Biology AHA
4th Marking Period
Benchmark Review

Table of Contents

Asexual vs. Sexual Reproduction

Asexual	***Sexual***
Advantages: faster, easier, only requires one "parent"	*Advantage:* variety
Disadvantage: No variety, offspring are the same as parent	*Disadvantages*: more time, effort and risk, requires two parents

MITOSIS

INSERT: http://www.biology101.org/studyguides/mitosis.pdf

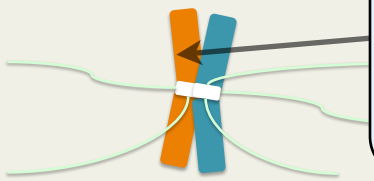
STUDY GUIDE FOR

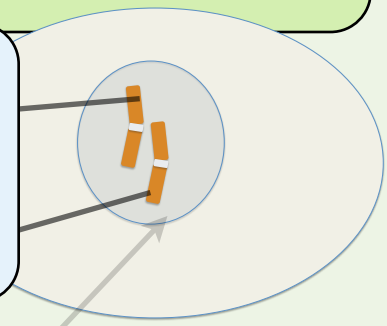
Mitosis

Mitosis is the process where a eukaryotic cell doubles its chromosomes (DNA) and then divides into two cells that are copies of the orginal cell. It is how new cells are made when an organism (like you) grows or repairs damaged tissue (like a cut).

Prophase

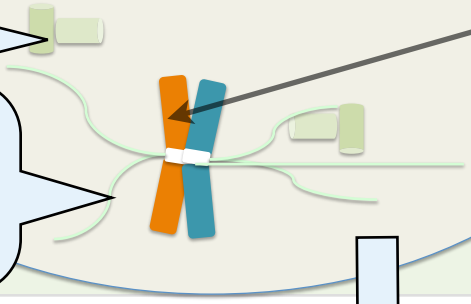
A cell with 2 chromosomes is shown to the right in interphase. Each of these chromsomes duplicates to produce copies (sister chromatids) shown in blue to the left (all the chromosomes are not condensed and visible until prophase).



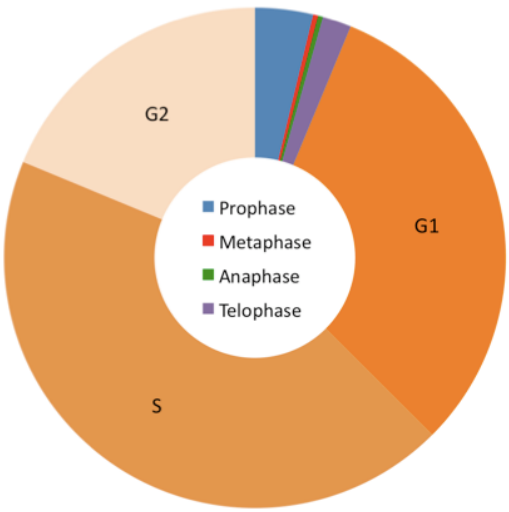


Centrioles within the centrsome.

A spindle fiber made of microtubules made of tubulin.

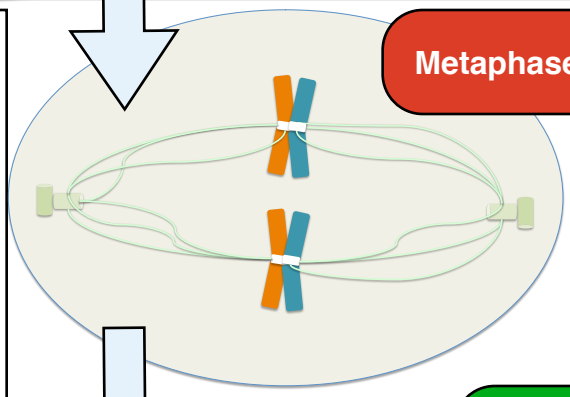


In prophase, the spindle fibers begin to form and attach to the **centromeres** (shown in white) of each pair of **sister chromatids**. The **nuclear envelope** dissolves and the **centrioles** move towards opposite poles of the cell. A protein structure called the **kinetochore** connects the spindle fibers to the centromeres.



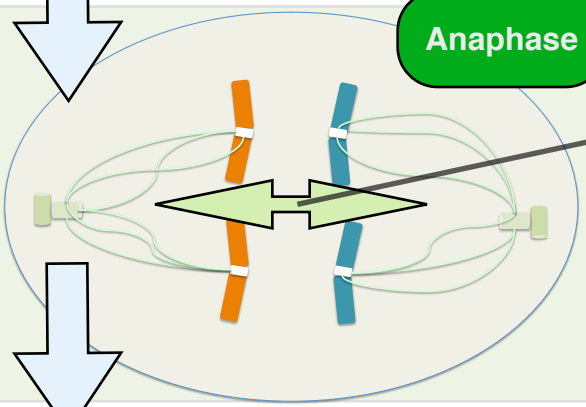
Mitosis is part of a larger cell cycle. When not in mitosis the cell is in **interphase** which is divided into **G1** (Gap1), **S** (Synthesis) and **G2** (Gap 2). The chromosomes are actually duplicated in the S phase but not visible until prophase. The relative time of each stage is shown in the pie chart above.

Metaphase



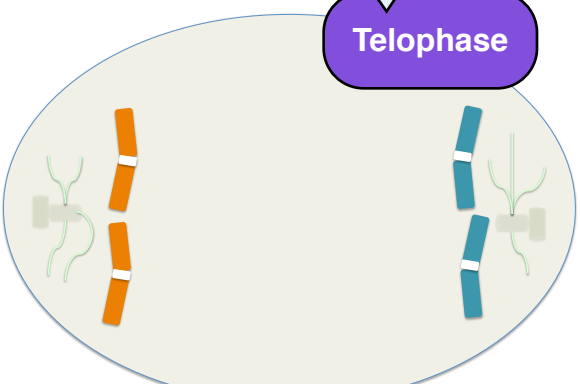
The spindle fibers pull the chromsomes to the center of the cell (the **metaphase plate)**. We call this stage metaphase, once all the centromeres are aligned in the center of the cell.

Anaphase



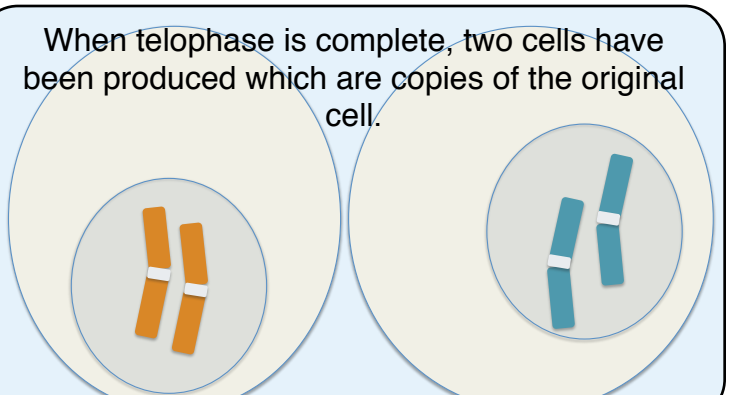
Anaphase is the stage of mitosis when the sister chromatids are pulled apart (they **disjoin**) and each copy is pulled to an opposite pole of the cell.

Telophase

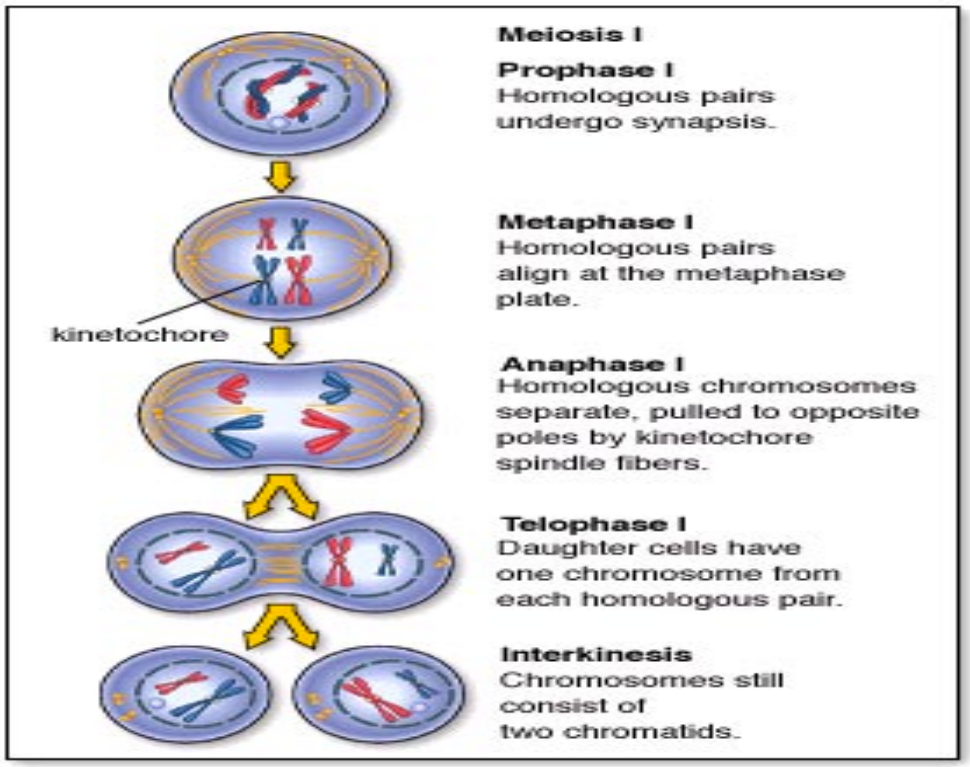


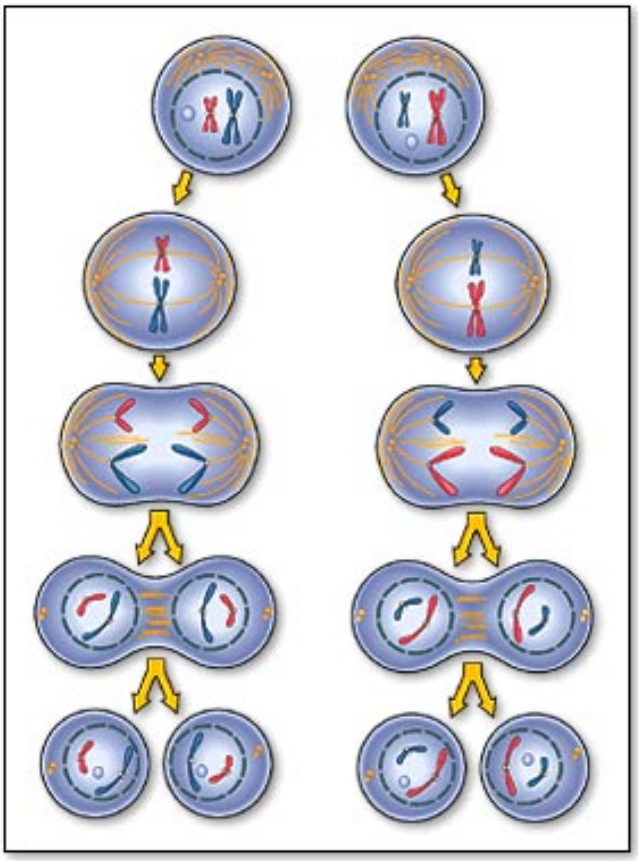
In telophase the cell divides in half (**cytokinesis**), spindle fibers disappear and the nuclear envelope forms around each set of chromsomes.

When telophase is complete, two cells have been produced which are copies of the original cell.



MEOISIS


Meiosis I
Prophase I
Homologous pairs undergo synapsis.
Metaphase I
Homologous pairs align at the metaphase plate.
kinetochore
Anaphase I
Homologous chromosomes separate, pulled to opposite poles by kinetochore spindle fibers.
Telophase I
Daughter cells have one chromosome from each homologous pair.
Interkinesis
Chromosomes still consist of two chromatids.


Meiosis II separates sister chromatids
Prophase II
Cells have one chromosome from each homologous pair.
Metaphase II
Chromosomes align at the metaphase plate.
Anaphase II
Daughter chromosomes move toward the poles.
Telophase II
Spindle disappears, nuclei form, and cytokinesis takes place.
Daughter Cells
Meiosis results in four haploid daughter cells.

Mitosis vs Meiosis

MITOSIS	*MEIOSIS*
1. Somatic (body) cells undergo mitosis 2. One division => two IDENTICAL, diploid (2n) cells. 3. Chromosome number in the daughter cells is the same as in the parent cell. 4. Large organisms use mitosis for growth and healing. Simple organisms use it to reproduce.	1. Sexual reproduction 2. One cell divides twice to make four DIFFERENT cells. 3. All 4 cells are haploid (n) meaning they have half the number of chromosomes found in the parent cell. 4. Makes gametes (sex cells). In humans 4 sperm cells or 1 egg and three polar bodies are produced each time meiosis occurs. 5. Separates pairs of homologous chromosomes so that offspring get one chromosome of each pair from a different parent.

E. Fertilization occurs in the fallopian tube. A fertilized egg is called a zygote and has a normal number of chromosomes (2n).

F. The fetus develops in the uterus. Cells divide without becoming larger (cleavage). After a few days, cells begin to differentiate – that is they start to form different types of cells (nerve, skin, bone, etc). At this stage the embryo is very vulnerable to alcohol, drugs, etc. because the important organs and systems are just starting to develop.

GENETICS AND HEREDITY

A. Humans have 46 chromosomes, or 23 homologous pairs.

B. Chromosome pairs carry alleles for the same trait. We all have two alleles for each gene—1 from each parent, 1 on each member of the homologous pair.

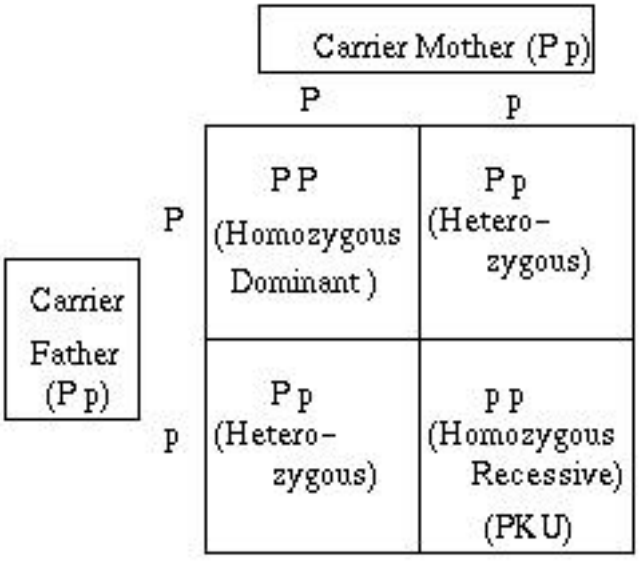
C. While genes determine our traits, the environment can affect expression of genes.

D. Each chromosome has hundreds or thousands of genes. Each gene codes for a particular protein (1 gene = 1 protein).

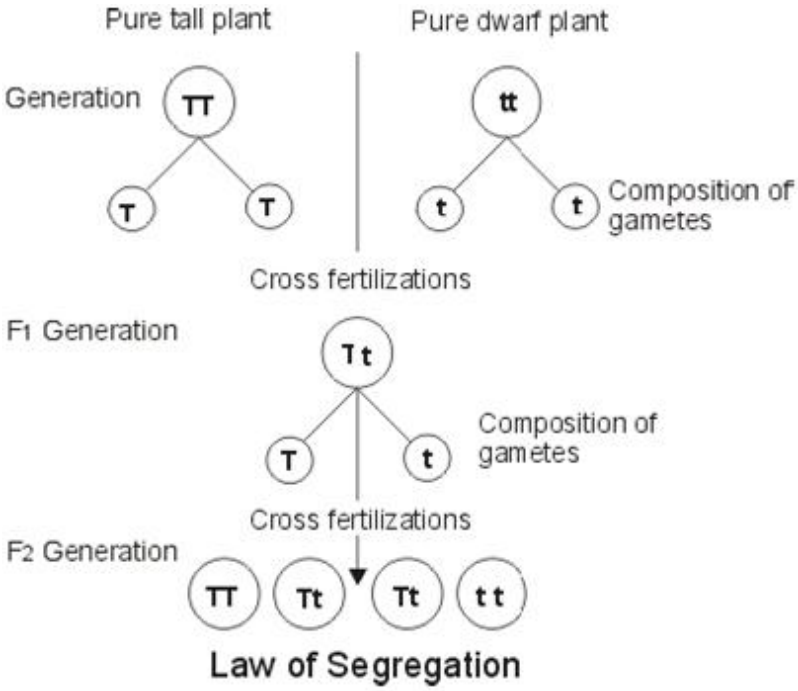
A person can be **heterozygous** or **homozygous** for any gene.

- **Heterozygous**-different types of gene (ex: Tt)
- **Homozygous**
    1. **Homozygous dominant**-same type of *dominant gene* (ex: TT)
    2. **Homozygous recessive**-same type of *recessive gene* (ex: tt)

PUNNETT SQUARE



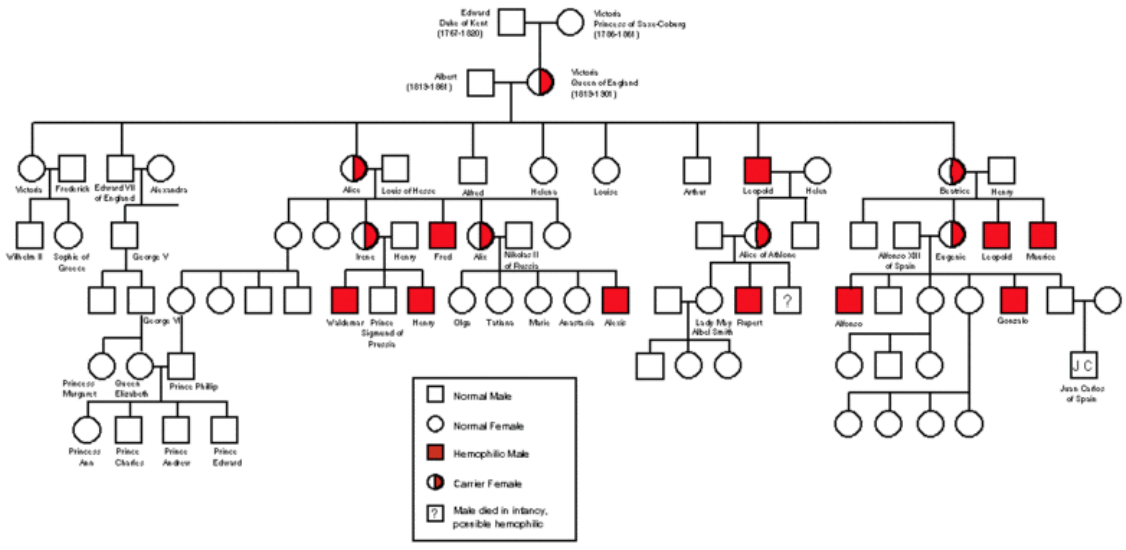
Mendel's Law of Segregation



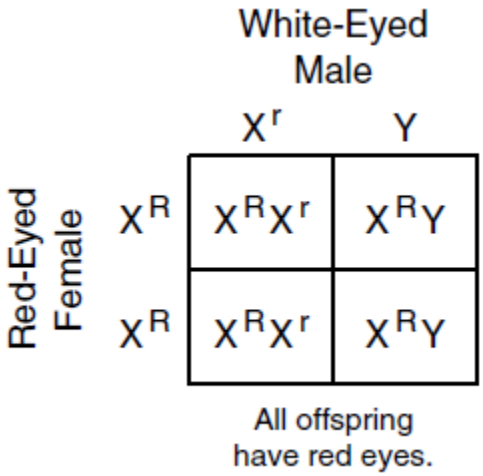
Law of segregation states the principle stating that during the production of gametes the two copies of each hereditary factor segregate so that offspring acquire one factor from each parent.

Recombination is when genetic factors from each parent are combined during the "crossing over" phase of Meiosis.

PEDIGREE



SEX-LINKED TRAITS

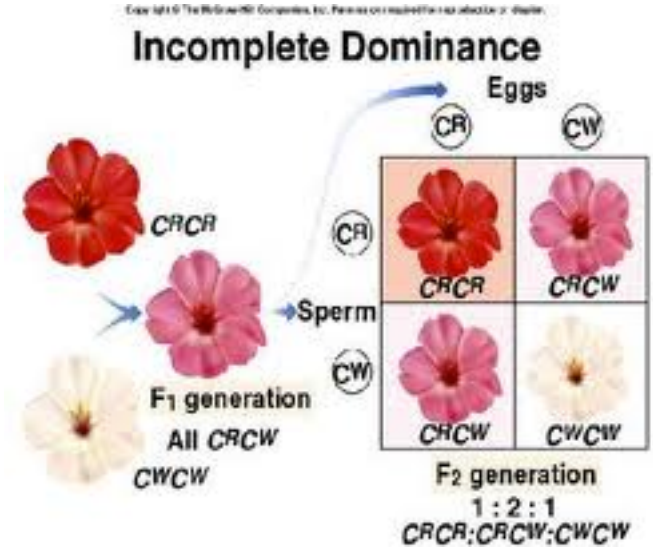


Possible Punnett Square of Hemophilia

	X^H	X^h
X^H	X^HX^H	X^HX^h
Y	X^HY	X^hY

- Hemophilia is sex-linked, meaning the allele that codes for the hemophilic trait is found on the 23rd chromosome, also known as the sex chromosome. Certain diseases cannot be passed on from father to son because of this sex-linkage.

Incomplete Dominance

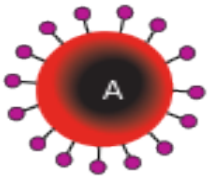
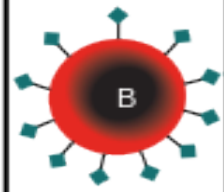
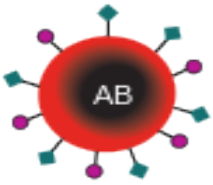
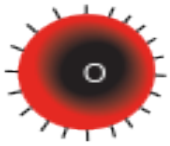
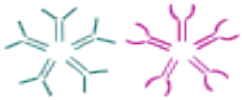


Neither allele is dominant or recessive. Having both allele will result in a *third* phenotype. (something in "between")

Codominance

BOTH alleles are dominant and are expressed simultaneously. Perfect example: blood type. Allele for both type A and type B blood are both dominant so together they are **codominant**. See "Genetics of Blood Type" below.

GENETICS OF BLOOD TYPE

	Group A	Group B	Group AB	Group O
Red blood cell type				
Antibodies in Plasma	 Anti-B	 Anti-A	None	 Anti-A and Anti-B
Antigens in Red Blood Cell	A antigen	 B antigen	 A and B antigens	None

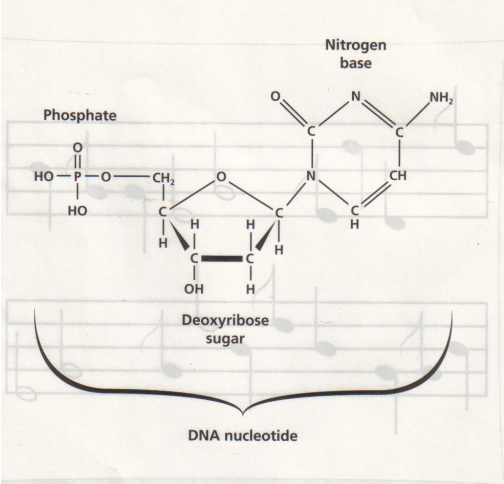
Phenotype (Blood type)	Genotype
Type A	I^AI^A or I^Ai
Type B	I^BI^B or I^Bi
Type AB	I^AI^B
Type O	i i

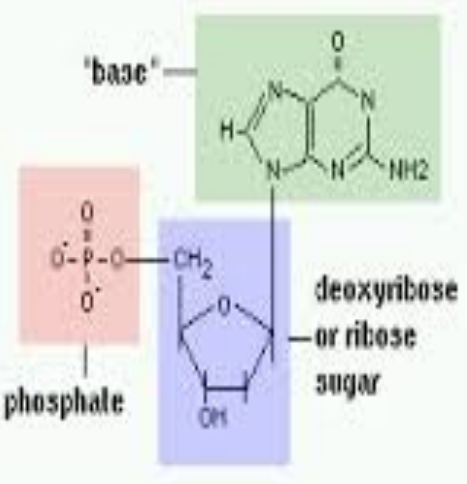
Two Alleles Controlling Human Blood Type

Symbol	Allele Description
I^A	produces antigen A on red blood cells
I^B	produces antigen B on red blood cells

MOLECULAR GENETICS

DNA Nucleotide:

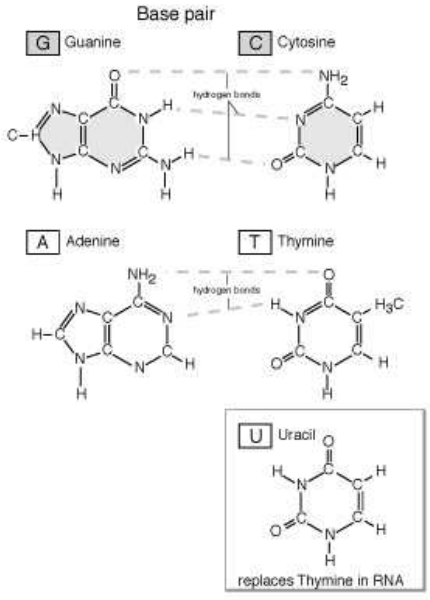


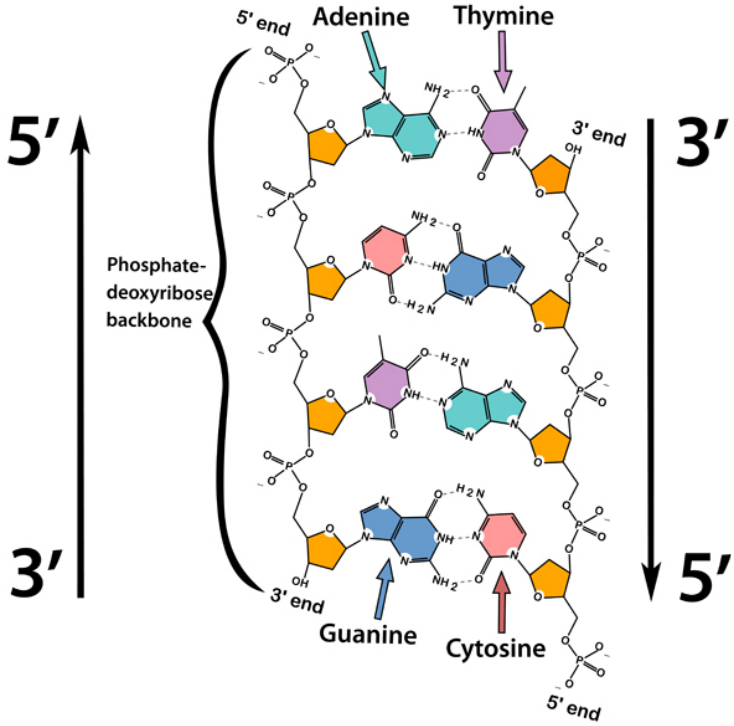


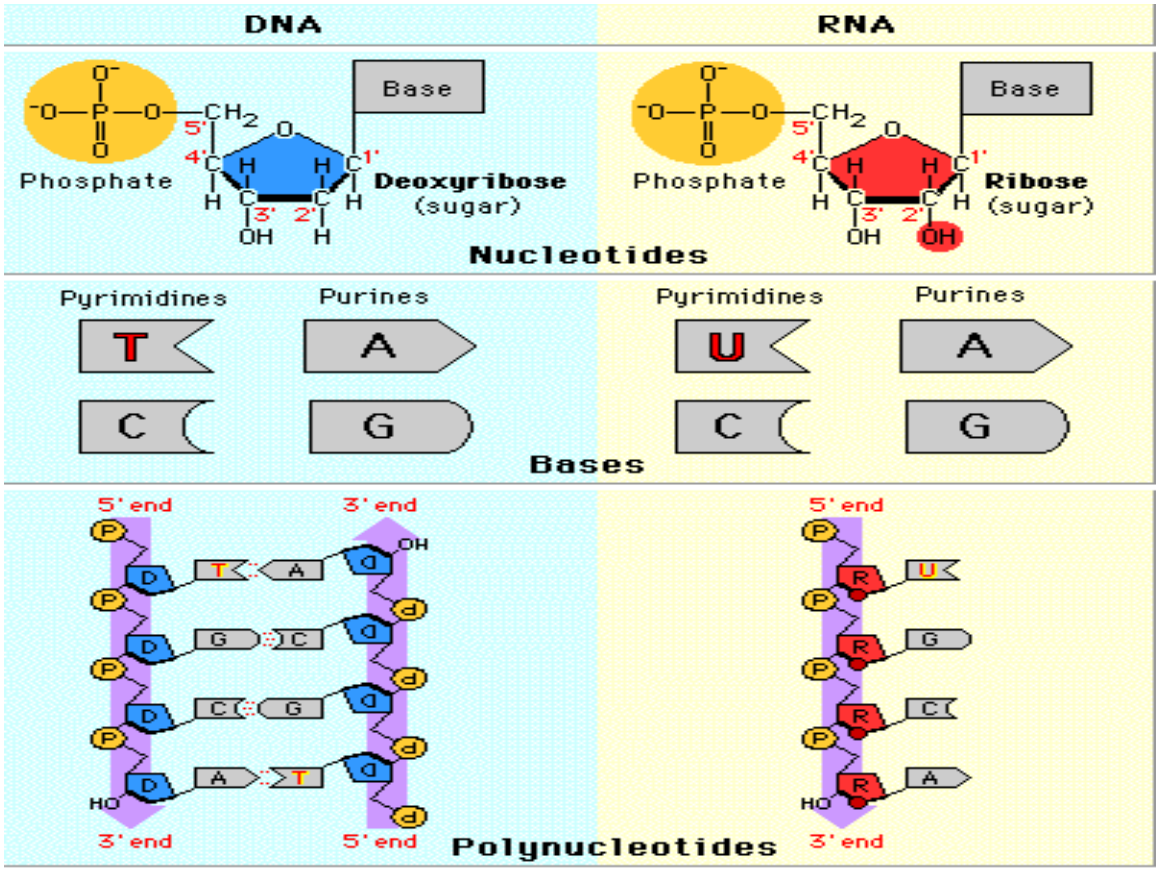
E. DNA (deoxyribonucleic acid) is made of 4 bases: ATCG.

A = adenine
T = thymine
C = cytosine
G = guanine

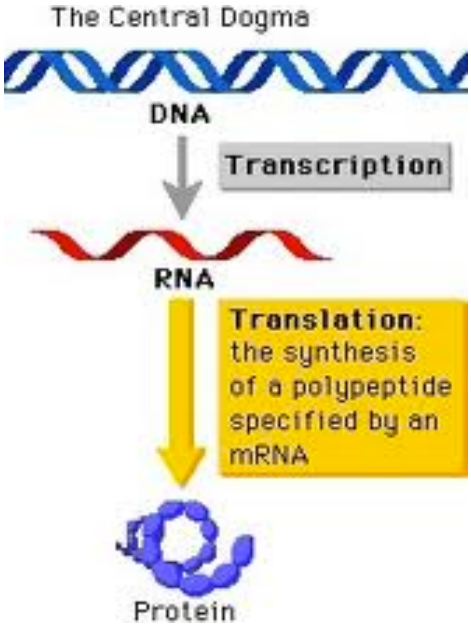
Base pairs: A=T, C-G (in **RNA**, A-U and C-G)



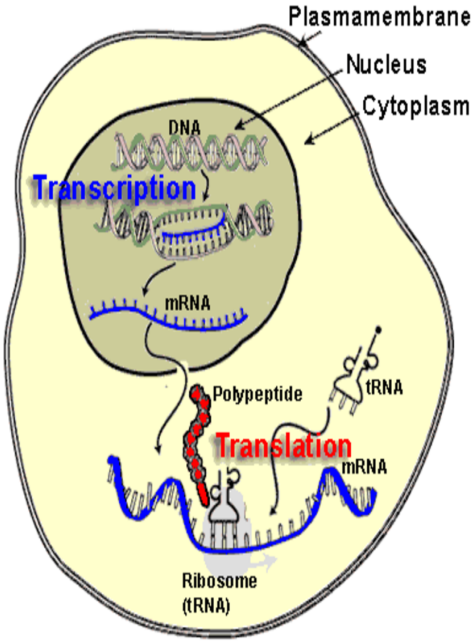




CENTRAL DOGMA OF MOLECULAR BIOLOGY

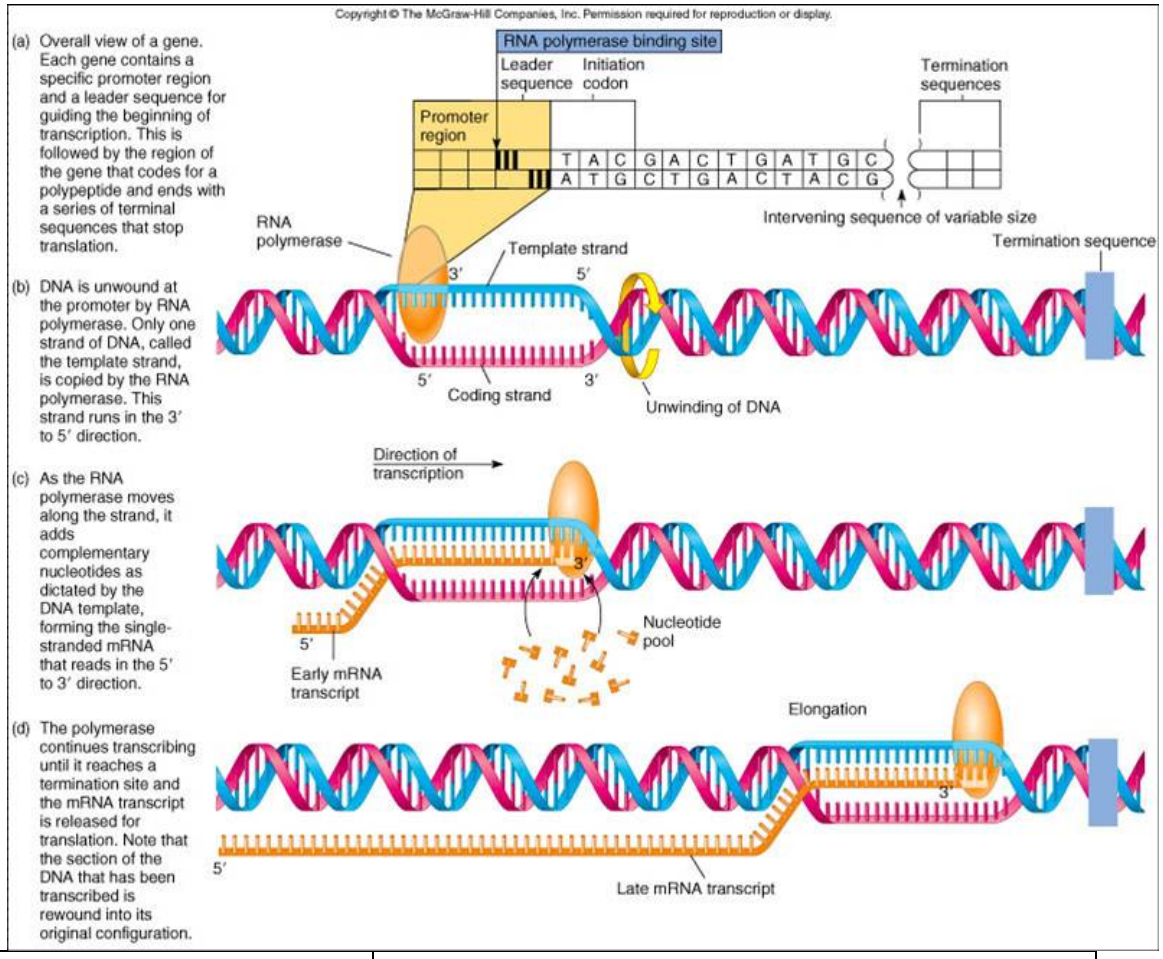


Transcription and Translation



- A three-letter codon represents a specific amino acid. These amino acids are assembles into proteins.
- RNA carries the genetic code to ribosomes. The ribosomes then synthesize protein.

TRANSCRIPTION



Transcription Step	
1. Initiation	-Transcription Factors and RNA polymerase bind to the promoter region (contains TATA box) -DNA helix is unwound and is ready to be transcribed
2. Elongation	-RNA polymerase moves along protein encoding gene and adds nucleotides to create mRNA in the 5' – 3' direction
3. Termination	- RNA polymerase reaches the terminator region of protein encoding gene -All enzymes and factors are released

TRANSLATION

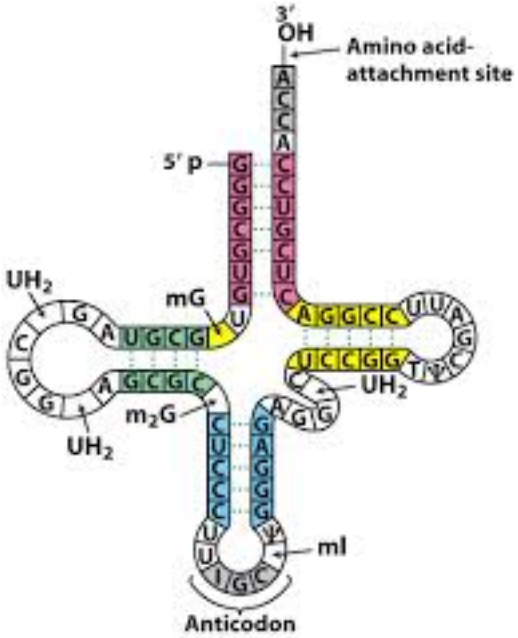
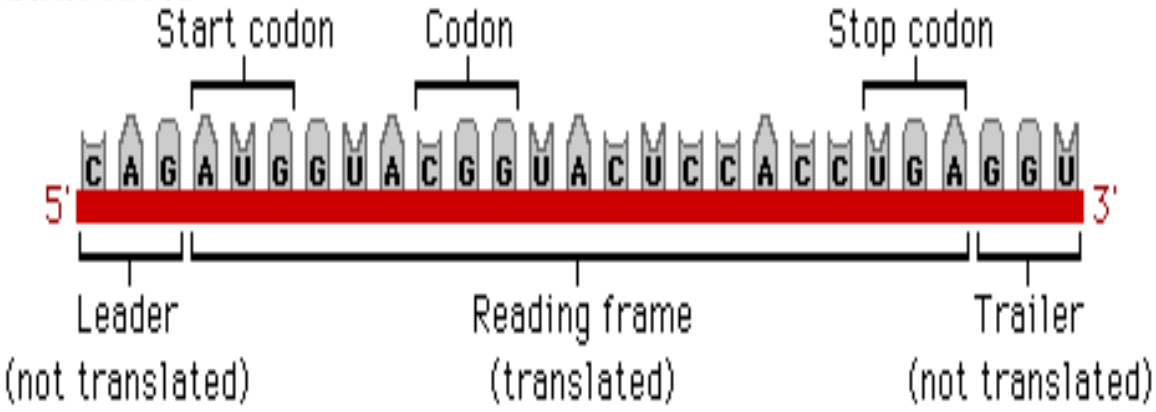
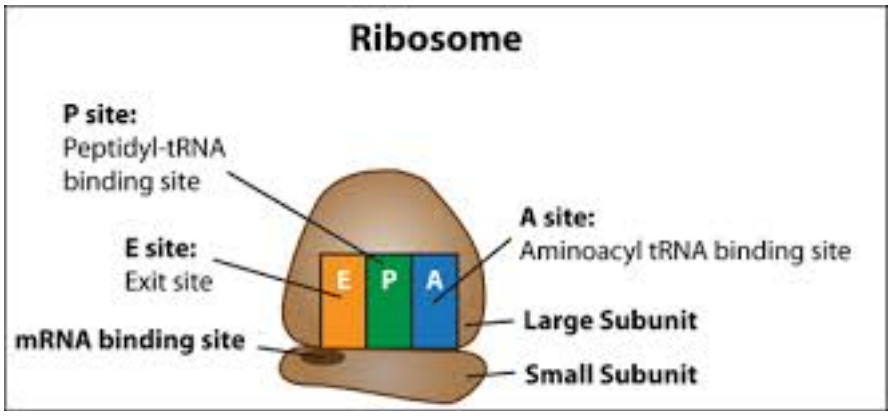


Figure 30.2
Biochemistry, Seventh Edition

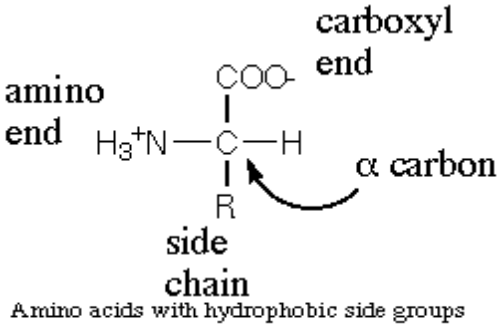




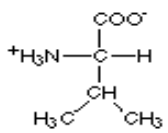
Universal Genetic Code Chart
Messenger RNA Codons and the Amino Acids for Which They Code

FIRST BASE	SECOND BASE: U	SECOND BASE: C	SECOND BASE: A	SECOND BASE: G	THIRD BASE
U	UUU, UUC: PHE UUA, UUG: LEU	UCU, UCC, UCA, UCG: SER	UAU, UAC: TYR UAA, UAG: STOP	UGU, UGC: CYS UGA: STOP UGG: TRP	U C A G
C	CUU, CUC, CUA, CUG: LEU	CCU, CCC, CCA, CCG: PRO	CAU, CAC: HIS CAA, CAG: GLN	CGU, CGC, CGA, CGG: ARG	U C A G
A	AUU, AUC, AUA: ILE AUG: MET or START	ACU, ACC, ACA, ACG: THR	AAU, AAC: ASN AAA, AAG: LYS	AGU, AGC: SER AGA, AGG: ARG	U C A G
G	GUU, GUC, GUA, GUG: VAL	GCU, GCC, GCA, GCG: ALA	GAU, GAC: ASP GAA, GAG: GLU	GGU, GGC, GGA, GGG: GLY	U C A G

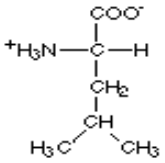
Amino Acids



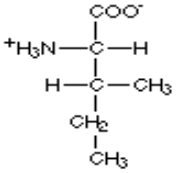
Amino acids with hydrophobic side groups



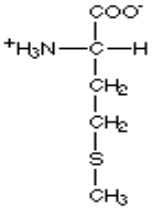
Valine (val)



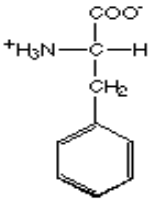
Leucine (leu)



Isoleucine (ile)

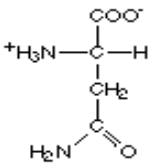


Methionine (met)

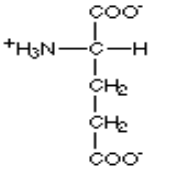


Phenylalanine (phe)

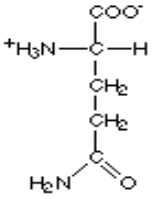
Amino acids with hydrophilic side groups



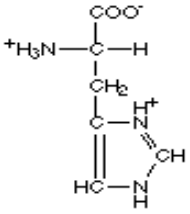
Asparagine (asn)



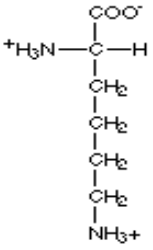
Glutamic acid (glu)



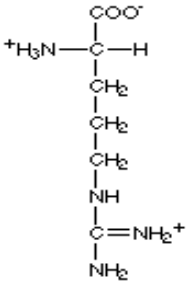
Glutamine (gln)



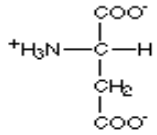
Histidine (his)



Lysine (lys)

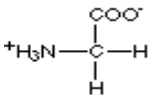


Arginine (arg)

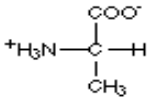


Aspartic acid (asp)

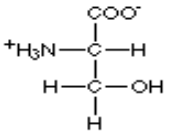
Amino acids that are in between



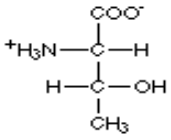
Glycine (gly)



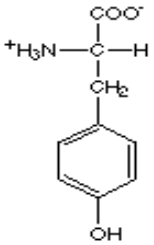
Alanine (ala)



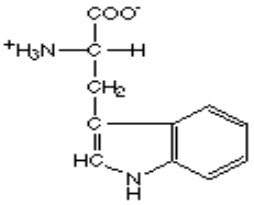
Serine (ser)



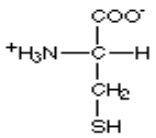
Threonine (thr)



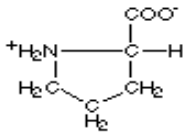
Tyrosine (tyr)



Tryptophan (trp)



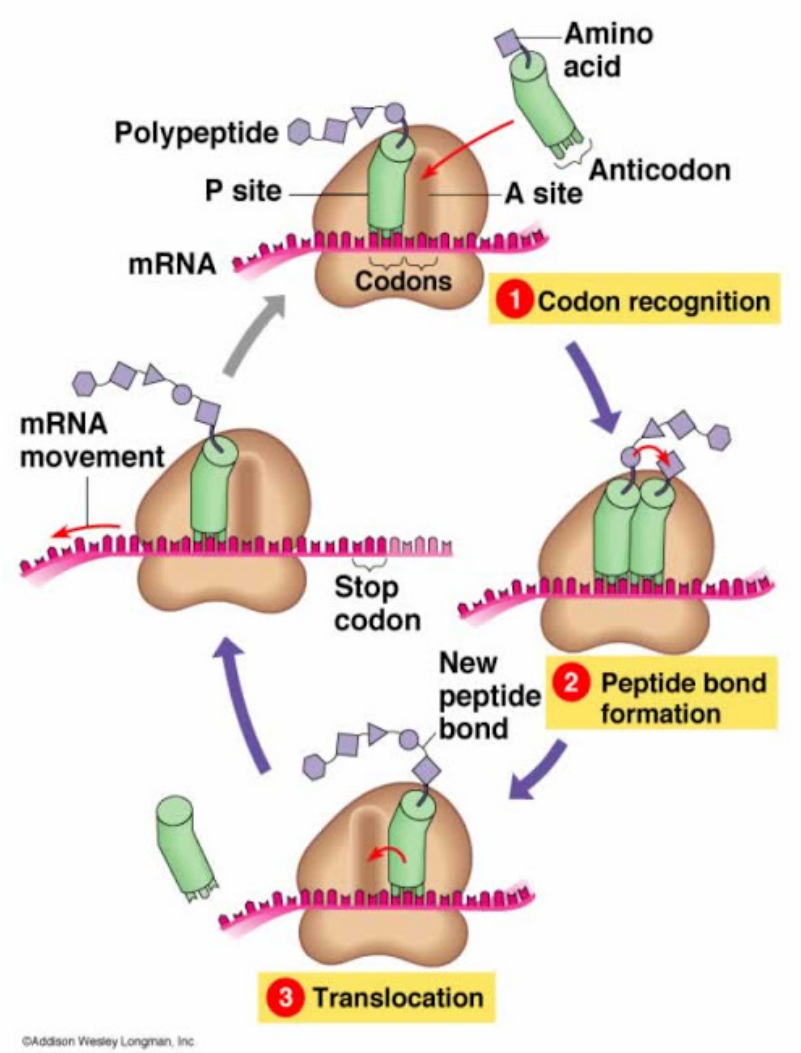
Cysteine (cys)



Proline (pro)

"The race is not always to the swift nor the strong, but to he or she who endures to the end." –Anonymous

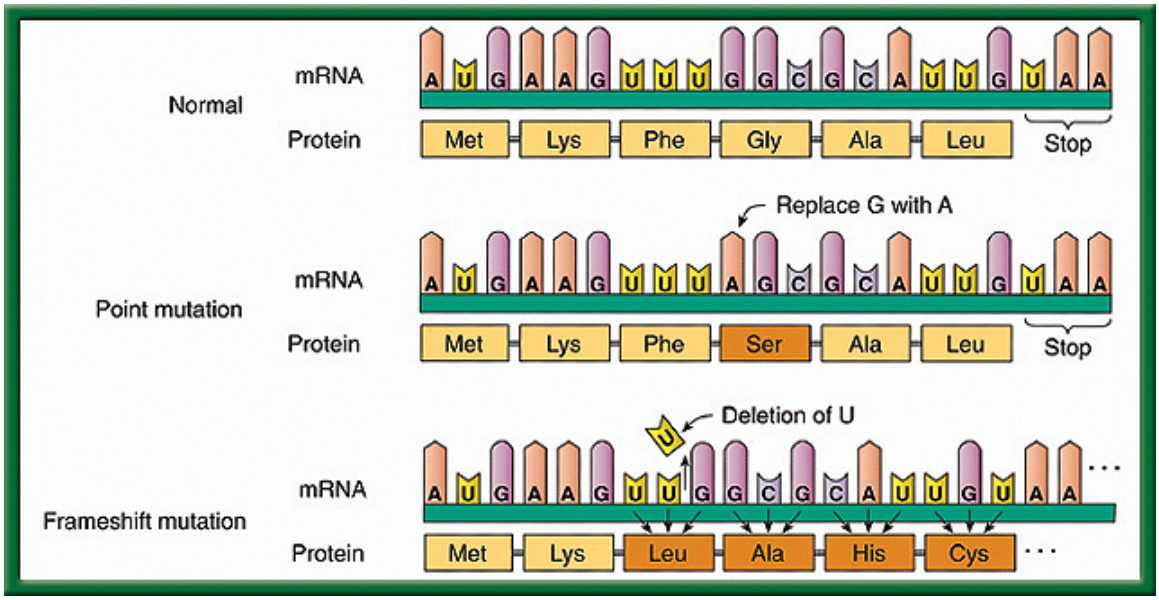
TRANSLATION SUMMARY



Translation Steps	
1. Initiation	• 5' G-cap of mRNA binds to ribosome • Start codon AUG and anticodon with Methionine bind **a P site** • **A site** is open and ready to receive new tRNAs
2. Elongation	• Codon recognition • Peptide bond formation (multiple amino acids together are called polypeptides) • Translocation: ribosome moves along mRNA, aminoacyl tRNA shifts from A site to P site
3. Termation	• A stop codon is reached (UAA UAG UGA) • All parts release

MUTATIONS

H. Changes to DNA are called **mutations**. Mutations that occur in somatic (body) cells DO NOT get passed onto offspring. *They can only be passed on if they occur in reproductive cells (sperm or egg).*

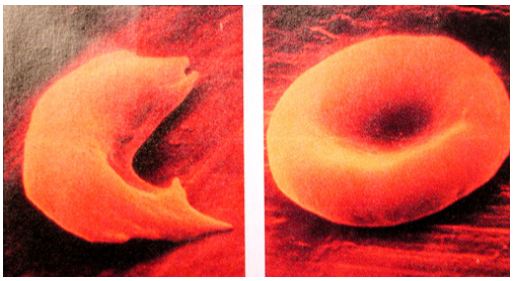


POINT MUTATION	**FRAMESHIFT MUTATION**
A point mutation is **a change in one base pair** in a DNA sequence. A point mutation can cause an amino acid to change, which will change the structure of the protein being made.	A frameshift mutation is when one nucleotide is **added (insertion) or deleted (deletion)** from the DNA strand. A frameshift mutation is much worse than a point mutation because it causes the entire DNA sequence to be shifted over!

A	wild type	TACAACGTCACCATT AUGUUGCAGUGGUAA ↓ met-leu-gln-trp-STOP	DNA mRNA protein
B	silent mutation	TACAATGTCACCATT AUGUUACAGUGGUAA ↓ met-leu-gln-trp-STOP	DNA mRNA protein
C	missense mutation	TACAAGGTCACCATT AUGUUCCAGUGGUAA ↓ met-phe-gln-trp-STOP	DNA mRNA protein
D	nonsense mutation	TACAACGTCACTATT AUGUUGCAGUGAUAA ↓ met-leu-gln-STOP	DNA mRNA protein
E	frameshift mutation	TATCAACGTCACCATT AUAGUUGCAGUGAUAA ↓ ile-val-gly-val-ile-	DNA mRNA protein

Sickle cell anemia is a blood disease caused by a point mutation.
A single nucleotide is changed from "A" to "T" which causes the amino acid to change from glutamic acid to valine:

Amino acids: Thr – Pro – Glu – Glu
Normal DNA: ACT CCT GAG GAG
Sickle cell DNA: ACT CCT GTG GAG
Amino acids: Thr – Pro – Val – Glu



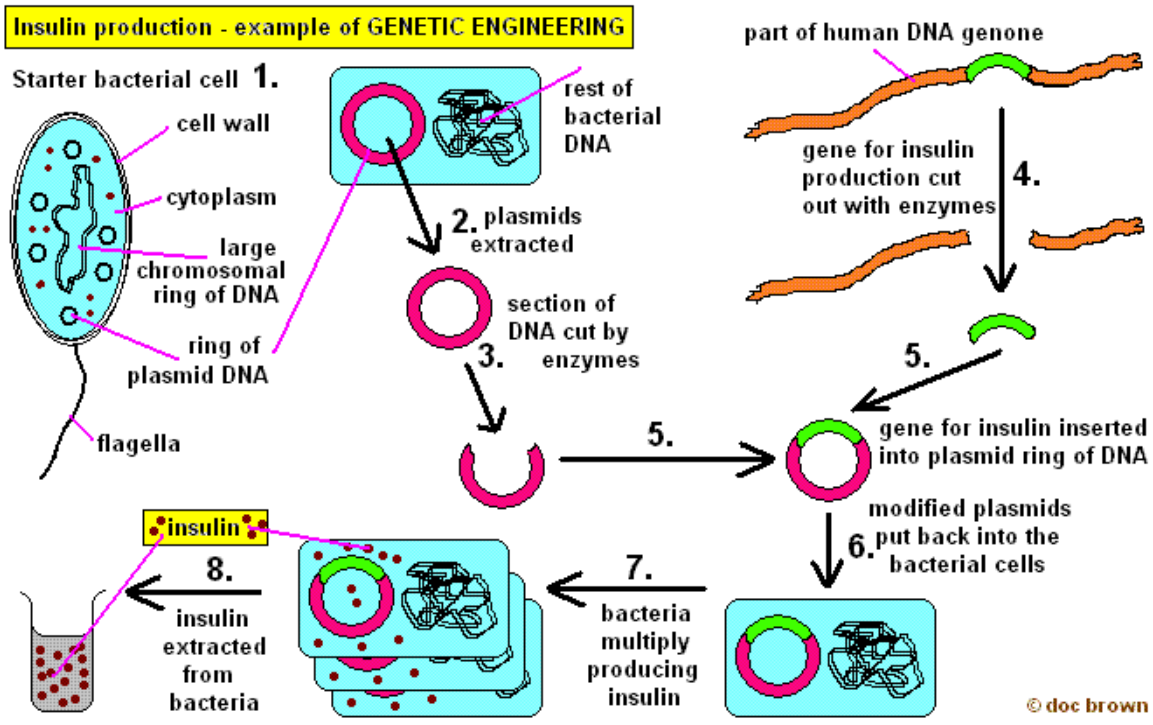
SICKLE CELL NORMAL

GENETIC ENGINEERING

K. *Genetic engineering or gene splicing inserts genes of one organism into the genes of another*. Enzymes are used to **cut and copy the DNA segments**. Bacteria are often used because they have no nucleus protecting their DNA and they reproduce very quickly, allowing large amounts of medicine (insulin) to be made.

a. The example of **gene splicing** you MUST know:

The gene to make human insulin was inserted into bacteria. These bacteria can now make insulin that is exactly the same as human insulin. This insulin is used by diabetics. This is safer than the cow and sheep insulin that were used in the past.

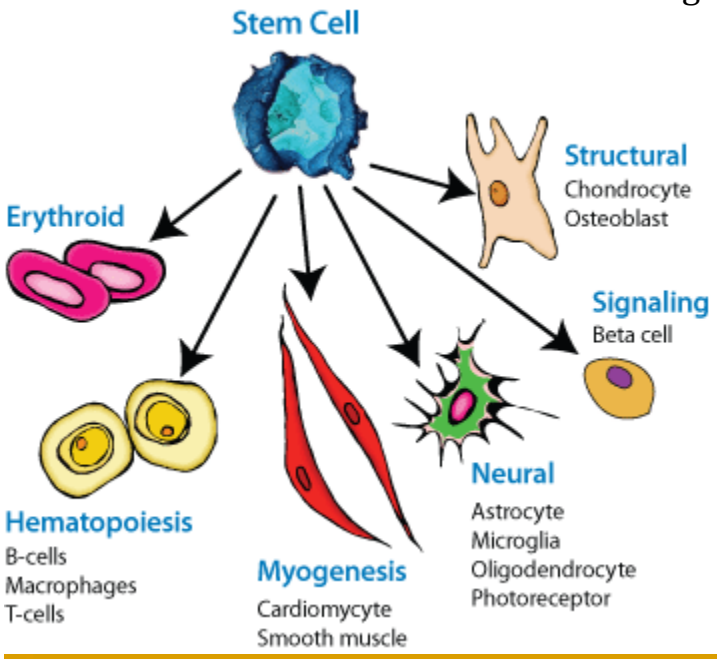


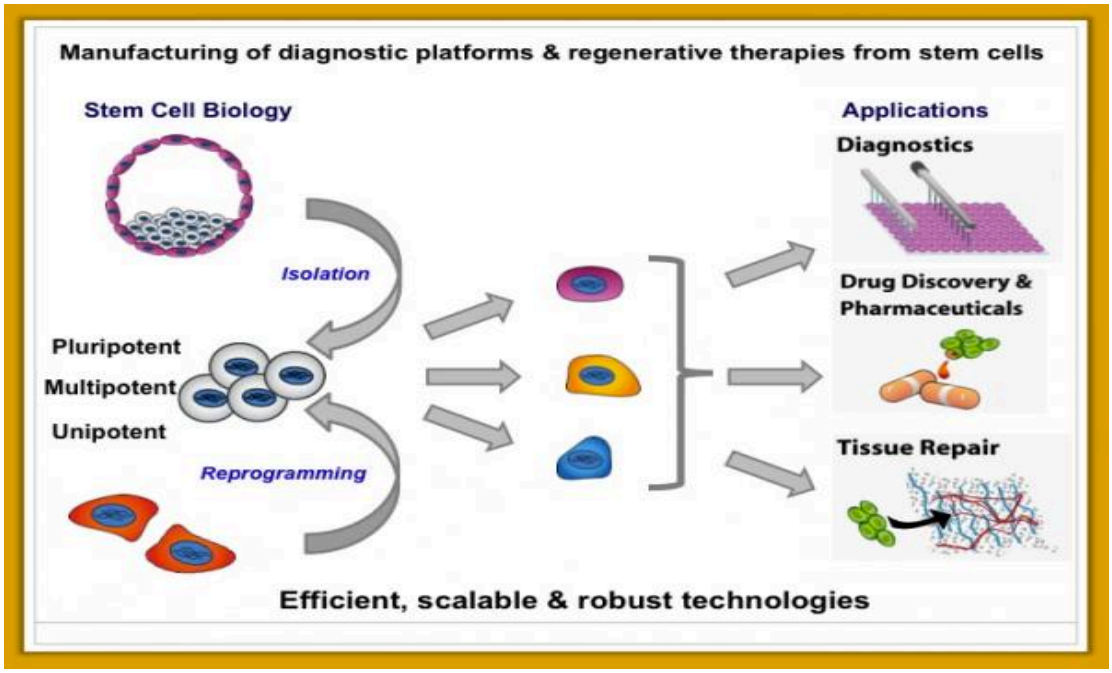
L. New technologies (karyotyping, DNA fingerprinting) are making it easier to diagnose and treat genetic disease, though we cannot yet cure them.

M. Genetic research has posed many ethical problems (ie right and wrong) that science alone cannot answer.

CELL DIFFERENTIATION

All cells in the body contain the same genes. Only some of these genes are **turned on** (that is, your eye cells contain the instructions on how to make bones, but only the genes to make new eye cells are actually turned on).
Cell differentiation can be controlled during **translation and transcription**.





"The race is not always to the swift nor the strong, but to he or she who endures to the end." –Anonymous

Stem Cell Research Controversy

"It is embryonic stem cells that cause controversy. Removing the stem cells requires the destruction of the embryo, which some people liken to destruction of a human being. The issue comes down to the question of when life begins: Those who believe that life starts at the moment of conception think that harvesting embryonic stem cells is akin to murder. Some critics of this viewpoint have argued that these embryos were marked for destruction and then donated by their owners, meaning that these embryos would never have come to term anyway, but others predict that this excuse might lead to more ethically questionable actions in the future, such as harvesting embryos specifically for research.

In recent years, researchers have tried to find ways to obtain embryonic stem cells without destroying the embryos. One method of deriving stem cells from mice embryos has proven successful. Researchers are also experimenting with reprogramming adult stem cells to act more like embryonic stem cells. These cells, known as **induced pluripotent stem cells**, hold promise, but scientists would still like the opportunity to pursue work with the embryonic stem cells." (SOURCE: http://science.howstuffworks.com/life/genetic/ethical-to-use-stem-cells.htm)

PRACTICE QUESTIONS

FOR MORE FUN EXCITING QUESTIONS, CHECK OUT THE NY STATE REGENTS WEBSITE: http://www.nysedregents.org/LivingEnvironment/

Exam writers LOVE to use this site for question ideas! How do I know? I used to write them! FUN!!! #ownthatstruggle

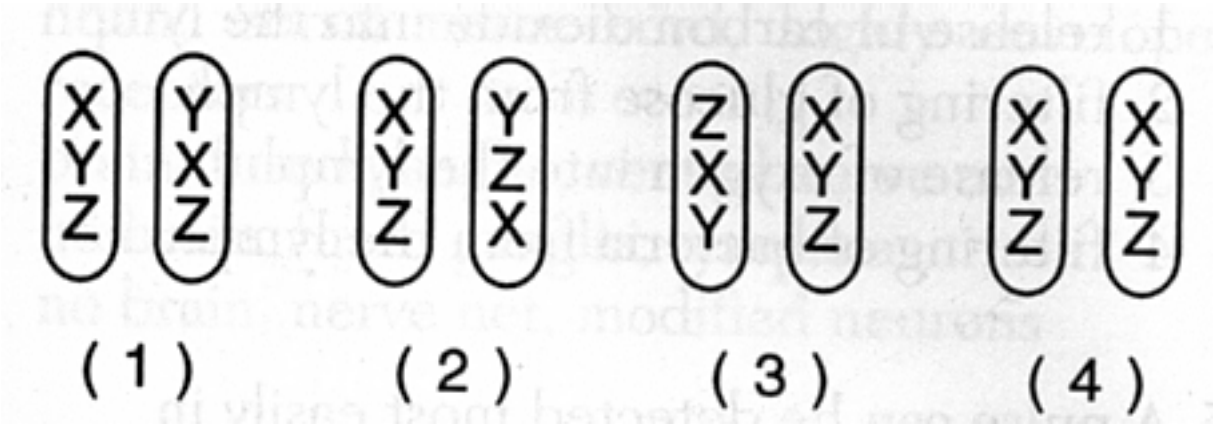
The presence of DNA is important for cellular metabolic activities because DNA

1. directs the production of enzymes
2. is a structural component of cell walls
3. directly increases the solubility of nutrients
4. is the major component of cytoplasm

A molecule of DNA is a polymer composed of

1. glucose
2. amino acids
3. fatty acids
4. nucleotides

Which chromosome pair below best illustrates the gene-chromosome theory?



1. 1
2. 2
3. 3
4. 4

Which nitrogenous bases make up DNA nucleotides?

1. adenine, thymine, guanine, and cytosine
2. adenine, uracil, guanine and cytosine
3. adenine, thymine, uracil, and cytosine
4. adenine, thymine, guanine, and uracil

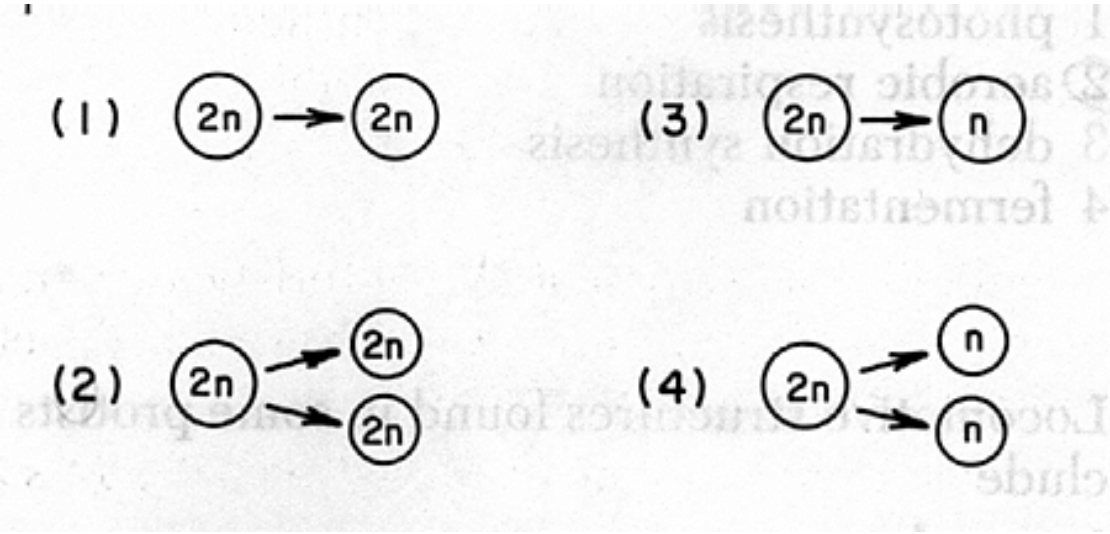
In squirrels, the gene for gray fur (G) is dominant over the gene for black fur (g). If 50% of a large litter of squirrels are gray, the parental cross that produced this litter was most likely

1. GG x Gg
2. GG x GG
3. Gg x gg
4. gg x gg

Which cross could produce a child with type O blood?

1. AO x BB
2. AA x BO
3. AB x OO
4. AO x BO

Which diagram most correctly represents the process of mitosis?



1. 1
2. 2
3. 3
4. 4

What percentages can be expected in the offspring of cross between a female carrier for color blindness and a male with normal color vision?

1. 25% normal male, 25% colorblind males, 25% normal females, 25% carrier females
2. 25% normal males, 25% colorblind males, 25% carrier females, 25% colorblind females
3. 75% normal males, 25% carrier females
4. 50% colorblind males, 50% colorblind females

Geneticists have observed that fruit flies that commonly inherit vestigial wings also inherit lobed eyes. Observations such as this have helped to develop the genetic concept known as

1. segregation
2. dominance
3. gene linkage
4. crossing-over

By which process are two daughter nuclei formed that are identical to each other and to the original nucleus?

1. meiosis
2. synapsis
3. fertilization
4. mitosis

Because the gene for hemophilia is located on the X-chromosome, it is normally impossible for a

1. carrier mother to pass the gene to her son
2. hemophiliac father to pass the gene on to his son
3. hemophiliac father to pass the gene to his daughter
4. carrier mother to pass the gene to her daughter

A man with a blood genotype AO marries a woman with a blood genotype of AO. What blood types could be expected in their children?

1. type A, only
2. type O, only
3. both type A and type O
4. neither type A nor type O

A hybrid black-coated guinea pig produces two million sperm cells. Approximately what number of its sperm cells contain the recessive gene for white coat color?

1. 1 million
2. 2 million
3. 0
4. 0.5 million

Some individuals with blood group A may inherit the genes for blond hair, while other individuals with blood group A may inherit the genes for brown hair. This can be explained by the principle of

1. dominance
2. multiple alleles
3. independent assortment
4. incomplete dominance

The outward appearance (gene expression) of a particular trait in an organism is referred to as

1. a genotype
2. a phenotype
3. an allele
4. a chromosome

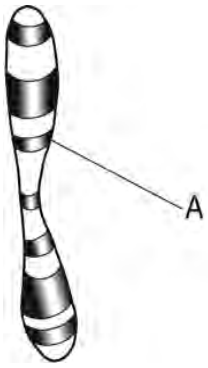
A child is born with an extra chromosome in each of its cells. This condition is usually the result of

1. nondisjunction
2. crossing-over
3. segregation
4. hybridization

Mutations can be considered as one of the raw materials of evolution because they

1. contribute to new variations in organisms
2. are usually related to the environment in which they appear
3. are usually beneficial to the organism in which they appear
4. usually cause species of organisms to become extinct

2 Human genetic material is represented in the diagram below.



The region labeled *A* is made up of a section of

(1) a protein that becomes an enzyme
(2) DNA that may direct protein synthesis
(3) a carbohydrate made from amino acids
(4) glucose that may be copied to make DNA

3 Brothers and sisters often have similar facial characteristics, such as nose shape or eye color, because they

(1) are raised in similar environments
(2) eat similar types of foods
(3) have similar types of proteins
(4) use similar types of facial care products

4 Compared to a normal body cell, a normal egg cell contains

(1) the same number of chromosomes
(2) half the number of chromosomes
(3) twice the number of chromosomes
(4) four times the number of chromosomes

Which factor would cause two specialized tissues that contain identical chromosomes to function differently?

(1) Specific sections of DNA molecules in the chromosomes are activated.
(2) All of the sections of DNA molecules in the chromosomes are activated.
(3) Specific sections of the amino acid molecules in the cytoplasm are activated.
(4) All of the amino acid molecules in the cytoplasm are activated.

Some variation must be present in a population in order for natural selection to take place. These variations arise from mutations in the DNA and

(1) sorting of chromosomes during sexual reproduction
(2) combining of chromosomes during organ development
(3) changing of chromosomes during cloning
(4) removal of chromosomes during selective breeding

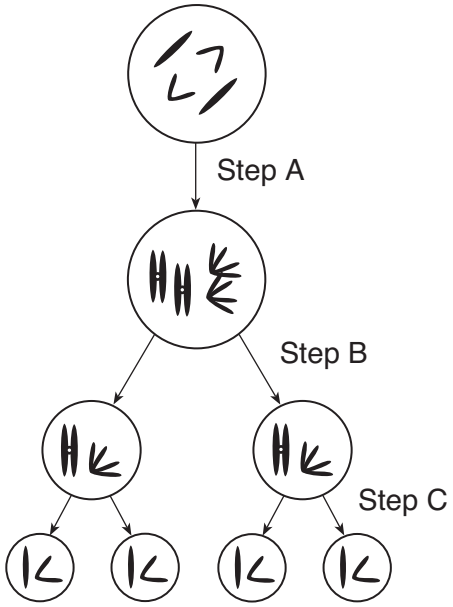
The diagram below represents a segment of a gene on two chromosomes.

Normal gene	A	T	A	C	C	T
Mutated gene	A	T	G	C	C	T

The change in the gene sequence is an example of

(1) an insertion
(2) a deletion
(3) a substitution
(4) a replication

Part of a process necessary for reproduction in complex organisms is represented below.



Step *C* results in the production of

(1) four zygotes that will develop into embryos
(2) embryonic cells that could unite and develop into an organism
(3) four cells that will recombine to form two offspring
(4) gametes that could be involved in the formation of a zygote

Which two cell structures work together in the process of protein synthesis?

(1) nucleus and chloroplast
(2) ribosome and vacuole
(3) nucleus and ribosome
(4) mitochondrion and cell membrane

Base your answers to questions 77 and 78 on the Universal Genetic Code Chart below and on your knowledge of biology.

Universal Genetic Code Chart
Messenger RNA Codons and the Amino Acids for Which They Code

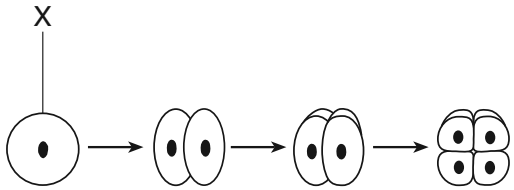
FIRST BASE	SECOND BASE: U	SECOND BASE: C	SECOND BASE: A	SECOND BASE: G	THIRD BASE
U	UUU, UUC → PHE UUA, UUG → LEU	UCU, UCC, UCA, UCG → SER	UAU, UAC → TYR UAA, UAG → STOP	UGU, UGC → CYS UGA → STOP UGG → TRP	U C A G
C	CUU, CUC, CUA, CUG → LEU	CCU, CCC, CCA, CCG → PRO	CAU, CAC → HIS CAA, CAG → GLN	CGU, CGC, CGA, CGG → ARG	U C A G
A	AUU, AUC, AUA → ILE AUG → MET or START	ACU, ACC, ACA, ACG → THR	AAU, AAC → ASN AAA, AAG → LYS	AGU, AGC → SER AGA, AGG → ARG	U C A G
G	GUU, GUC, GUA, GUG → VAL	GCU, GCC, GCA, GCG → ALA	GAU, GAC → ASP GAA, GAG → GLU	GGU, GGC, GGA, GGG → GLY	U C A G

77 The table below shows the DNA, mRNA, and amino acid sequences from two similar plant species. Using the information given, fill in the missing mRNA base sequences for species *A* on the table below. [1]

78 Using the Universal Genetic Code Chart, fill in the missing amino acids for species *B* on the table below. [1]

Species A	DNA base sequence	CCG	TGC	ATA	CAG	GTA
	mRNA base sequence	_____	_____	UAU	_____	_____
	amino acid sequence	GLY	THR	TYR	VAL	HIS
Species B	DNA base sequence	CCG	TGC	ATA	CAG	GTT
	mRNA base sequence	GGC	ACG	UAU	GUC	CAA
	amino acid sequence	GLY	_____	_____	VAL	_____

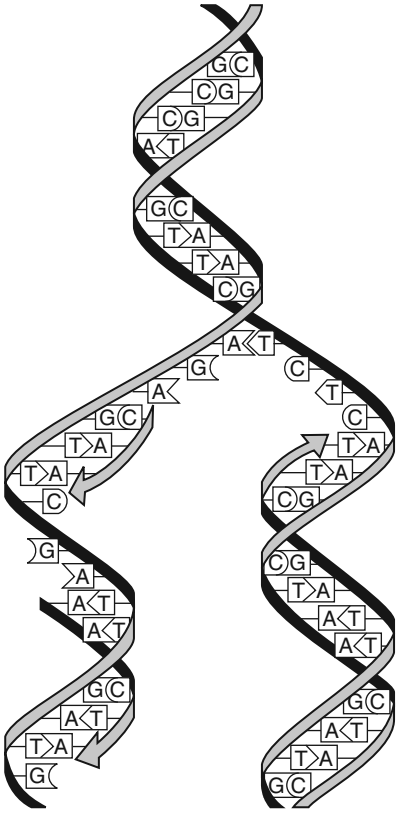
The diagram below represents some stages that occur in the formation of an embryo.



Which statement best describes stage *X*?

(1) Stage *X* is a zygote and contains half the number of chromosomes as the body cells of the parents.
(2) Stage *X* is formed by the process of meiosis and is known as a gamete.
(3) Stage *X* is a zygote and is formed as a result of the process of fertilization.
(4) Stage *X* is formed by mitosis and is known as an egg cell.

8 The process represented in the diagram belo occurs in many cells.



The main function of this process is to

(1) provide an exact copy of the genetic code
(2) ensure genetic variation in a species
(3) synthesize cellular proteins
(4) produce antibodies to combat disease

Which process allows a mammal to continue to grow in size?

(1) mitosis of sex cells
(2) mitosis of body cells
(3) meiosis of sex cells
(4) meiosis of body cells

2 Which factor has the greatest influence on the development of new, inheritable characteristics?

(1) combinations of genes resulting from mitosis
(2) mutations of genes in reproductive cells
(3) sorting of genes during asexual reproduction
(4) recombining of genes during differentiation

Base your answers to questions 83 through 85 on the chart below and on your knowledge of biology. T
DNA Sequences chart shows a portion of the code for insulin in humans and cows. These DNA sequences
repeated in the Human Insulin and Cow Insulin charts.

83 In the DNA Sequences chart, circle the number over each three-letter portion of the DNA that
different in humans and cows. [1]

DNA Sequences

	1	2	3	4	5	6	7	8
Human Insulin	CCA	TAG	CAC	CTT	GTT	ACA	ACG	TGA
Cow Insulin	CCG	TAG	CAT	CTT	GTT	ACA	ACG	CGA

84 For *each* number *circled* for the DNA sequences above, write the complementary mRNA base sequer
in the Human Insulin and Cow Insulin charts that each of these circled portions would produce. Be s
to complete *only* the circled portions. [1]

Human Insulin

	1	2	3	4	5	6	7	8
DNA Sequence	CCA	TAG	CAC	CTT	GTT	ACA	ACG	TGA
mRNA Sequence								
Amino Acid								

Cow Insulin

	1	2	3	4	5	6	7	8
DNA Sequence	CCG	TAG	CAT	CTT	GTT	ACA	ACG	CGA
mRNA Sequence								
Amino Acid								

"The race is not always to the swift nor the strong, but to he or she who endures to the end." 31
–Anonymous