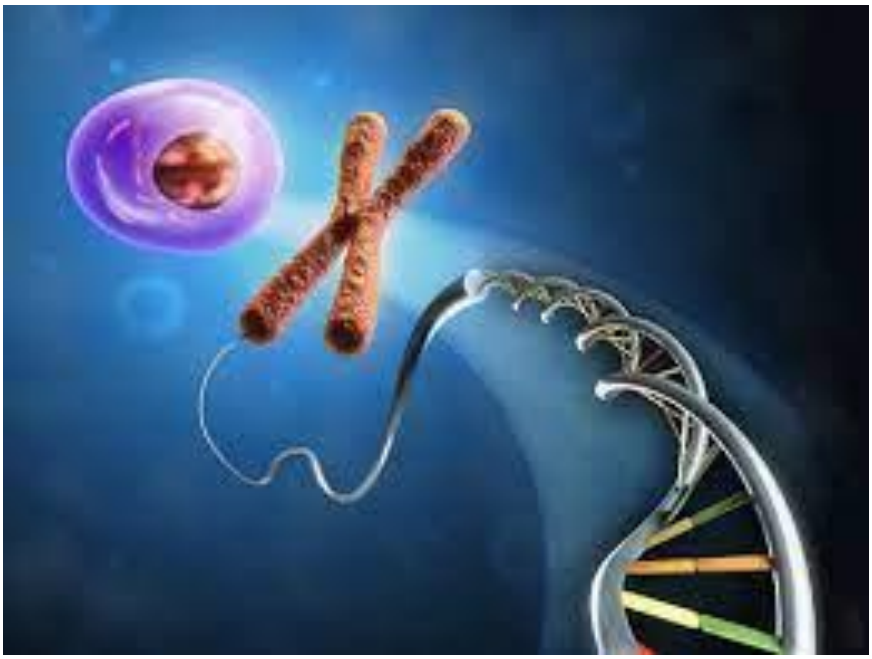
Biology 3201

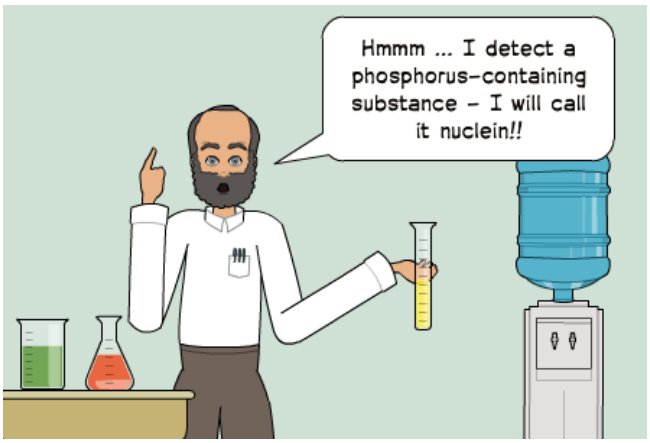
Unit 2 Part 2

Name: _____



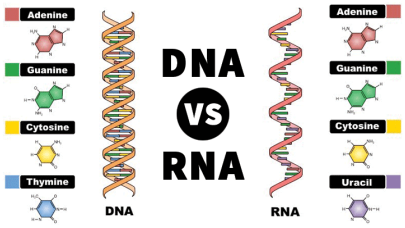
Launch Lab DNA Extraction Investigation

DNA Structure and Replication



In 1869, a young Swiss physician named _____ coined the term "nuclein" to describe a weakly acidic, phosphorus-containing substance that he had isolated from the nuclei of white blood cells. It later became known as _____.

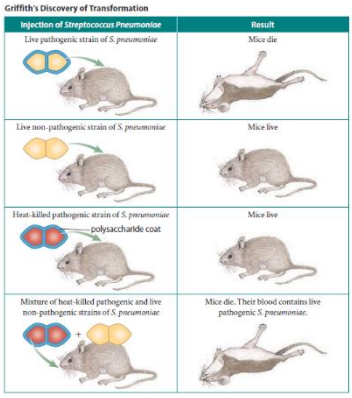
In the early 1900s, a Russian-born American biochemist named _____ isolated _____.



He called them _____ (_____) and _____ (_____).

Levene went on to show that chromosomes are made up of a combination of DNA and proteins.

In 1928, _____, an English medical officer, designed an experiment to study the pathogenic (disease causing) bacteria that were responsible for a pneumonia epidemic in London.



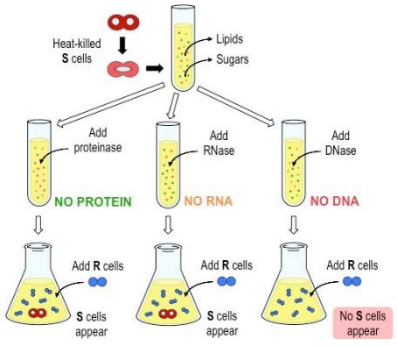
Griffith set up his experiment using dead Streptococcus pnemoniae bacteria as a control.

He discovered that the _____

_____

_____

Griffith called this phenomenon the _____ because something from the heat-killed pathogenic bacteria must have transformed the living non-pathogenic bacteria to make them disease-causing.



In 1944, the team of _____

_____

conducted a series of experiments and discovered the following:

When they treated heat-killed pathogenic bacteria with a protein-destroying enzyme, transformation still occurred.

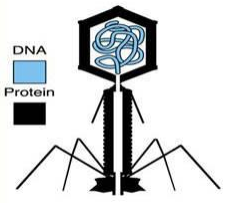
When they treated heat-killed pathogenic bacteria with a DNA destroying enzyme, transformation did not occur.

_____.

Even so, most scientists still were not prepared to view DNA as the likely source of hereditary material. Instead, they thought that DNA might activate gene-carrying proteins.

Hershey and Chase: Evidence in Favour of DNA as the Hereditary Material

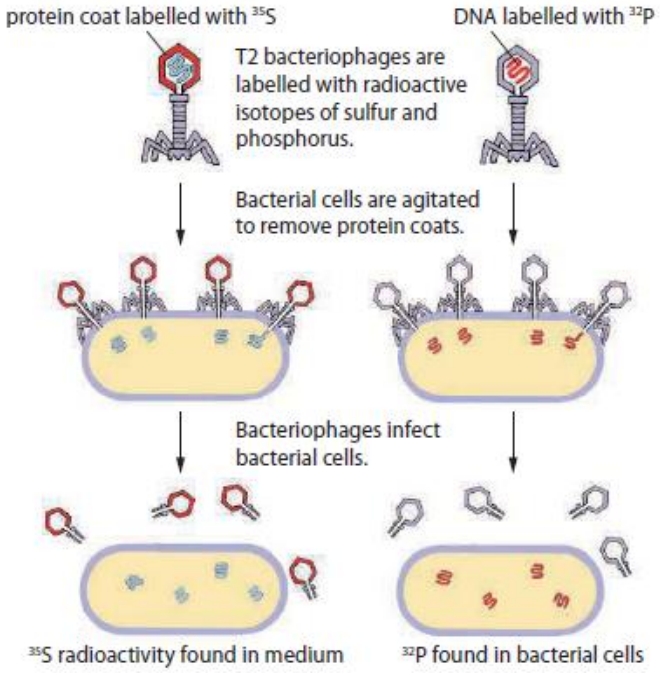
Convincing evidence that _____, _____, carried genetic information was finally provided in 1952. The American research team of _____ and _____ used a new technology, radioactive labelling, to show that genes are made of DNA. Hershey and Chase used a strain of virus known as a _____ _____, which consists of a _____ _____ _____ _____



This virus attaches to a bacterial cell and injects genetic information into the cell. The infected cell manufactures new viruses, and then it bursts. The newly released viruses go on to infect other cells. To determine whether viral protein or viral DNA was responsible for taking over the genetic machinery of the host cell, Hershey and Chase created _____.

In one batch, they labelled the _____ using _____.

In the other batch, they labelled the _____ with _____.



The labelled viruses were allowed to infect bacterial cells. The cells were then _____

_____ to separate the viral coats from the bacterial cells.

Each medium was tested for radioactivity.

_____

_____

_____

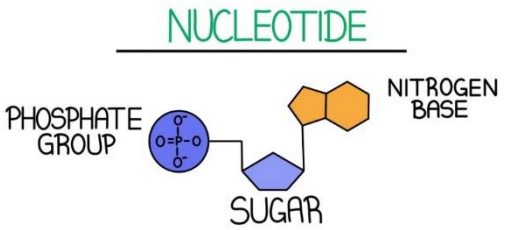
_____

_____

_____

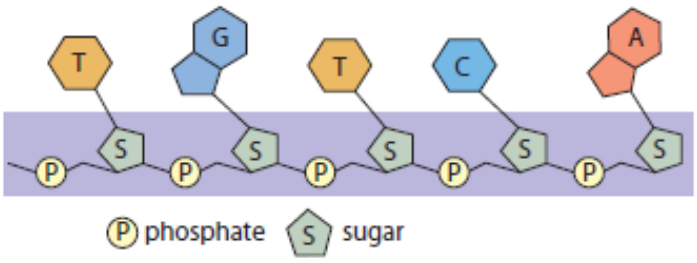
_____

The Structure of DNA and RNA



After isolating DNA and RNA, _____ determined that both molecules are made up of long chains of individual units he called nucleotides. Levene also determined that nucleic acids are made up of long chains of nucleotides, strung together

_____ repeating unit of nucleic acids; composed of sugar, phosphate, and nitrogenous groups

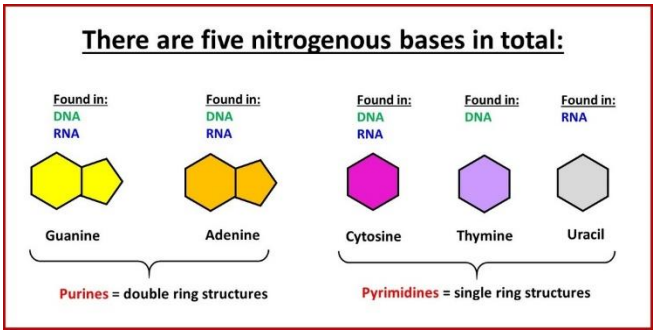


The four nitrogenous bases that are found in DNA nucleotides are _____

_____

_____

_____ has the base _____ instead of _____



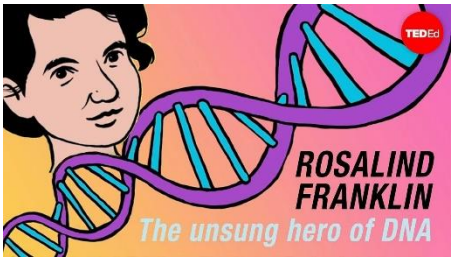
Chargaff's Rule

_____ found that the nucleotides are not present in equal amounts as Levene said.

_____

_____ refers to hydrogen-bonded base pairs (A-T, C-G)

_____ in a DNA sample, the amount of adenine is about the same as thymine and the amount of cytosine is about the same as guanine

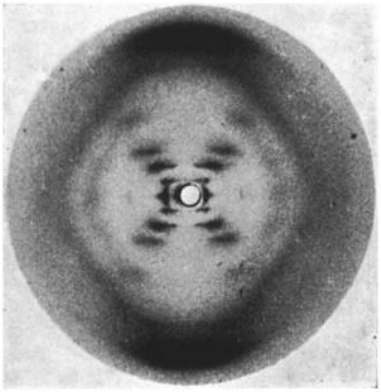


Activity 15.1 DNA Deductions

Exit Card #8

The Three-Dimensional Structure of DNA

Early in the 1950s, British scientist _____ used _____to analyze the structure of DNA.



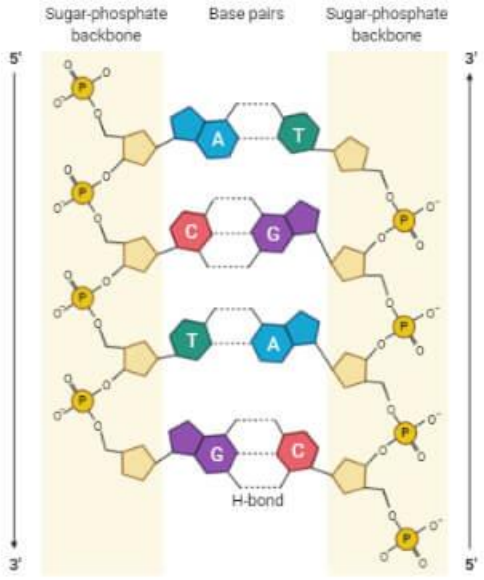
Her observations provided crucial new information about the molecular structure of DNA. She was able to conclude that DNA has a _____ _____ with two regularly repeating patterns

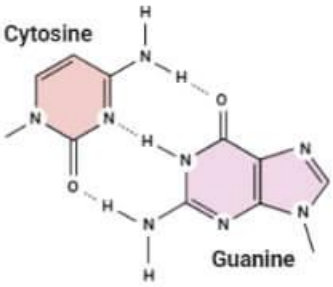
From her observations, she concluded that the _____ _____ _____ and the

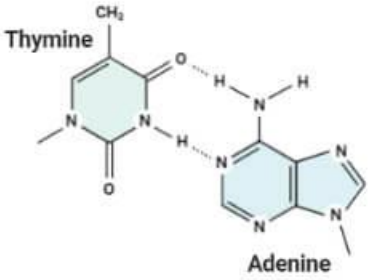
_____.

Watson and Crick

Watson and Crick DNA Model







In 1953, _____ and _____ published a two-page paper describing a _____ model. This model soon became accepted as the molecular structure of DNA. The discovery of the double helix marked a milestone in the history of science.

_____

_____

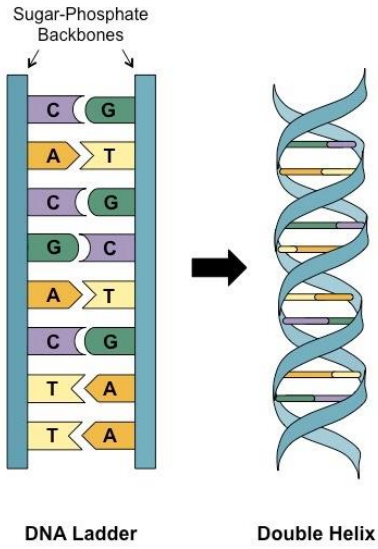
_____

_____

DNA is a thread-like molecule, made up of _____ _____of nucleotides that are bound together in a spiral shape called a double helix. If the helix were unwound, the DNA molecule would look something like a twisted ladder. The “handrails” of the ladder are the _____

_____ of the two nucleotide strands. The “rungs” are the bases that protrude inward at regular intervals along each strand.

The two strands are _____, as well. That is, the phosphate bridges run in opposite directions in the two strands. Each end of a double-stranded DNA molecule contains the 5′ end of one strand and the 3′ end of the complementary strand.



The Structure of RNA vs DNA

The molecular structure of RNA is similar to the molecular structure of DNA, with three key differences:

1.) _____

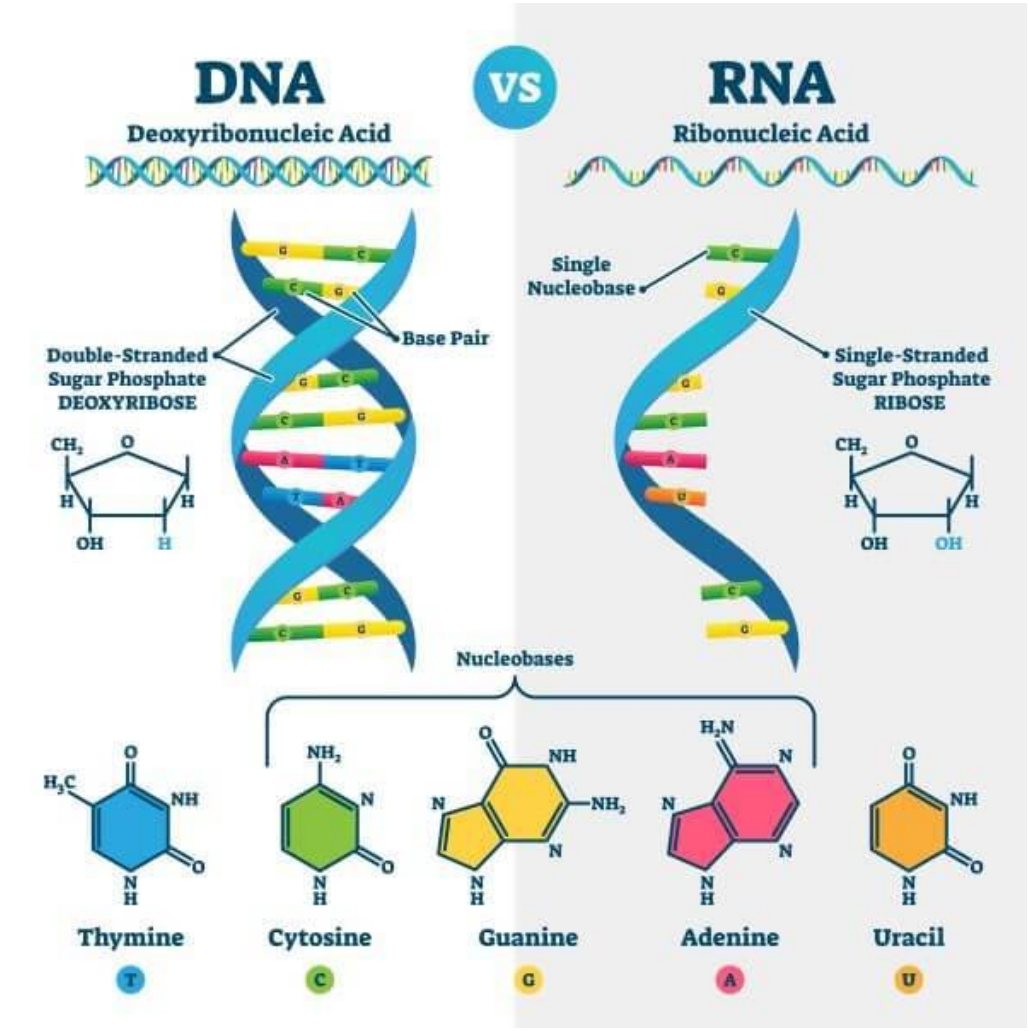
2.) _____

_____

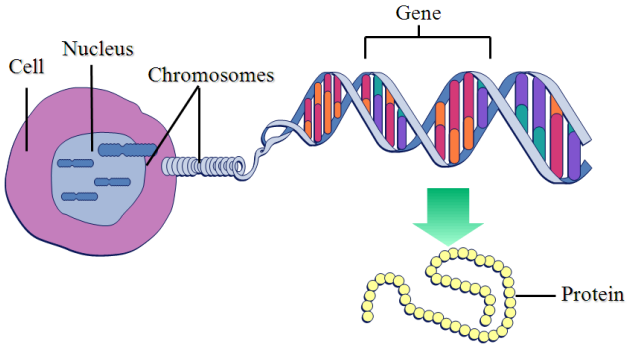
3.) _____

_____

_____



Genes and the Genome

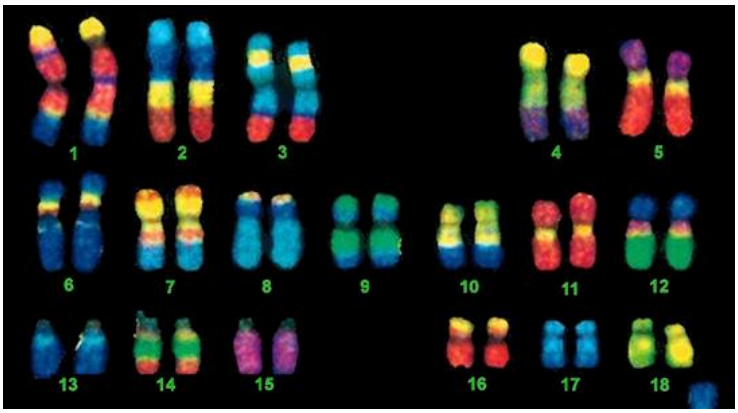


_____ a length of DNA and associated protein; condensed form of genetic material

_____a functional sub-unit of DNA that directs the production of one or more polypeptides (protein molecules)

_____ the total DNA in an organism's cells

The Human Genome



In humans, chromosome 4 is about 200,000,000 bases long and has about 800 genes, while chromosome 19 is only 55,000,000 bases long but has almost 1500 genes.

The total human genome is about 3 billion base pairs, and it includes an estimated _____

_____ genes.

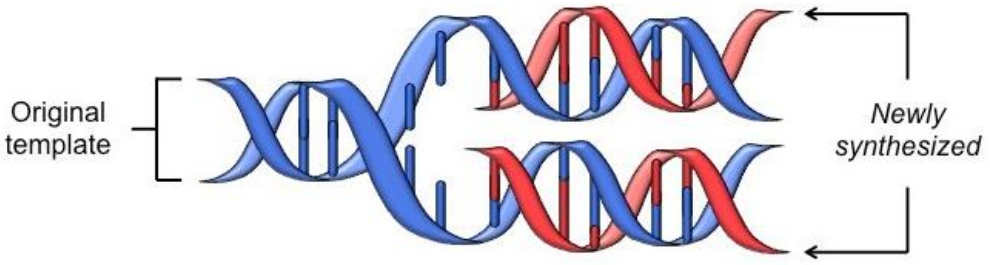
DNA Replication (DNA Synthesis)

_____ genetics, the process of copying DNA

_____ each new molecule of DNA contains one strand of the original complementary DNA molecule and one new parent strand. Thus, each new DNA molecule conserves half of the original molecule.

Four stages of DNA Replication

1. Initiation
2. Elongation
3. Termination
4. Proofreading



Initiation

_____ nucleotide sequence where DNA replication begins

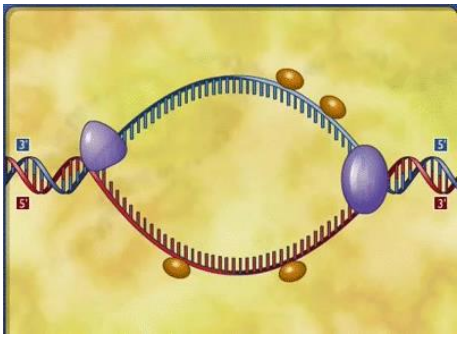
_____ enzyme that bind to the DNA at the replication origin.

The helicases cleave and unravel a segment of the double helix. This opening up of a region of DNA creates two Y-shaped areas at each end of the unwound area.

The oval-shaped unwound area is called a _____.

Each Y-shaped end of the bubble is called _____.

Elongation



_____ in replication, the process of joining nucleotides to extend a new strand of DNA

_____ adds new nucleotides to the 3' OH group of an existing nucleotide strand; dismantles the RNA primer; proofreads base pairing

_____ synthesizes an RNA primer to begin the elongation process

First, elongation can only take place in the 5´ to 3´ direction.

Second, a short strand of RNA, known as a _____, must serve as a starting point for the attachment of new nucleotides.

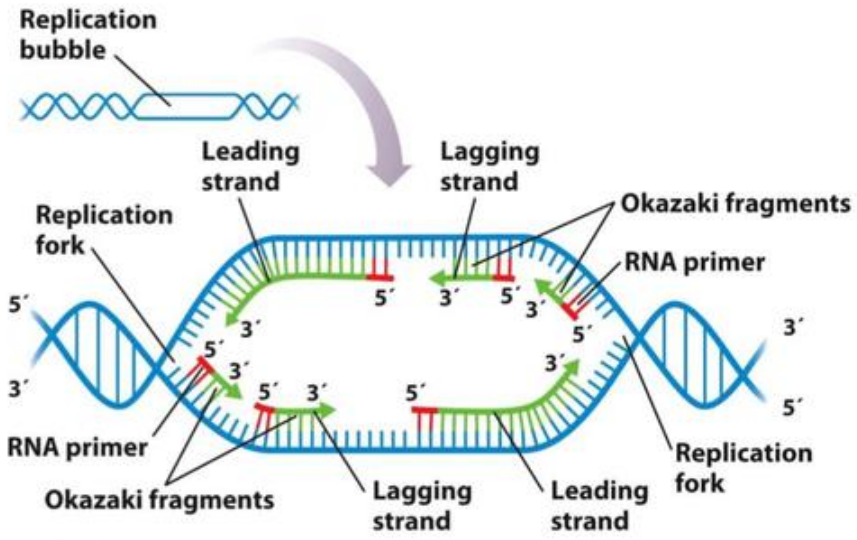
Replication occurs in a slightly different way along each strand of the parent DNA.

One strand is replicated continuously in the 5′ to 3′ direction. This strand is known as the leading strand.

The other strand, known as the lagging strand, is replicated in short segments.

_____ in replication, the strand made continuously

_____ in replication, the strand made in segments



Elongation on the Lagging Strand

Nucleotides are still added in the 5′ to 3′ direction on the lagging strand, but the new DNA is synthesized in short segments called Okazaki fragments.

_____

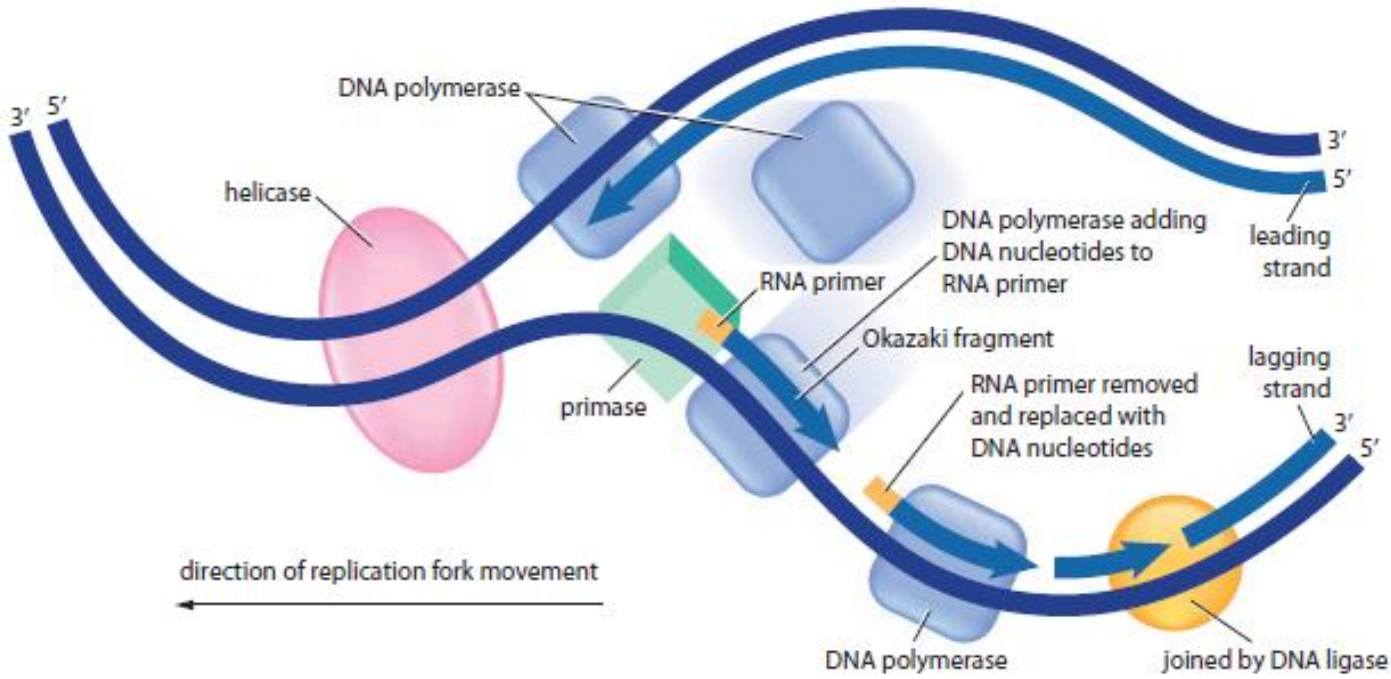
short nucleotide fragments of the lagging strand

_____

Joins together Okazaki fragments in the lagging strand

Termination

_____ in DNA replication, the completion of new DNA strands and dismantling of the replication machine



As the replication fork progresses along the replicating chromosome, only a very short region of DNA is found in a single-stranded form.

As soon as the newly formed strands are complete, they rewind automatically into their chemically stable helix structure. Replication proceeds until the new strands are complete and the two new DNA molecules separate from one another.

Proofreading

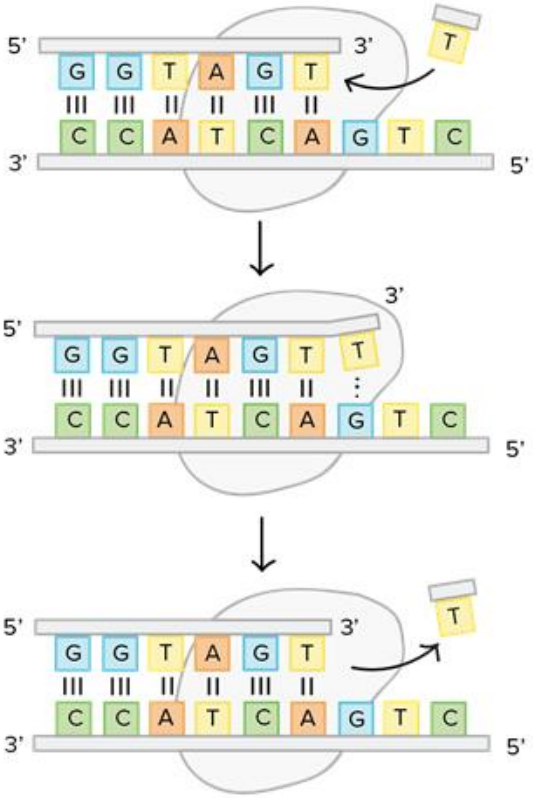
_____ has an important proofreading function, as well.

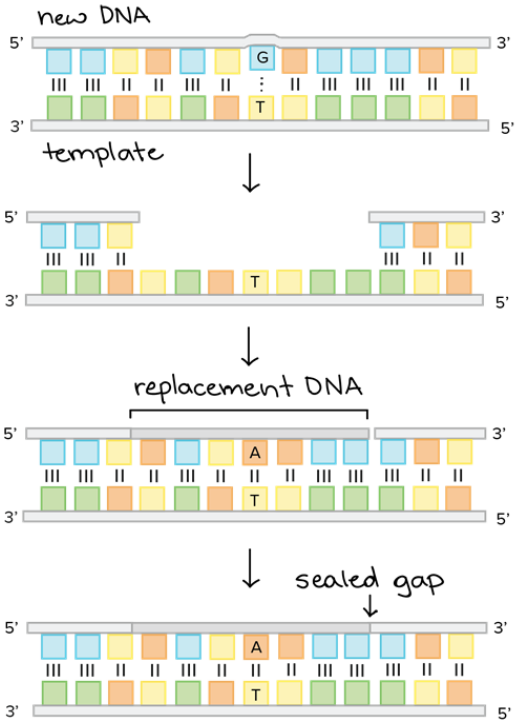
After each nucleotide is added to a new DNA strand, DNA polymerase can recognize whether or not hydrogen bonding is taking place between the new base and its complement on the original strand.

_____

_____. When this occurs, DNA polymerase excises the incorrect base from the new strand and _____

_____





A mismatch is detected in newly synthesized DNA.

The new DNA strand is cut, and the mispaired nucleotide and its neighbors are removed.

The missing patch is replaced with correct nucleotides by a DNA polymerase.

A DNA ligase seals the gap in the DNA backbone.

Example 1

Given the Parent DNA sequence ATG – GTA – CGT what is the complementary DNA sequence?

Example 2

Given the complementary DNA sequence GCA – AAA – CAC what is the parent DNA sequence?

Investigation 15.A

Exit Card #9

<u>Gene Expression & The Genetic Code</u>

_____

_____

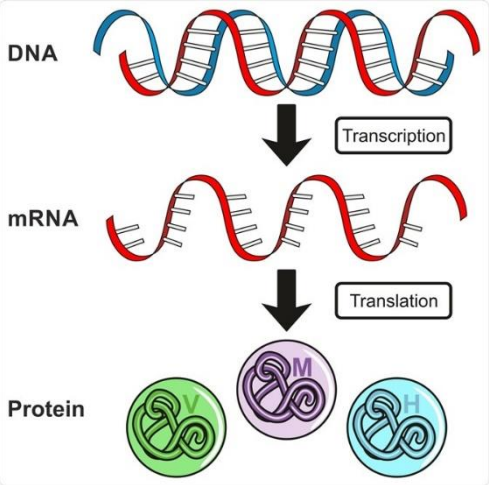
The specific sequence of amino acids determines the chemical properties of each protein.

A given set of amino acids, arranged in a particular order, could produce the proteins that are responsible for inherited traits

The genetic code determines how the amino acids are strung together and how the proteins are made.

The order of the nucleotides in a gene provides the information, written in genetic code, that is necessary to build a protein.

The genetic code has three important characteristics.



1. _____—that is, more than one codon can code for the same amino acid.

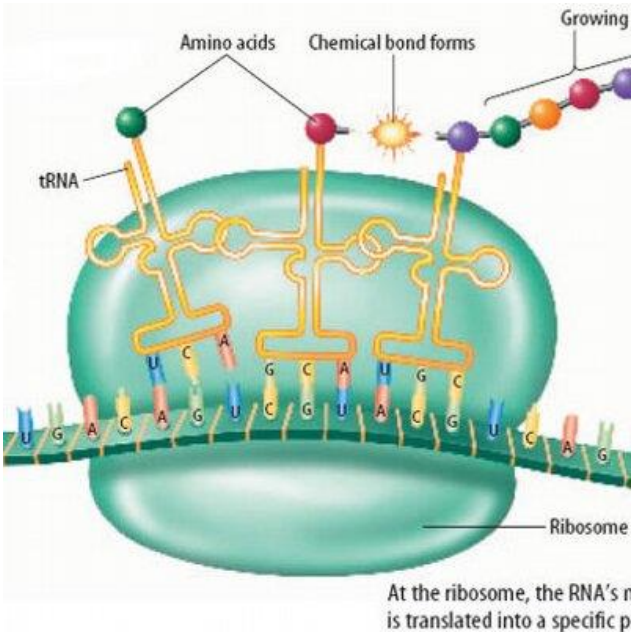
2. _____ That is, the genetic code reads as a series of three-letter codons without spaces, punctuation, or overlap. Knowing exactly where to start and stop translation is essential.

3. The genetic code is nearly universal. Almost all living organisms build proteins with the same genetic code.

Second Position

First Position	U	C	A	G	Third Position
U	Phenylalanine	Serine	Tyrosine	Cysteine	U
	Phenylalanine	Serine	Tyrosine	Cysteine	C
	Leucine	Serine	Stop	Stop	A
	Leucine	Serine	Stop	Tryptophan	G
C	Leucine	Proline	Histidine	Arginine	U
	Leucine	Proline	Histidine	Arginine	C
	Leucine	Proline	Glutamine	Arginine	A
	Leucine	Proline	Glutamine	Arginine	G
A	Isoleucine	Threonine	Asparagine	Serine	U
	Isoleucine	Threonine	Asparagine	Serine	C
	Isoleucine	Threonine	Lysine	Arginine	A
	Methionine	Threonine	Lysine	Arginine	G
G	Valine	Alanine	Aspartic acid	Glycine	U
	Valine	Alanine	Aspartic acid	Glycine	C
	Valine	Alanine	Glutamic acid	Glycine	A
	Valine	Alanine	Glutamic acid	Glycine	G

Protein Synthesis



The theory that genetic information flows from DNA to RNA to protein is often referred to as the "_____" of gene expression.

Protein Synthesis takes place in two steps.

1.) _____n process of producing RNA from DNA

2.) _____ process of producing a polypeptide based on an mRNA sequence

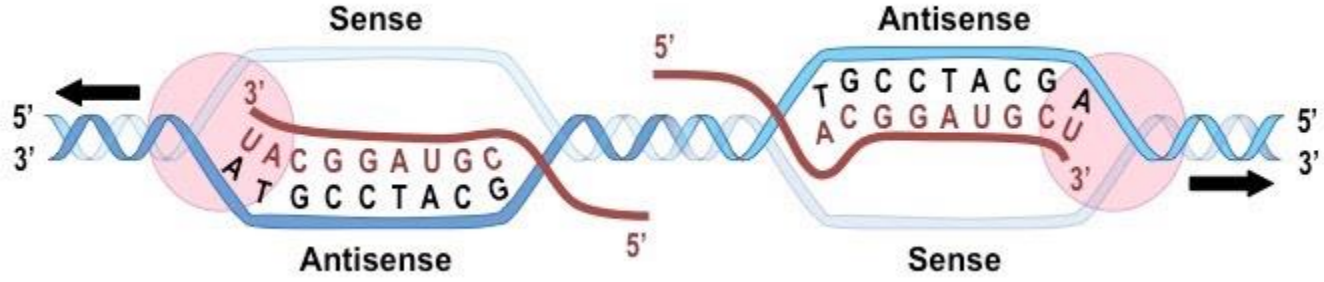
Transcription

During transcription, the information in a segment of DNA is copied into messenger RNA (mRNA).

_____ RNA that carries the genetic code from DNA to protein synthesis machinery

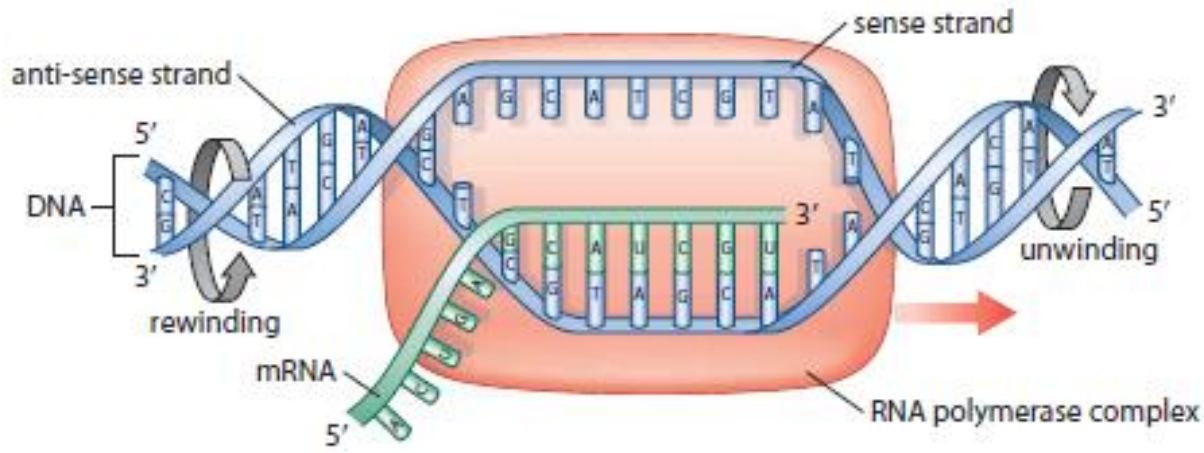
Only one strand of the double-stranded DNA molecule is transcribed.

This strand is called the _____, or coding, strand. The other strand, which is not transcribed, is called the _____, or non-coding, strand.



_____ main enzyme involved in formation of RNA from DNA

_____ set of three bases that code for an amino acid



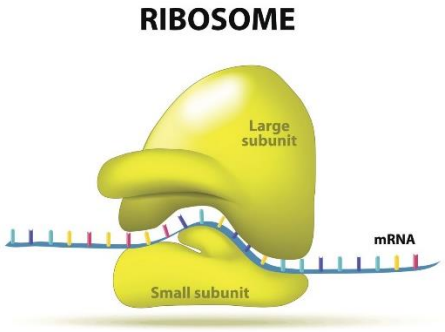
Translation

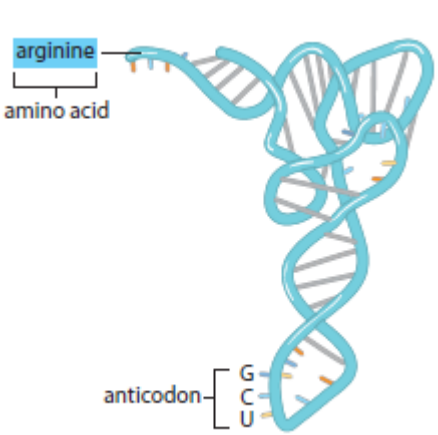
For a cell to create the proteins it needs, it must _____

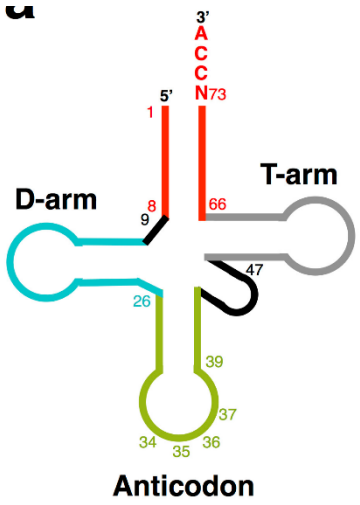
_____.

This process requires both a chemical translator and a set of cellular protein synthesis equipment.

Once the mRNA reaches the cytoplasm, the translator and protein synthesis equipment work together to assemble the proteins.







_____ works with mRNA in translation by delivering correct amino acid

_____base triplet on tRNA complementary to mRNA codon

_____ RNA associated with ribosomes

Translation follows a cycle of four steps:

1.) The first tRNA molecule, carrying the amino acid _____, base-pairs with the first exposed mRNA codon—the _____.

2. A second loaded tRNA molecule arrives at the codon adjacent to the first tRNA.

3. Enzymes catalyze the formation of a chemical bond that joins the amino acid carried by the first tRNA to the amino acid carried by the second tRNA. At the same time, the _____

_____

_____

4. The ribosome moves a distance of one codon along the mRNA strand. The first tRNA molecule detaches from the mRNA and _____. The second tRNA now holds a growing amino acid chain. A third tRNA molecule arrives at the newly exposed codon next to the second tRNA, and the cycle repeats. The translation cycle continues until a _____ is reached.

Types of Codon Tables

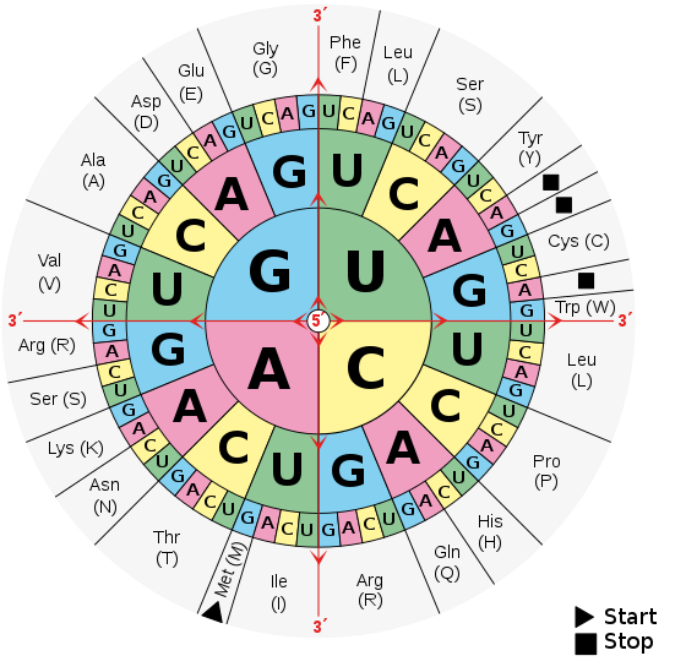
**********************CODON TABLES USE mRNA ONLY!**********************

RNA codon table

1st position	2nd position U	2nd position C	2nd position A	2nd position G	3rd position
U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Leu	Ser	stop	stop	A
	Leu	Ser	stop	Trp	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Gln	Arg	A
	Leu	Pro	Gln	Arg	G
A	Ile	Thr	Asn	Ser	U
	Ile	Thr	Asn	Ser	C
	Ile	Thr	Lys	Arg	A
	Met	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
	Val	Ala	Asp	Gly	C
	Val	Ala	Glu	Gly	A
	Val	Ala	Glu	Gly	G

Amino Acids

Ala: Alanine
Arg: Arginine
Asn: Asparagine
Asp:Aspartic acid
Cys:Cysteine
Gln: Glutamine
Glu: Glutamic acid
Gly: Glycine
His: Histidine
Ile: Isoleucine
Leu: Leucine
Lys: Lysine
Met: Methionine
Phe: Phenylalanine
Pro: Proline
Ser: Serine
Thr: Threonine
Trp: Tryptophane
Tyr: Tyrosisne
Val: Valine



Start from the middle and work your way out

Do not forget that mRNA and tRNA do not have thymine

DNA has A T G C

A – T

G – C

RNA has A U G C

A – U

G – C

Example 1

What amino acid does the _____ sequence AGC code?

Example 2

What amino acid does the _____ sequence ATG code?

Example 3

What amino acid does the _____ sequence AUU code?

RNA codon table

1st position	2nd position U	2nd position C	2nd position A	2nd position G	3rd position
U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Leu	Ser	stop	stop	A
	Leu	Ser	stop	Trp	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Gln	Arg	A
	Leu	Pro	Gln	Arg	G
A	Ile	Thr	Asn	Ser	U
	Ile	Thr	Asn	Ser	C
	Ile	Thr	Lys	Arg	A
	Met	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
	Val	Ala	Asp	Gly	C
	Val	Ala	Glu	Gly	A
	Val	Ala	Glu	Gly	G
	Amino Acids				

Ala: Alanine
Arg: Arginine
Asn: Asparagine
Asp:Aspartic acid
Cys:Cysteine
Gln: Glutamine
Glu: Glutamic acid
Gly: Glycine
His: Histidine
Ile: Isoleucine
Leu: Leucine
Lys: Lysine
Met: Methionine
Phe: Phenylalanine
Pro: Proline
Ser: Serine
Thr: Threonine
Trp: Tryptophane
Tyr: Tyrosisne
Val: Valine

Example 4

If the polypeptide sequence, phenylalanine - isoleucine - threonine, were produced through transcription, what mRNA sequence was present originally

(A) AAA UAA UGG

(B) AAG UAU AAU

(C) UUC AUG ACA

(D) UUU AUU ACC

Example 5

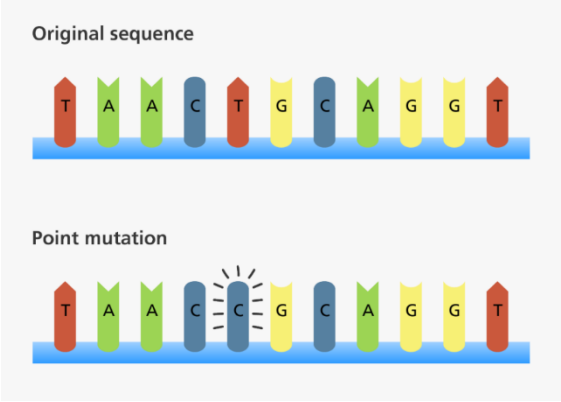
Using the codon table, which _____ sequence was used as a template to produce the polypeptide sequence glycine - isoleucine - phenylalanine?

(A) CCC TAG AAC

(B) CCG TAA AAG

(C) GGA TAC AAT

(D) GGC TAT AAA



Activities 15.2 and 15.3

INVESTIGATION Simulating Protein Synthesis

Exit Card #10

<u>Mutations</u>

_____ permanent change to a cell's DNA

Mutations that occur in the body cells are called _____.

Mutations that occur in reproductive cells are called _____.

<u>Types of Mutations</u>

_____ substitution, insertion, or deletion of one or very few nucleotides

_____

_____

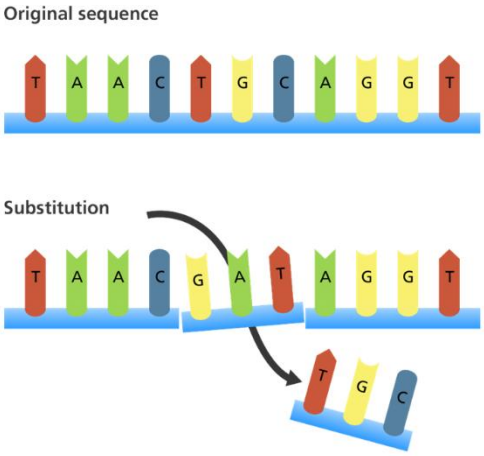
For example, a change in the DNA coding strand sequence from _____ to _____ will not alter the polypeptide produced, since the associated mRNA codons (GGA and GGG) both code for the same amino acid, glycine.

_____

Can be one nucleotide or several.

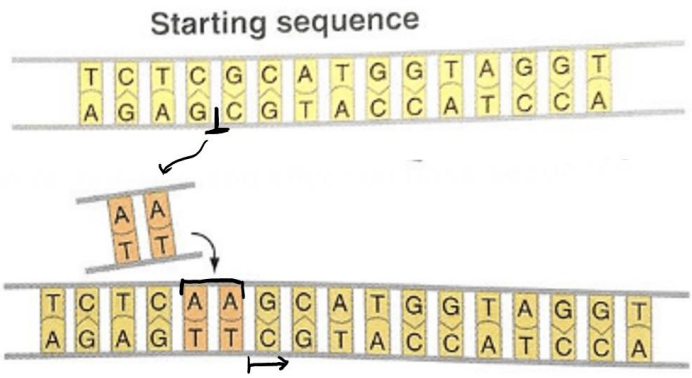
Normal ...GCTATACGCTAGG...

Base pair substitution ...GCTATTCGCTAGG...
↓
G



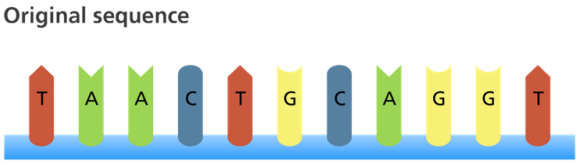
_____

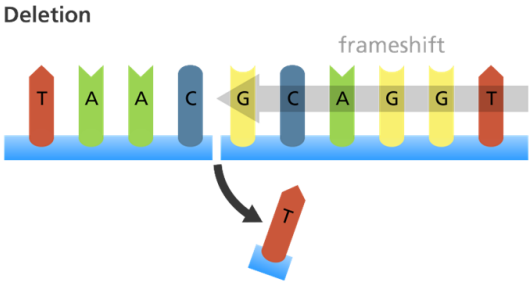
An extra nucleotide or several are inserted into the DNA sequence



_____

A nucleotide or several are deleted from a DNA sequence

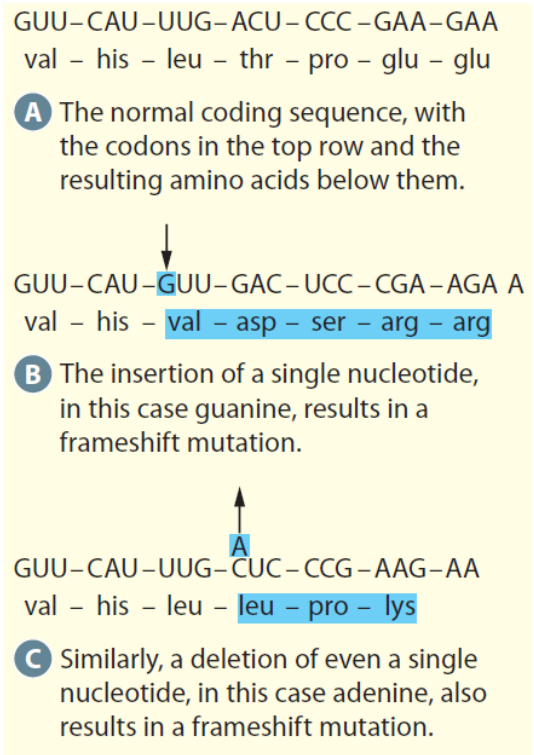




_____ insertion or deletion that results in a change to the reading frame of a gene

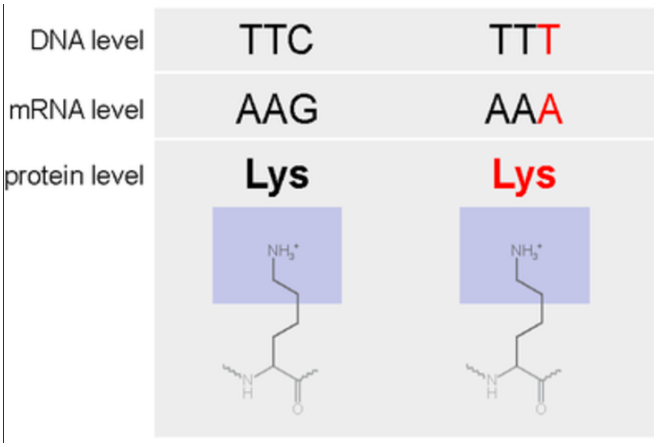
A frameshift mutation causes the entire reading frame of the gene

Frameshift mutations may be caused by nucleotide insertion or deletion.



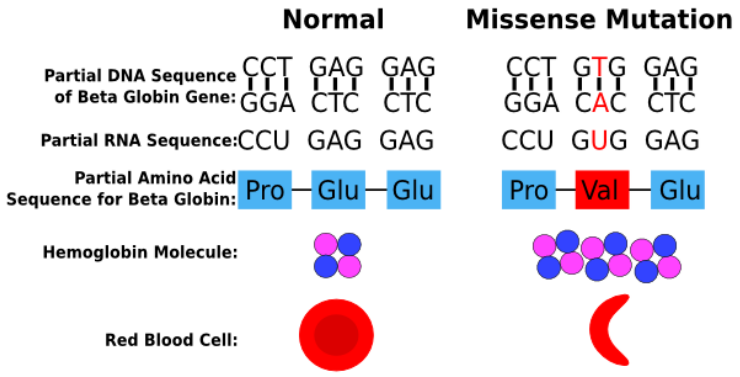
_____ has no effect on a cell

Even when a point mutation involves the substitution of one amino acid for another, this substitution may not have a significant effect on the final structure or function of the polypeptide produced.



_____

mutation that results in an altered but functional protein



Mis-sense mutations can be harmful.

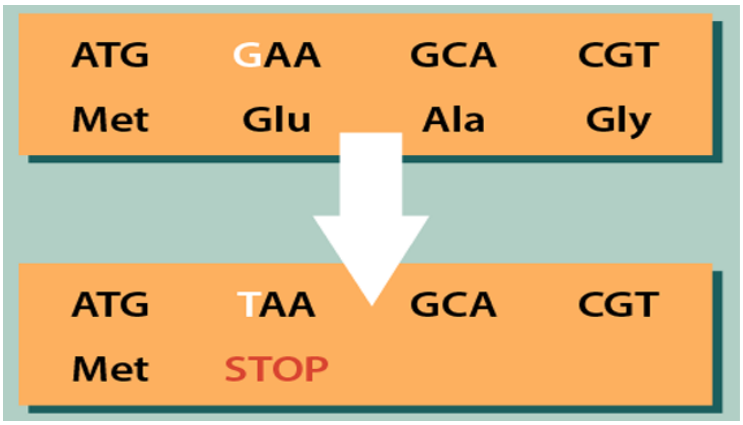
A change in a single amino acid in one of the polypeptides that makes up hemoglobin is responsible for the genetic blood disorder known as _____.

_____

_____.

_____ results in loss of production of a protein

some substitutions can have severe consequences. **If a change in a gene's coding sequence deletes a start signal or results in a premature stop signal, the gene may be unable to produce a functional protein.**



Similarly, a _____ _____ that affects a _____ _____ may result in the cell being unable to respond properly to metabolic signals.

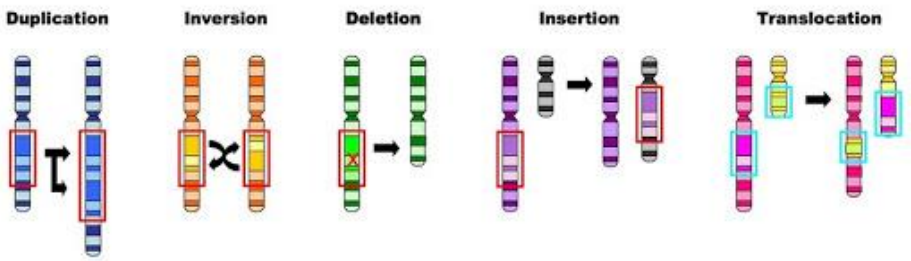
Worksheet - Mutations

Exit Card #11

_____ is the change in the chromosomes as a result of rearranged chromosome parts or changes in the number of individual chromosomes present in the genome.

Mutations that involve a rearrangement of genetic material.

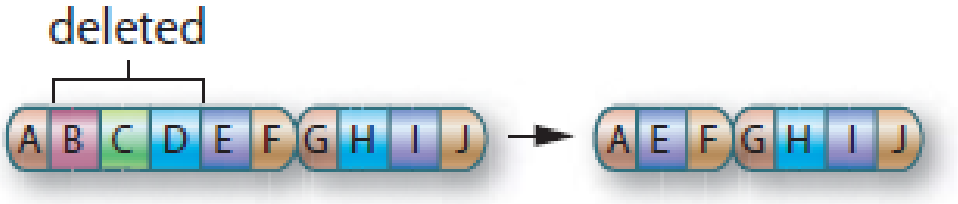
These may affect several genes, including genes located on different chromosomes.
Duplication
Inversion
Deletion
Insertion
Translocation

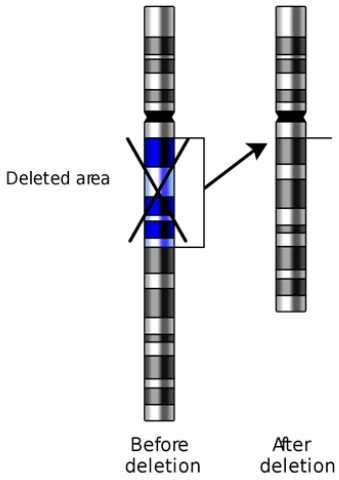


_____

When a section of a chromosome is deleted

They tend to cause birth defects and limited intellectual development and physical development. In some cases, defects can be severe and affected children die during infancy or childhood.





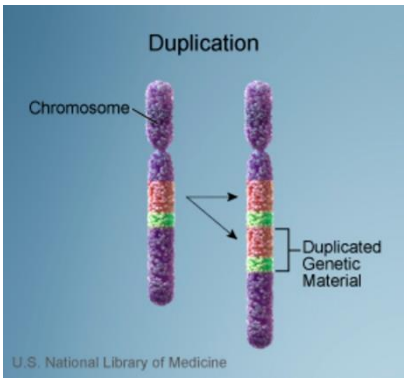
_____

_____

p_____

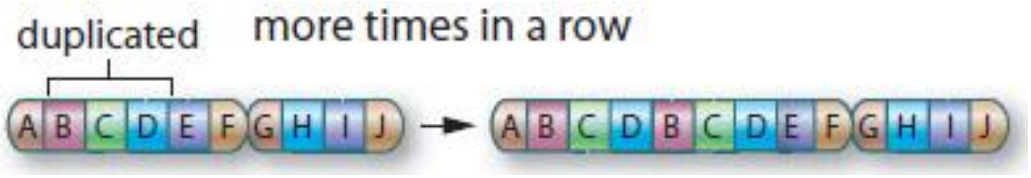
is a type of mutation that involves the production of one or more copies of a gene or region of a chromosome.

a section of a chromosome appears two or more times in a row



_____

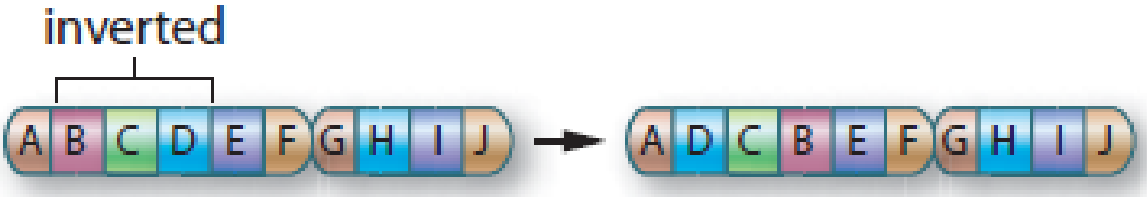
_____



_____

If two breaks occur in one chromosome, sometimes the region between the breaks rotates 180 degrees before rejoining with the two end fragments.

a section of a chromosome is inverted



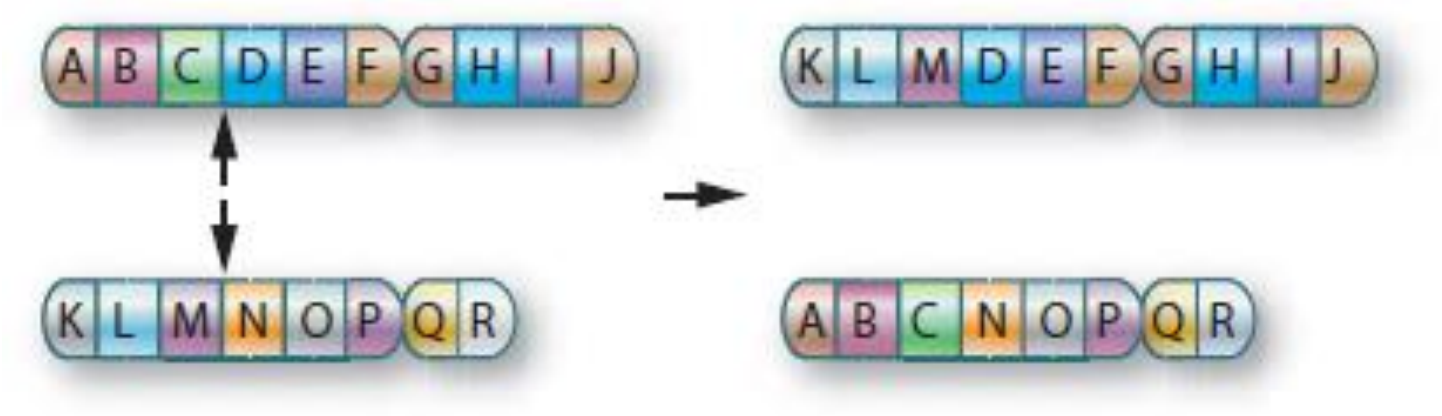
_____

_____

a segment of one chromosome becomes attached to a different chromosome

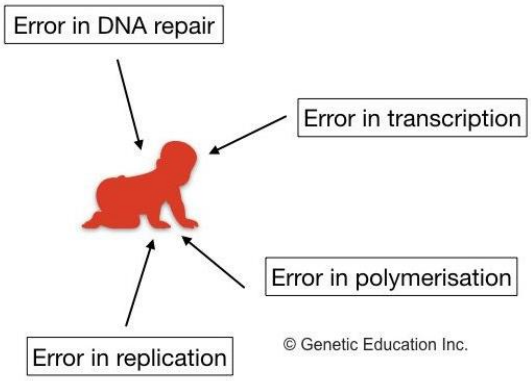
Most cases of _____

_____



What causes mutations?

Many mutations are caused by molecular interactions that take place naturally within cells. These mutations are known as _____.



One source of spontaneous mutations is incorrect base pairing by DNA polymerase during the process of DNA replication.

Mutations that are caused by agents outside the cell are said to be _____.

_____ causes an increase in mutation rate in an cell

Physical Mutagens

Mutagens that cause physical changes in the structure of DNA, they are known _____

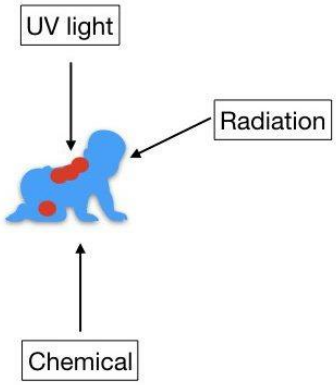
_____

_____

High-energy radiation, such as that from _____

_____

_____ is the most damaging form of mutagen known. They tear through DNA molecules, causing random changes that range from point mutations to the loss of large portions of chromosomes.



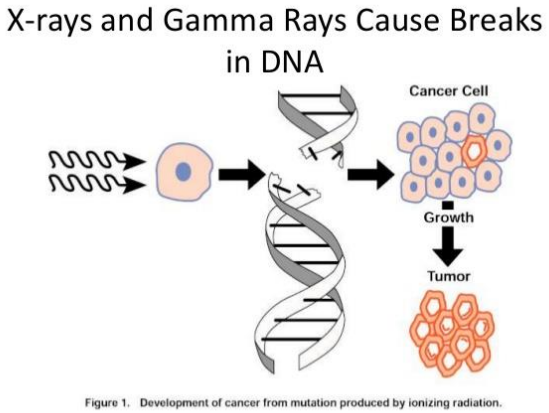
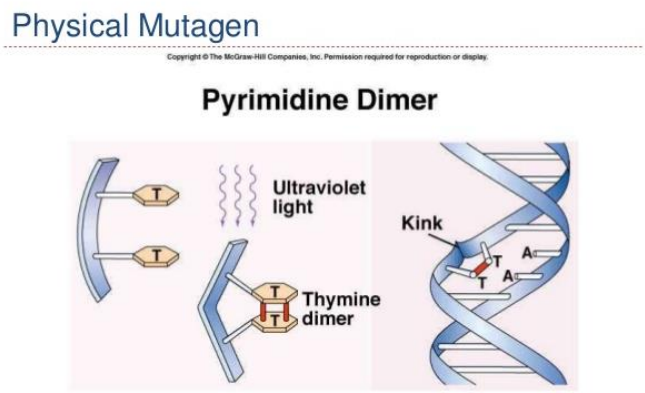


Figure 1. Development of cancer from mutation produced by ionizing radiation.

_____ radiation, which is present in sunlight, has a lower range of energy levels than X rays, but it is still a powerful mutagen. UV radiation can cause a chemical reaction between

_____

_____ bases. The result is a distortion in the DNA molecule that interferes with replication.



Damage from UV radiation, as a result of exposure to _____, is a known cause of _____, a form of skin cancer.

A single sunburn doubles a light-skinned person's chances of developing skin cancer.

<u>Chemical Mutagens</u>

A _____ is a molecule that can enter the nucleus of a cell and induce mutations by reacting chemically with the DNA.

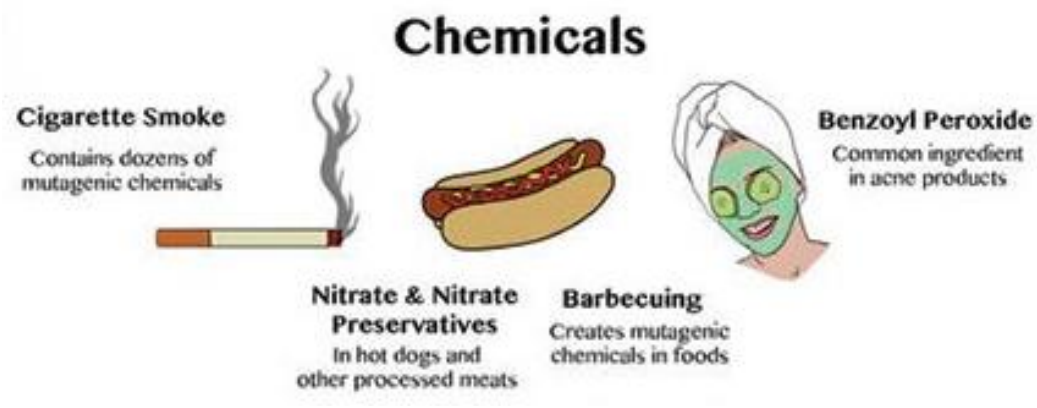
A chemical mutagen may act by _____ in a manner that causes a nucleotide substitution or a frameshift mutation.

Other chemical mutagens have a structure that is _____

_____

_____

When these mutagens are incorporated into a DNA strand, they can cause incorrect nucleotides to be inserted during DNA replication.



Examples of chemical mutagens include _____ (which are sometimes used as a food preservative), _____ _____ and more than

_____

_____

_____

_____

Most chemical mutagens are carcinogens

_____ cancer-causing agent

Cancer is the result of somatic cell mutations that disrupt the expression of genes involved in the regulation of the cell cycle. While carcinogens are present throughout the environment, personal choices can increase or decrease a person's risk of developing cancer.

CHEMICAL COMPOUNDS IN CIGARETTE SMOKE

THIS GRAPHIC OFFERS A SUMMARY OF A SELECTION OF HAZARDOUS COMPOUNDS IN CIGARETTE SMOKE & THEIR EFFECTS

ESTIMATED NUMBER OF CHEMICAL COMPOUNDS IN CIGARETTE SMOKE

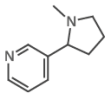
7,357

70

NUMBER OF THESE COMPOUNDS WITH CONFIRMED CARCINOGENIC ACTIVITY

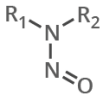
The compounds shown below are all found in cigarette smoke. The mass figures, given in µg, take into account both mainstream (inhaled) and sidestream smoke. 1 µg is equal to 1 millionth of a gram. Amounts of these compounds vary in different brands of cigarettes - these figures are approximate.

NICOTINE



- Approx. 919µg per cigarette
- Addictive
- Increases heart rate
- Increases blood pressure
- Increases blood glucose
- Lethal dose: around 500-1000mg

N-NITROSAMINES

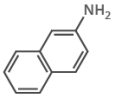


- Large class of compounds
- Several are tobacco-specific
- **Known human carcinogens**
- Most carcinogenic: NNK & NNN
- NNK: approx. 0.3µg per cigarette
- NNN: approx. 2-50µg per cigarette
- May cause reproductive damage

BENZENE

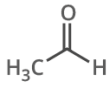
- Approx. 46-272µg per cigarette
- **Known human carcinogen**
- Damages bone marrow
- Lowers red blood cell count
- May harm reproductive organs

AROMATIC AMINES



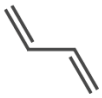
- Large class of compounds
- Includes 2-aminonaphthalene:
  - **Known human carcinogen**
  - Linked with bladder cancer
  - Approx. 0.04µg per cigarette

ACETALDEHYDE



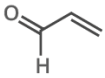
- Approx. 680-1571µg per cigarette
- **Known animal carcinogen**
- **Probable human carcinogen**
- Irritant to skin & eyes
- Irritant to respiratory tract

1,3-BUTADIENE



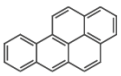
- Approx. 36-191µg per cigarette
- **Known human carcinogen**
- **Suspected human teratogen**
- Irritant to eyes & skin
- Irritant to upper respiratory tract

ACROLEIN



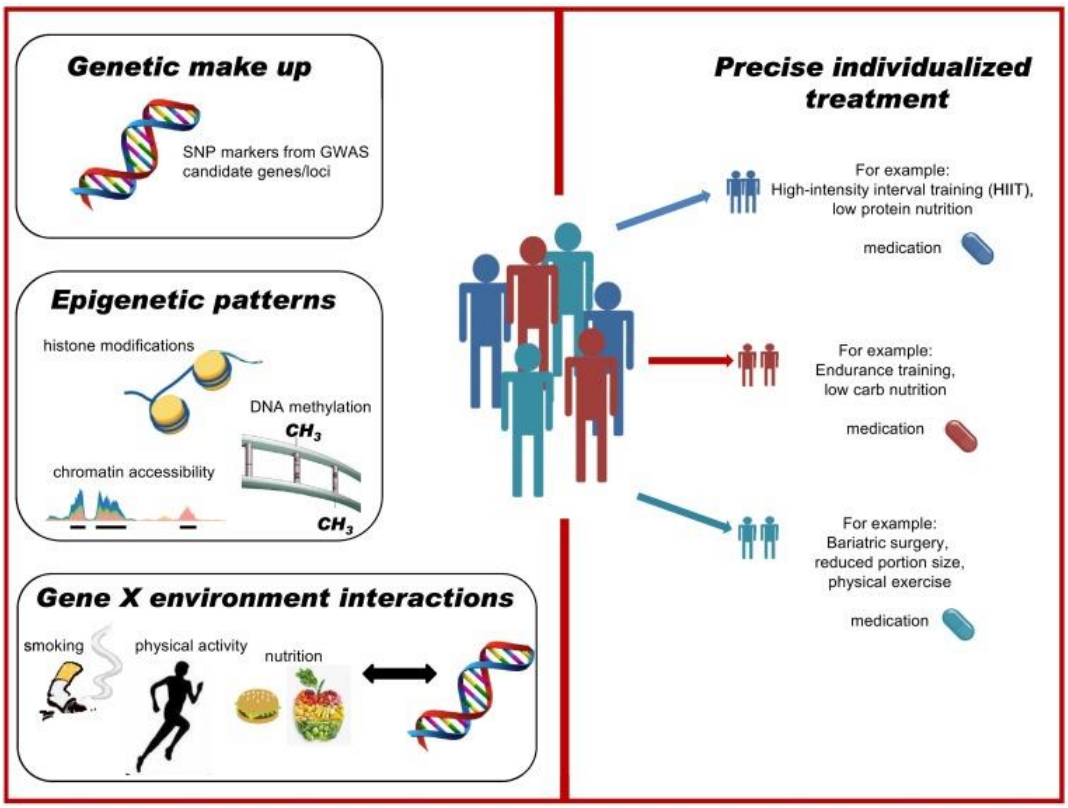
- Approx. 69-306µg per cigarette
- **Possible human carcinogen**
- **Known DNA mutagen**
- Irritant to skin & nasal passages
- May contribute to heart disease

POLYAROMATICS



- Large class of compounds
- Includes benzo[a]pyrene:
  - **Known human carcinogen**
  - **Known DNA mutagen**
  - Affects reproductive capacity
  - Up to 0.14µg per cigarette

_____ is the study of how your behaviors and environment can cause changes that affect the way your genes work.



Unlike genetic changes, epigenetic changes are reversible and do not change your DNA sequence, but they can change how your body reads a DNA sequence.

Gene expression refers to how often or when proteins are created from the instructions within your genes. While genetic changes can alter which protein is made, epigenetic changes affect gene expression to

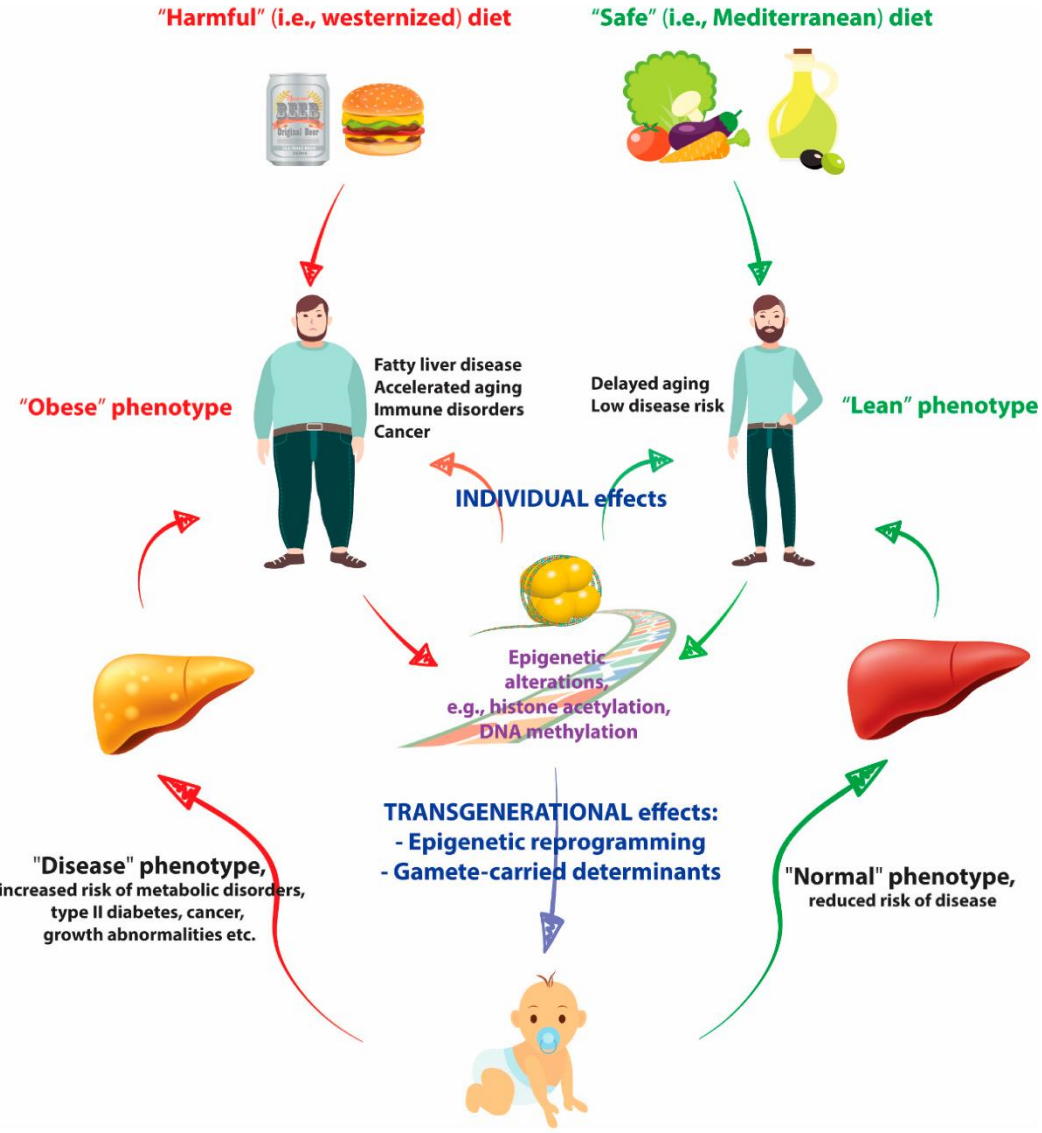
_____

_____

Since your environment and behaviors, such as

_____

can result in epigenetic changes, it is easy to see the connection between your genes and your behaviors and environment.

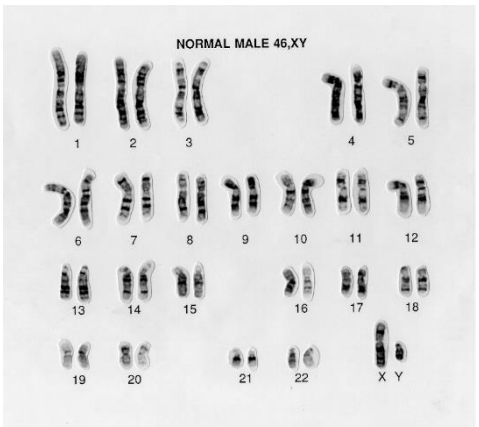


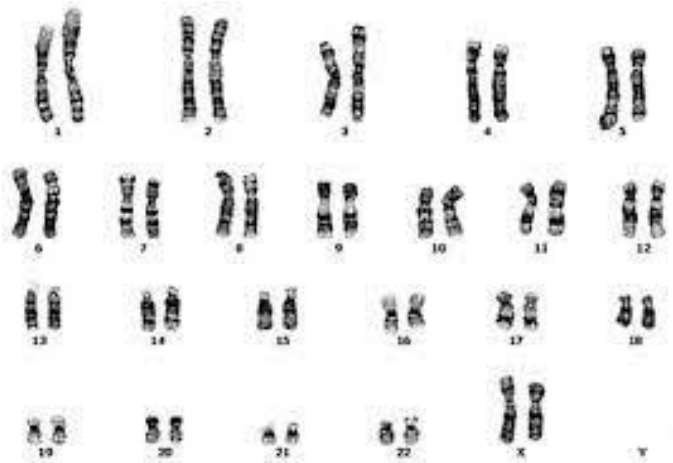
<u>Genetic Disorders Due to Chromosomal Changes</u>

karyotype an individual's set of chromosomes; often represented as a photo

XX = Female

XY = Male





_____ failure of homologous chromosomes or sister chromatids to separate in meiosis

Genetic disorders that result from an incorrect number of chromosomes are often due to an error that occurs during _____.

Nondisjunction can occur in _____.

In anaphase I, nondisjunction occurs when homologous chromosome pairs do not separate to opposite poles; instead, one entire pair is pulled toward the same pole together.

In anaphase II, nondisjunction occurs when sister chromatids do not separate to opposite poles; instead, both sister chromatids are pulled toward the same pole together.

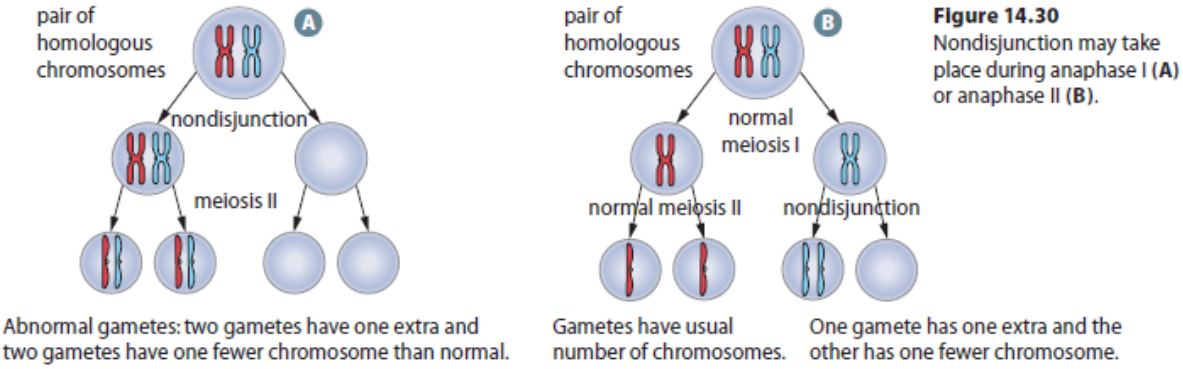
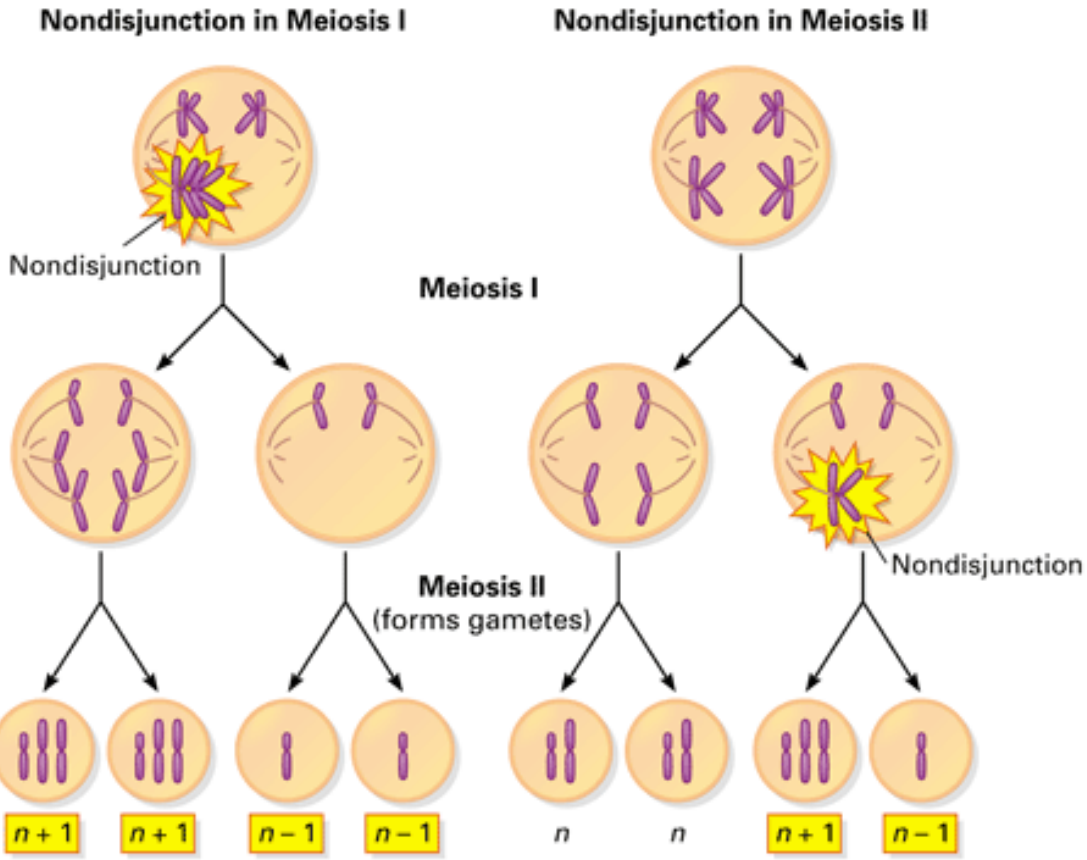
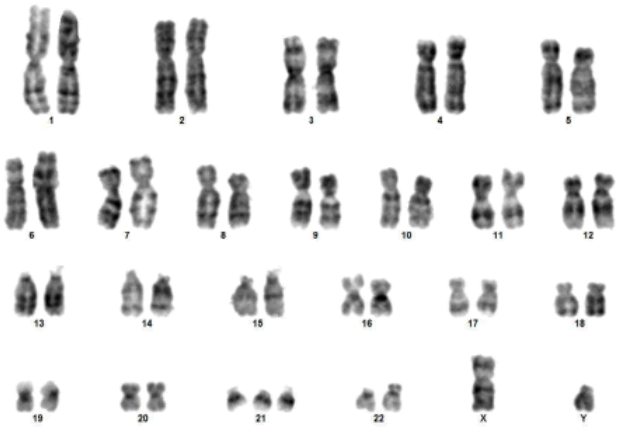


Figure 14.30
Nondisjunction may take place during anaphase I **(A)** or anaphase II **(B)**.



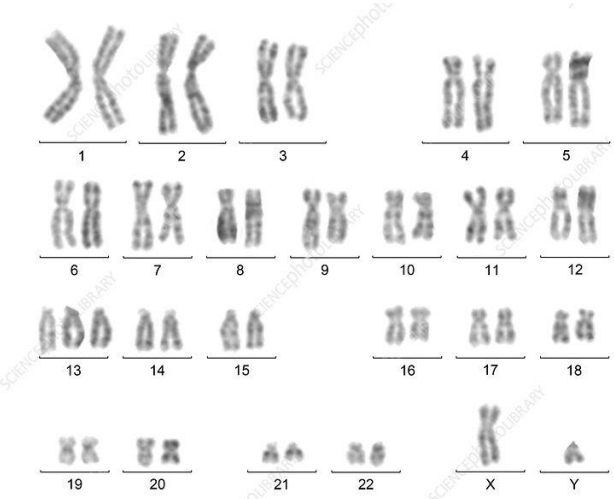
Down Syndrome

What is wrong with this Karyotype?



Patau Syndrome

What is wrong with this Karyotype?

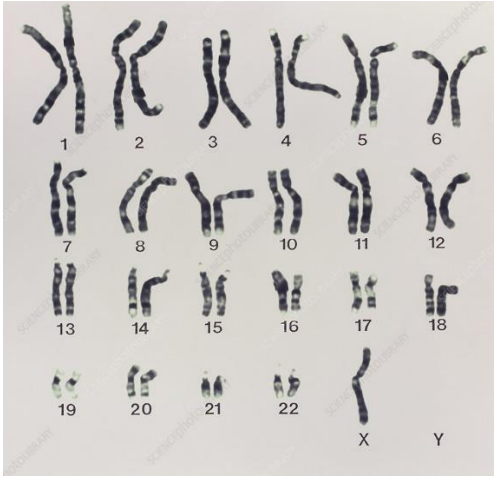


Edward Syndrome

What is wrong with this Karyotype?

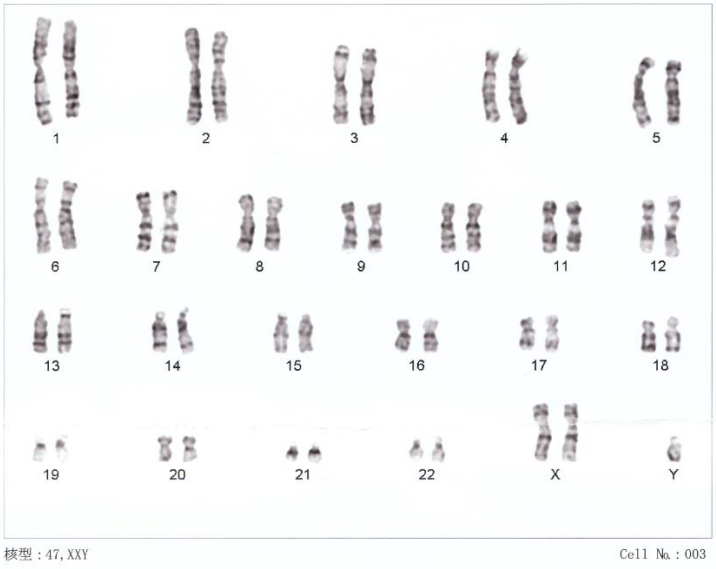
Turner Syndrome

What is wrong with this Karyotype?



Klinefelter Syndrome

What is wrong with this Karyotype?



XYY Syndrome

What is wrong with this Karyotype?

Sequencing Genomes

_____ process of identifying the nucleotide sequence of a DNA fragment

In 1977, the genome of the virus X174 became the first entire genome to be sequenced. At that time, the sheer size of eukaryotic genomes made it impossible for scientists to sequence these genomes using the same techniques.

The Human Genome Project

In 2003, an international team of researchers completed the _____, monumental effort to sequence the entire human genome.

The Human Genome Project is a landmark in the field of human genetics, and it has _____

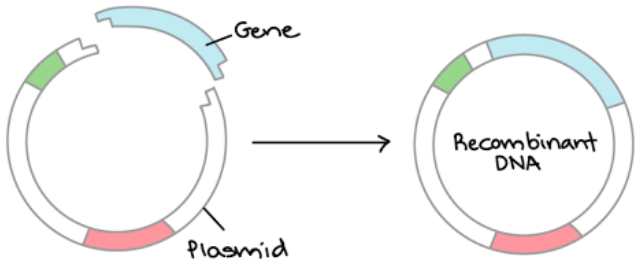
_____

STSE CONNECTIONS + SCIENCE AND TECHNOLOGY The Human Genome Project

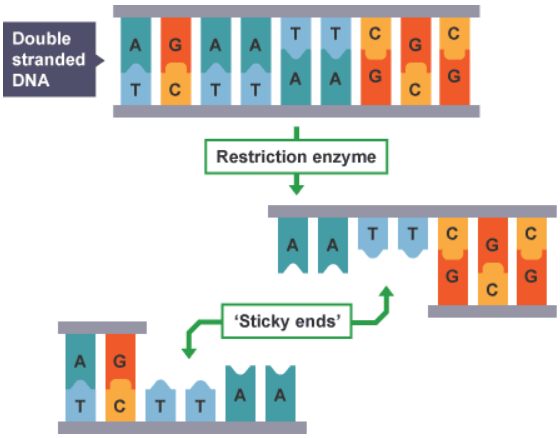
Genetic Technologies

_____ manipulation of genetic material to alter genes and blend plant, animal, and bacterial DNA

_____ a molecule of DNA that includes genetic material from different sources



_____ enzyme that catalyzes the cleavage of DNA at specific nucleotide sequences



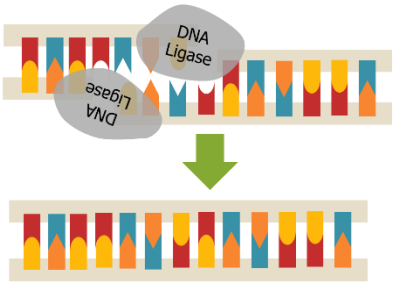
Two characteristics of restriction enzymes:

_____: The cuts made are specific and predictable. That is, the same enzyme will cut a particular strand of DNA the same way each time, producing an identical set of small DNA fragments.

_____: Most produce a staggered cut that leaves a few unpaired nucleotides on a single strand at each end of the restriction fragment.

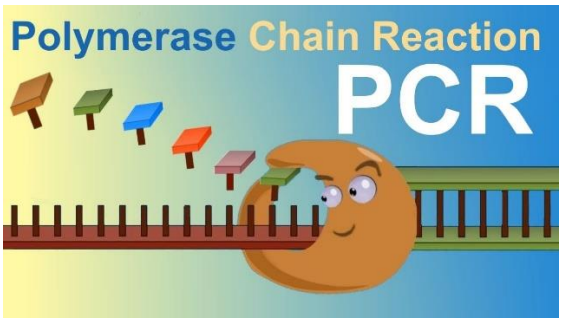
These short strands, often referred to as _____, can then form base pairs with other short strands that have a complementary sequence.

Once the sticky ends have formed base pairs with one another, the action of another enzyme, _____, joins them together. The result is a stable recombinant DNA molecule.



The human insulin gene can be combined with a type of_____ called a _____. The recombinant DNA molecule can be introduced into bacteria where it will replicate numerous times and produce the human insulin protein, which can then be isolated and used medicinally.

_____ is a method widely used to rapidly make millions to billions of copies (complete copies or partial copies) of a specific DNA sample, allowing scientists to take a very small sample of DNA and amplify it to a large enough amount to study in detail.



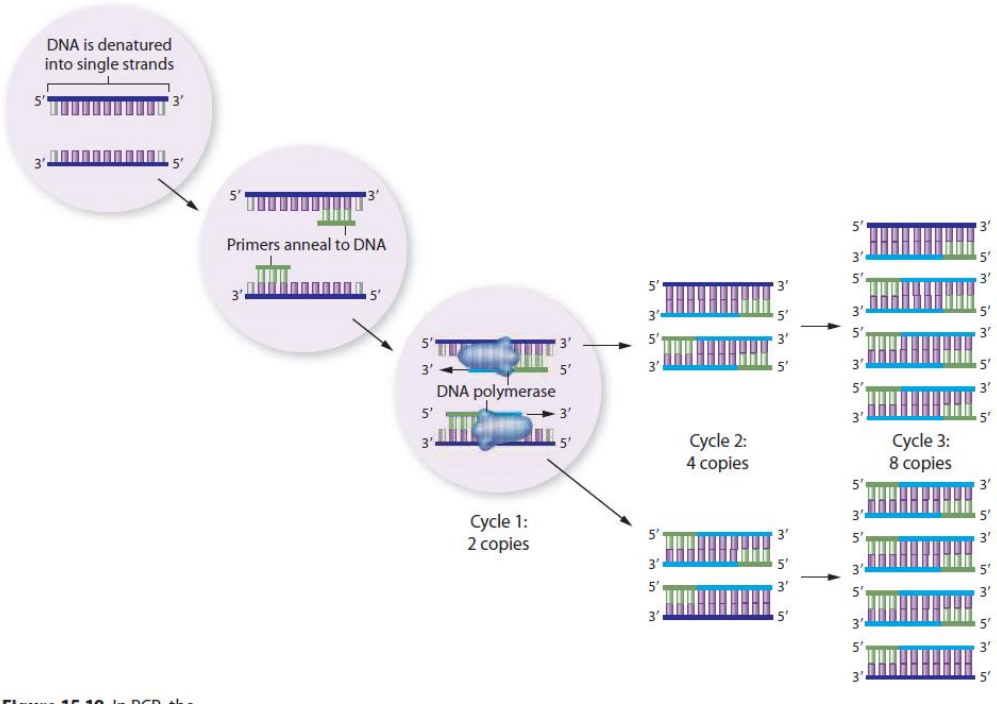
DNA Amplification

PCR uses _____ and a special type of _____ that adds nucleotides onto _____that bind to each end of the region to be amplified.

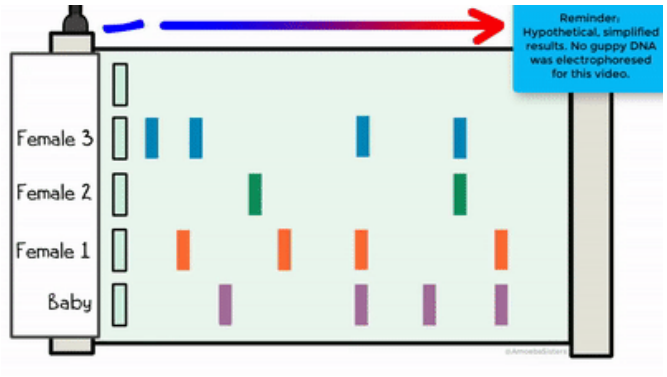
_____

_____

The same cycle is typically repeated 20 to 30 times. This results in sufficient amounts of DNA



Sorting and Analyzing DNA



_____ tool used to separate molecules according to mass and charge

To begin, a solution that contains DNA fragments is applied at one end of a gel. An electric current is then passed through the gel.

This causes one end of the gel to develop a positive electric charge and the other end to develop a negative electric charge.

Because DNA has a negative charge, the DNA fragments tend to move toward the gel's positive end. _____

_____

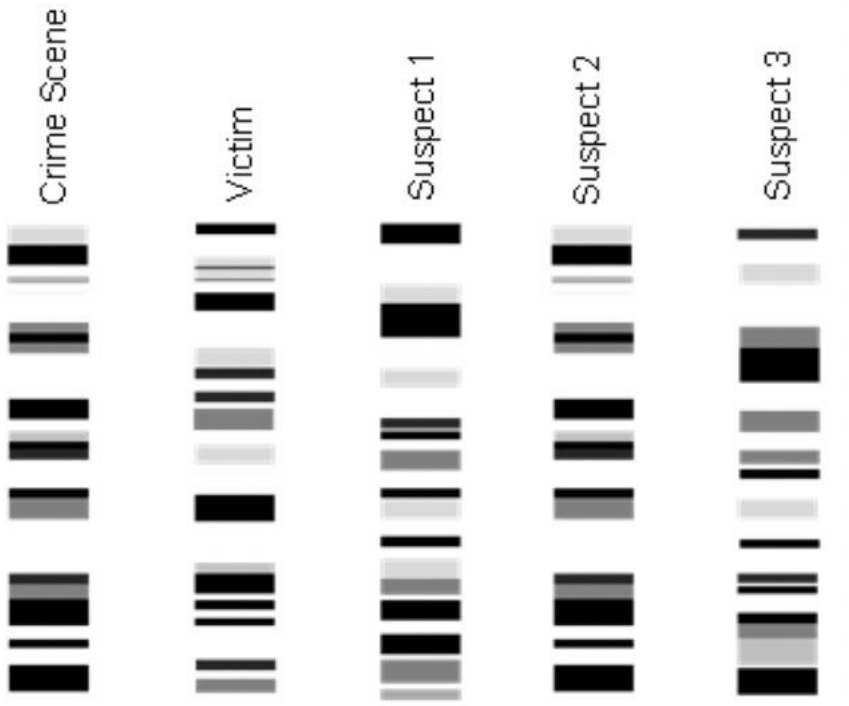
_____ uses gel electrophoresis to distinguish between samples of the genetic material.

Since no two people (other than identical twins) have the same DNA, a person's DNA fingerprint is unique and can be used for identification purposes.

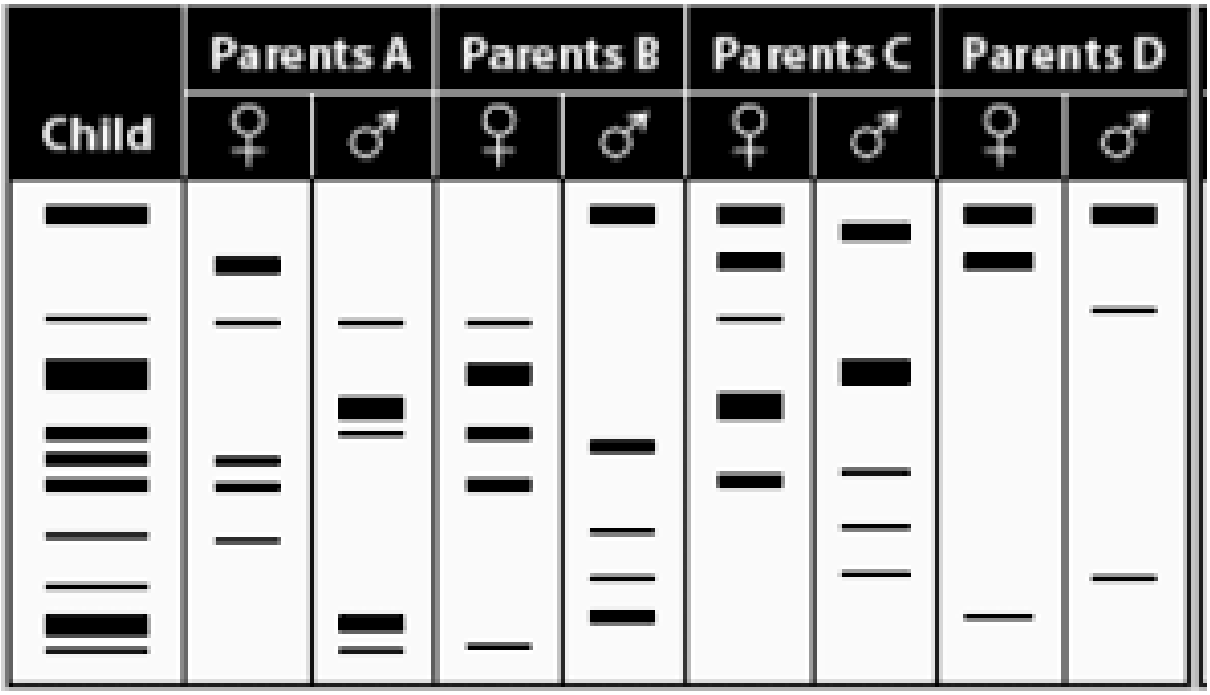
A DNA fingerprint of a sample from a crime scene can be compared with the DNA fingerprint of a suspect. A match is very strong evidence that the suspect was present at the crime scene.

Similarly, DNA fingerprints can be used to solve disputes over parentage. DNA is inherited equally from both parents, a child's DNA fingerprint will show some matches with the DNA fingerprint of each parent.

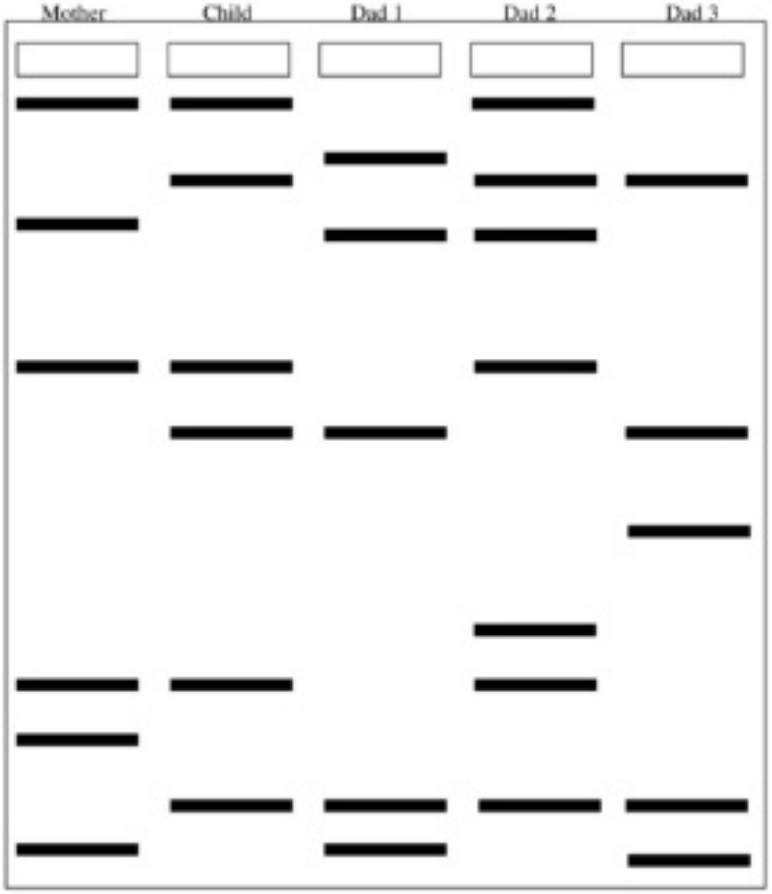
Who committed the crime?



Which parents own the child?



Which dad owns the child?



Exit Card #12

CRISPR

_____ a genetic engineering tool that uses a CRISPR sequence of DNA and its associated protein to edit the base pairs of a gene.

The essence of CRISPR is simple: it's a way of finding a specific bit of DNA inside a cell. After that, the next step in CRISPR gene editing is usually to alter that piece of DNA.

How it works

CRISPR uses a type of bacteria protein (Cas) to find a section of RNA/DNA, cut it and then modify it with alternate nucleotides.

1.) Design - Ensure that you select the optimum guide RNA and other components for your experiment

2.) Edit - Introduce the CRISPR components into cells to allow the genome engineering to occur

3.) Analyze - Verify the effectiveness of your experiment and move on to the next steps

How is it being used/can it be used right now?

1. Turning pigs into organ donors

2. Making new and improved fruit

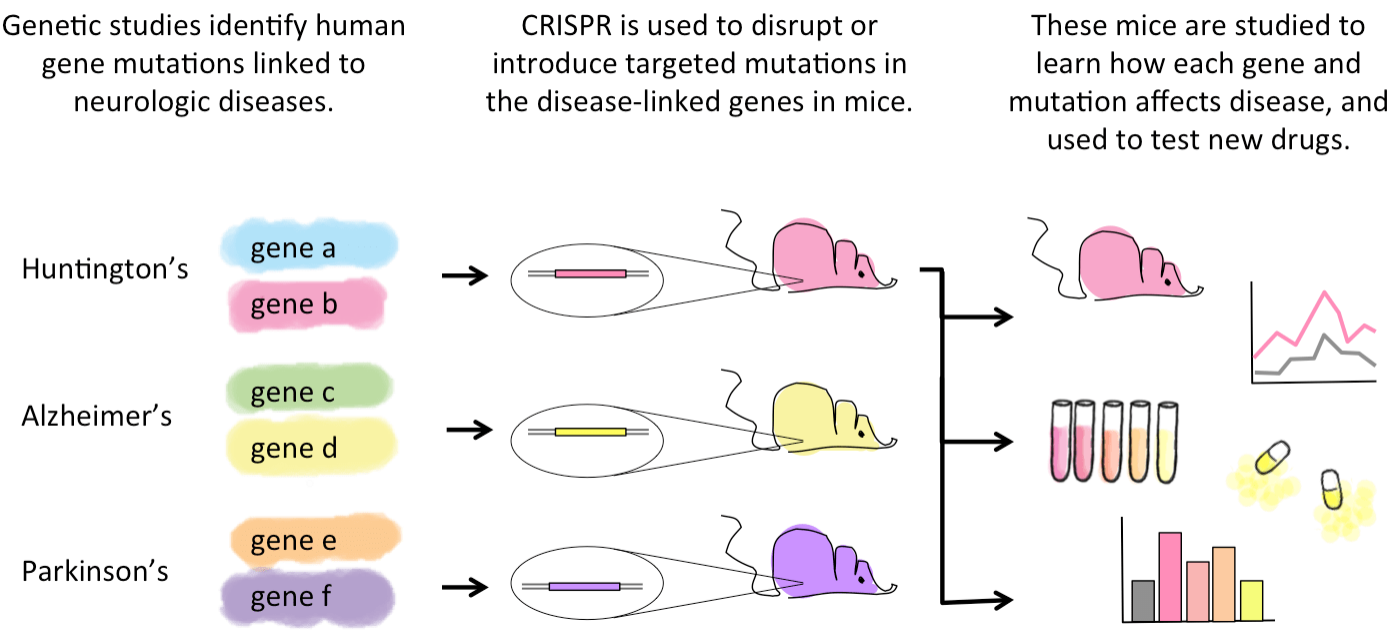
3. Changing flowers from violet to white

4. Modifying human embryos

5. Halting muscular dystrophy in dogs

6. Creating new treatments for cancer and blood disorders

7. Eliminating mosquitoes



DNA microarray

_____ tool for analysis of gene expression levels using cDNA probes

A DNA microarray is a chip (usually a glass microscope slide or a polymer membrane) that contains a grid of thousands of microscopic cells.

Each cell contains a nucleic acid sequence that can bind with one of the mRNA molecules transcribed during gene expression.

A typical microarray experiment includes the following steps:

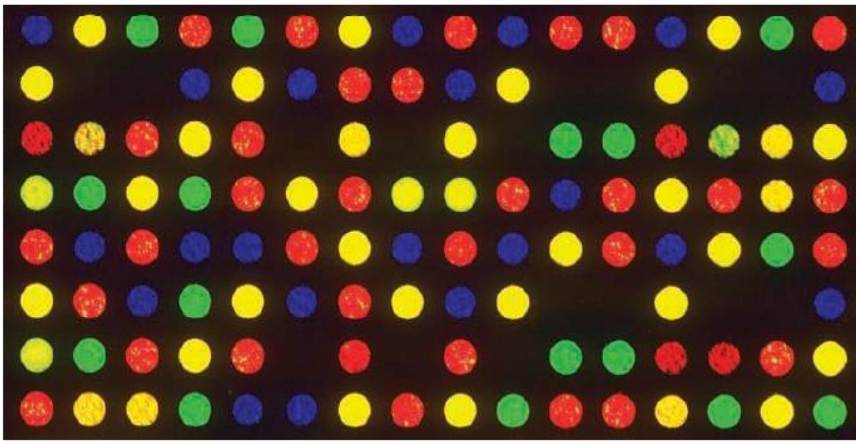


Figure 15.21 The results of a DNA microarray analysis comparing gene expression in two different cell samples. The red spots indicate genes that are expressed only by cells in the first sample, and the green spots indicate genes that are expressed only by cells in the second sample. The yellow spots indicate genes that are expressed by cells in both samples.

1. _____ from the cell or cells to be studied.

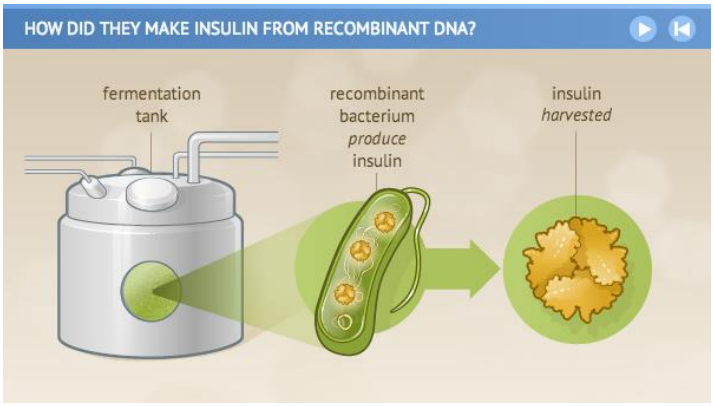
2. mRNA from each cell sample is used as a template to _____ an _____ form of DNA, called _____ (cDNA). The cDNA from each sample is marked by a fluorescent tag for later identification.

3. The labelled cDNA samples are _____ with the microarray. The cDNA binds to the microarray at locations that correspond to individual genes in the cell genome.

4. The microarray is scanned and analyzed to _____ of gene expression in each cell sample.

Biotechnology

_____ use of biological systems to create new technologies and products



Biotechnology Products

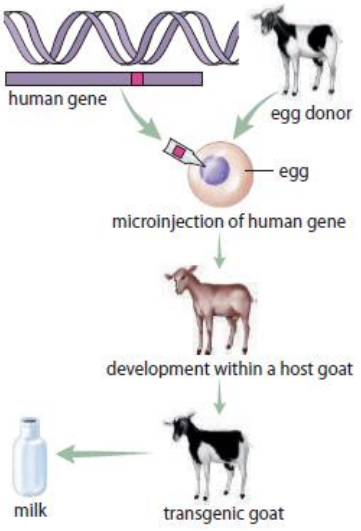
_____ bacteria are used to produce antibiotics, vaccines, and medically-useful enzymes.

In 1982, human insulin synthesized by transgenic bacteria was approved for medical use in the United States.

Some bacteria naturally degrade toxic substances, such as polychlorinated biphenyls (PCBs). The use of living cells for environmental remediation is known as _____.

Clean up oil spills, to filter air from factory smokestacks, or to remove heavy metals from water.

_____ animal genetically engineered to contain DNA from another organism. Researchers have been able to create new varieties of animals with useful traits. For example, _____ _____ animals, such as _____, are being used to produce pharmaceutical products.



Similar steps have been used by a Canadian research company to insert a spider gene into goats. The transgenic goats secrete

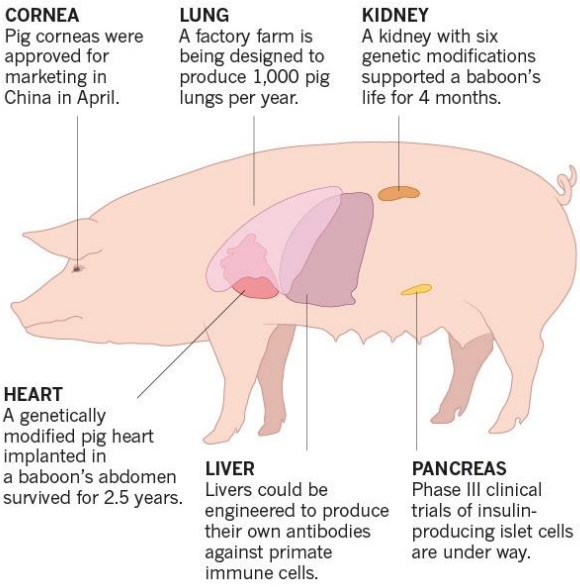
_____

_____

The silk can be extracted and spun into lightweight, strong fibres with many uses.

Another area of research involves developing _____ that can serve as _____

Researchers are looking to source an increasing variety of living tissues, including solid organs, from pigs. Many are attempting to genetically engineer the animals to reduce the risk of rejection and infection in humans.



Usually, the transplantation of organs from animals, such as pigs, into human patients has limited success

Pigs could become a source of organs that are more compatible to the human body.

_____ plant genetically engineered to contain DNA from another organism

Crop plants that contain recombinant DNA now account for over half the corn and canola produced in North America.

Many of these plants have been modified to increase their resistance to herbicides, insect pests, or viruses.

_____ is genetically modified to contain nutrients otherwise not found in rice.

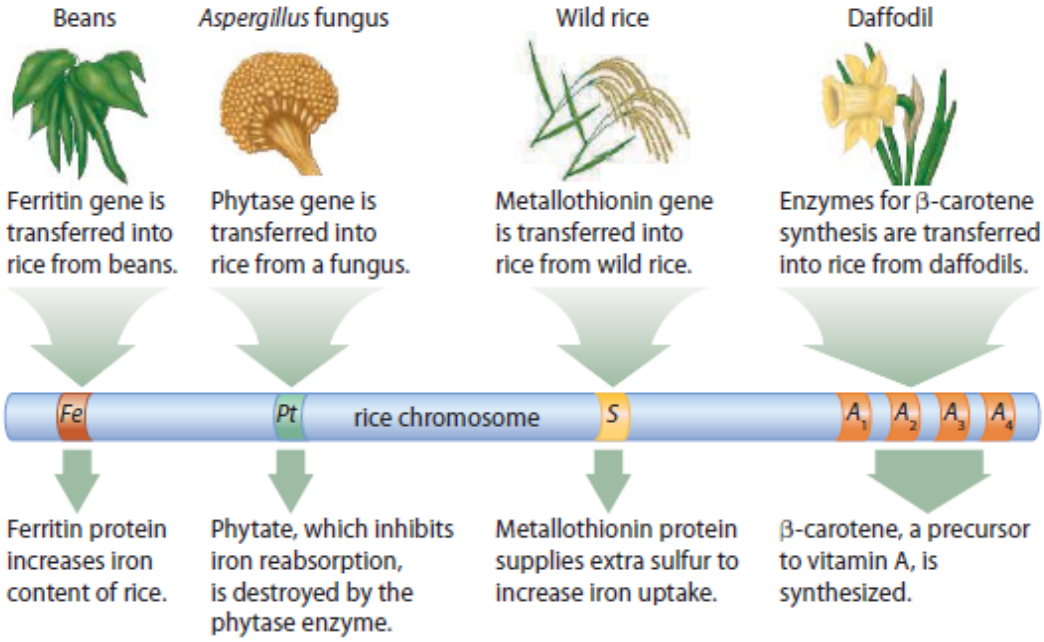


Figure 15.24 The transgenic product, golden rice, contains four different foreign genes. Three of these genes come from other plants and one comes from a fungus.

_____ genetically identical organisms

Cloned offspring suffer from a high mortality rate, however, as well as a high incidence of disease. Many also show signs of metabolic disorders, such as premature aging. Outcomes such as these reflect the need for ongoing research into the complexities of gene expression in animals.

_____ the sheep

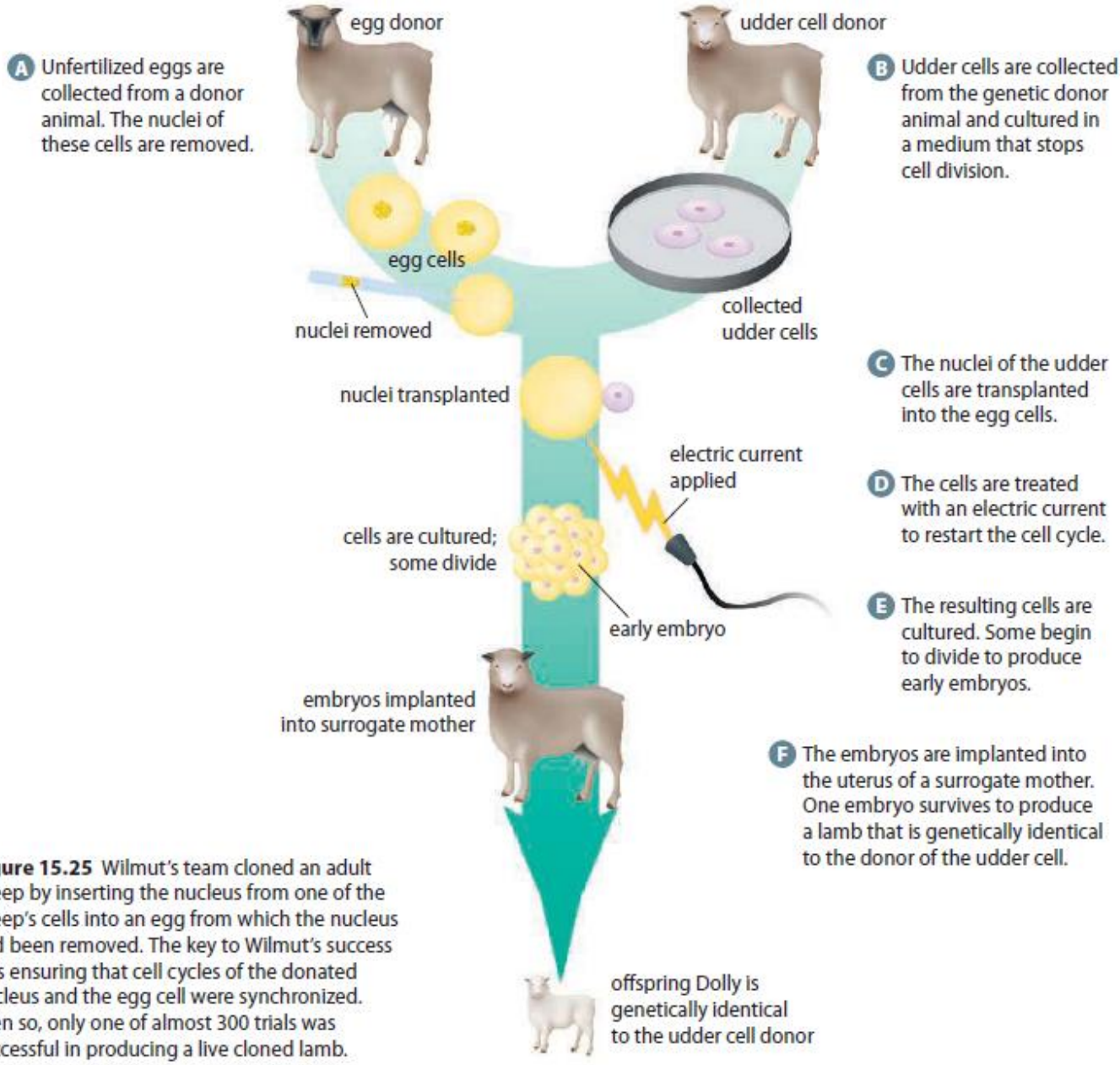


Figure 15.25 Wilmut's team cloned an adult sheep by inserting the nucleus from one of the sheep's cells into an egg from which the nucleus had been removed. The key to Wilmut's success was ensuring that cell cycles of the donated nucleus and the egg cell were synchronized. Even so, only one of almost 300 trials was successful in producing a live cloned lamb.

Assessing the Benefits and Risks

_____: The use of herbicide-resistant plants could encourage farmers to use higher levels of herbicides.

This, in turn, could lead to a _____

_____

_____ As well, there is evidence that engineered genes can be transferred to wild plants and other organisms, raising concerns about the emergence of "_____" and "_____."

More generally, ecosystems involve complex and delicate balances among many different organisms.

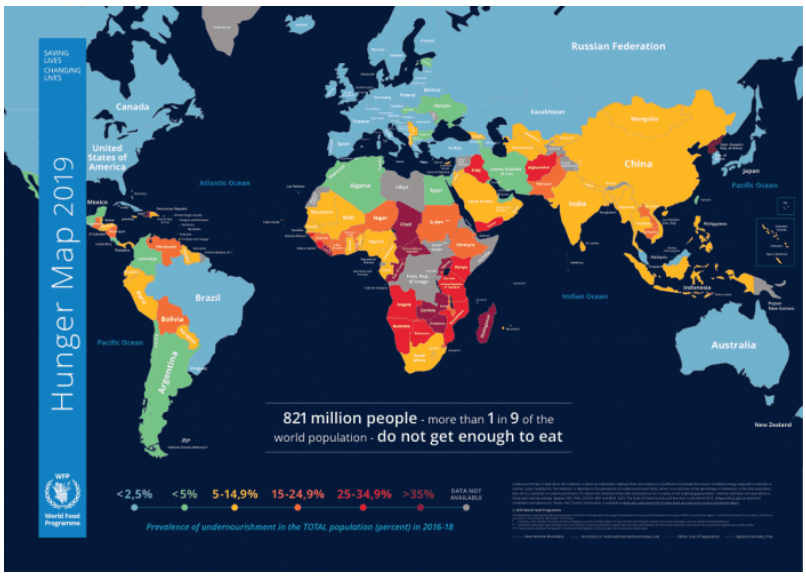
The introduction of transgenic bacteria, plants, or animals could _____

_____: Many consumer groups _____

_____about the long-term effects of consuming transgenic products, including genetically modified foods and medicines. The complex processes of gene regulation are not well understood, so it is difficult to predict potential health risks.

_____: Advocates of genetically modified foods argue that these foods will help to improve human health and _____.

Their opponents argue that genetic research absorbs millions of dollars, which would be better spent directly helping people in need.



Many people are concerned about the growing influence of private corporations over global food production.

The treatment of plants and animals as commodities to be manipulated and patented also raises questions about our relationships with—and responsibilities to—other living organisms.

Research Poster Project

Students are expected to research social, environmental, and ethical issues associated with application of a specific genetic technology (e.g., human gene therapy, genetically modified foods, personal genomics). They should take a position on the use of a specific genetic technology and construct arguments to support and defend their position.

STSE case study to analyze the risks and benefits to society of gene therapy applications.