frameshift) (B.2.3.1)

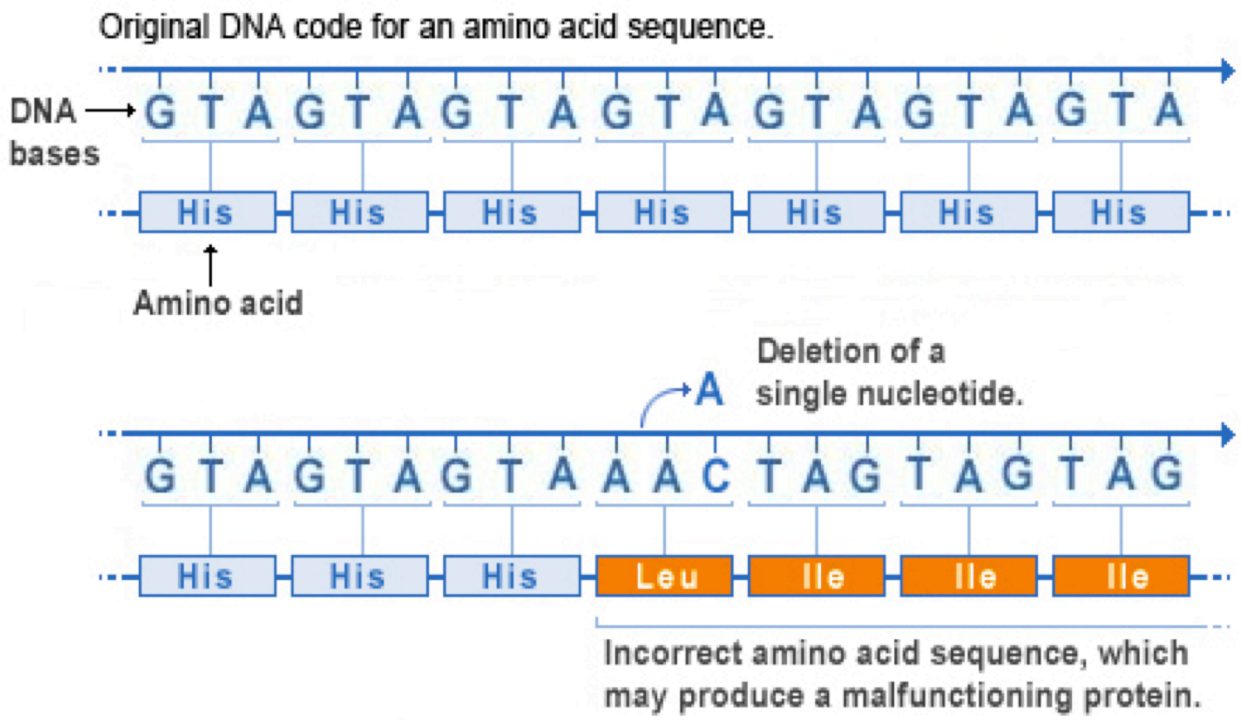




Silent Mutation



Frameshift Mutation



Assessment Anchor: Describe how genetic engineering has impacted the fields of medicine, forensics, and agriculture (e.g. selective breeding, gene splicing, cloning, genetically modified organisms, gene therapy) (B.2.4.1)

Genetic Technology	Description	Pros	Cons
Selective breeding	when humans select the individuals that will reproduce in order to achieve desirable characteristics in their offspring	• free • doesn't alter the environment • higher profit • reducing diseases	• slow (generations) • loss of variety
Genetically modified organisms	removing the gene for a desirable characteristic from organism and inserting it into the DNA of another organism	• Plants that are pest resistant would result in less pesticides used. • Plants that are drought resistant could grow in areas that don't have enough food. • Production of medicine	• expensive • some people are opposed • we don't know how this will affect natural crops in the future • fear of food allergies
Gene therapy	inserting functional genes to replace defective genes in order to treat genetic disorders	• could treat diseases that currently are unable to be treated	• expensive (so may only be available to the wealthy) • so far not much luck in finding a reliable delivery system
Forensics	using genetic technologies (or other areas of expertise) in court	• DNA is very reliable evidence	• People are worried what might be done with their DNA information once it is put into a database.
Cloning	producing identical organisms from an existing organism	• Large amounts of some medicine (insulin) can be produced by bacteria • Possibly increasing the population of endangered organisms	• moral implications of cloning people