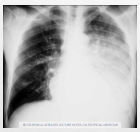
CHAPTER 12- RISE OF GENETICS

- KENNEDY
- BIOL. 1AB

I. DISCOVERY OF DNA

- DNA WAS FIRST DISCOVERED IN 1898 BY MIESHNER.
- HE USED PROTEASE TO DIGEST THE PROTEIN AWAY FROM WHITE BLOOD CELLS.
- HE DESCRIBED WHAT HE HAD LEFT AS A STRINGY BALL OF PUS.

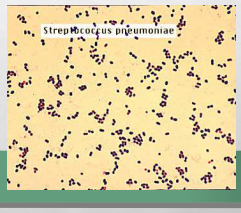
A. GRIFFITH (1928)



- 1. WORK WITH BACTERIA- STUDIED TWO STRAINS OF PNEUMOCOCCUS OR PNEUMONIA CAUSING BACTERIA.

A. VIRULENT FORMS

- THE VIRULENT FORM IS THE LETHAL FORM THAT CAUSES PNEUMONIA.
- IT IS RECOGNIZED BY ITS SMOOTH OUTER COAT.

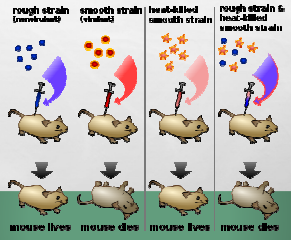


B. HARMLESS FORMS

- THE HARMLESS FORM DOES NOT CAUSE THE DISEASE.
- IT IS RECOGNIZED BY ITS ROUGH OUTER COAT.

2. EXPERIMENT

- GRIFFITH PERFORMED EXPERIMENTS ON MICE WITH THE BACTERIA.



A. LIVE CELLS (HARMLESS)

- FIRST HE TOOK LIVE HARMLESS CELLS AND INJECTED THEM INTO THE MICE.
- EVERY TIME THE MOUSE LIVED.

B. LIVE CELLS (VIRULENT)

- HE THEN TOOK LIVE VIRULENT CELLS AND INJECTED INTO THE MICE.
- EVERY TIME HE DID THIS THE MICE DIED.

C. HEAT KILLED (VIRULENT)

- HE THEN TOOK HEAT KILLED VIRULENT BACTERIA AND INJECTED IT IN TO LIVE MICE.
- EVERY TIME THE MICE LIVED.

D. LIVE (HARMLESS) + HEAT KILLED (VIRULENT)

- FINALLY HE TOOK LIVE HARMLESS CELLS PLUS HEAT KILLED VIRULENT CELLS AND INJECTED IT IN TO THE MICE.
- EVERY TIME HE DID THIS THE MICE DIED.

3. RESULTS

- HE CONCLUDED THAT THE HARMLESS BACTERIA HAD BEEN TRANSFORMED INTO THE VIRULENT BACTERIA WITHIN THE MICE.
- HE DID NOT IDENTIFY WHAT THE TRANSFORMATION PRINCIPLE WAS JUST THAT THE BACTERIA CHANGED.

4. AVERY (1941)-

- AVERY WAS THE FIRST PERSON TO IDENTIFY THE TRANSFORMATION PRINCIPLE.

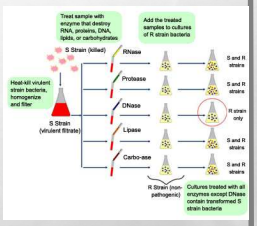
A. EXPERIMENTS

HIS EXPERIMENTS WERE SIMILAR TO GRIFFITH'S, WITH SOME MINOR CHANGES.

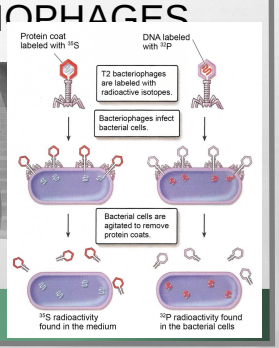
HE TOOK THE VIRULENT STRAIN OF BACTERIA AND BROKE IT DOWN IN TO ITS INDIVIDUAL PARTS.

HE MIXED ONE AT A TIME PROTEIN, CARBS, LIPIDS, AND DNA WITH THE HARMLESS BACTERIA THEN INJECTED IT INTO THE MICE.

THE ONLY ONE THAT CAUSED A TRANSFORMATION WAS THE DNA



B. HERSHEY AND CHASE (1952) BACTERIOPHAGES



HERSHEY AND CHASE (1952) BACTERIOPHAGES

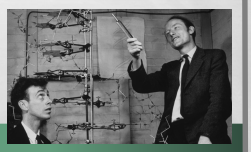
Wanted to see how the DNA could get into the cell.

They used radioactively labeled bacteriophage DNA.

They mixed it with E.coli. and through the use of X rays they were able to photograph the DNA moving from the virus to the bacteria.

C. WATSON/CRICK (1953-1962)

- DEVELOPED THE STRUCTURE OF DNA
- DID NONE OF THEIR OWN RESEARCH, JUST COLLECTED DATA FROM OTHER SCIENTISTS.
- DEVELOPED THE DOUBLE HELIX



1. OBTAINED INFORMATION FOR SEVERAL SOURCES

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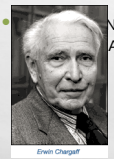


Erwin Chargaff

Rosalind Franklin, 1920–1958

Maurice Wilkins

A. CHARGAFF

- GAVE THEM COMPLEMENTARY BASE PAIR SEQUENCING.

B. PATTERNS OF BASE PAIRING

- 1. CHARGAFF'S RULE: CHARGAFF NOTICED IN HIS STUDIES OF DNA THAT THERE WERE PROPORTIONAL AMOUNTS OF ADENINE AND THYMINE AND GUANINE AND CYTOSINE.
- HE THEN DEDUCED THAT A BIND WITH T AND G BINDS WITH C.
- EVEN THOUGH THE QUANTITIES OF A AND T CAN BE TOTALLY DIFFERENT THAN G AND C

B. LINUS PAULING

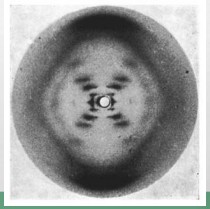
- DEVELOPED THE FIRST MODEL OF DNA , BUT HE MADE SEVERAL MISTAKES

C. FRANKLIN/WILKINS

- GAVE WATSON AND CRICK PICTURE OF DNA TAKEN BY X RAY DIFFRACTION.

1. X-RAY DIFFRACTION

- IN X RAY DIFFRACTION THE DNA IS CRYSTALLIZED AND THE PHOTOGRAPHED WITH X RAYS



D. RACE FOR THE DOUBLE HELIX

- THE RACE FOR THE DOUBLE HELIX IS NOT A REAL RACE, IT'S A COMPETITION FOR THE PRODUCTION OF THE FIRST DNA MODEL.

E. NOBEL PRIZE

- WATSON, CRICK AND WILKINS WERE AWARDED THE PRIZE FOR SUCCESSFULLY BUILDING THE FIRST MODEL OF DNA

II. DNA STRUCTURE

- **WHAT IS DNA MADE OF ?**

A. COMPONENTS

- 1. NUCLEOTIDE MACROMOLECULE
  - A.DEOXYRIBOSE SUGAR
  - B.PHOSPHATES
  - C.NUCLEOTIDE BASES

What is DNA?

Although the environment influences how an organism develops, the genetic information that is held in the molecules of DNA ultimately determines an organism's traits.

DNA achieves its control by determining the structure of proteins.

What is DNA?

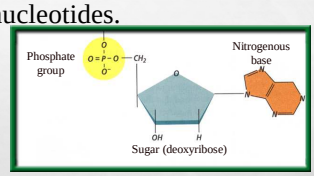
All actions, such as eating, running, and even thinking, depend on proteins called enzymes.

Enzymes are critical for an organism's function because they control the chemical reactions needed for life.

Within the structure of DNA is the information for life—the complete instructions for manufacturing all the proteins for an organism.

The structure of nucleotides

DNA is a polymer made of repeating subunits called nucleotides.



Nucleotides have three parts: a simple sugar, a phosphate group, and a nitrogenous base.

The structure of nucleotides

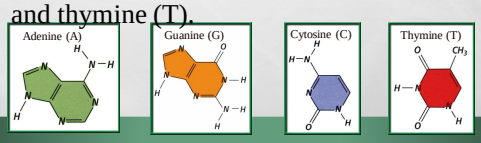
The simple sugar in DNA, called deoxyribose (dee ahk sih RI bos), gives DNA its name—deoxyribonucleic acid.

The phosphate group is composed of one atom of phosphorus surrounded by four oxygen atoms.

The structure of nucleotides

A nitrogenous base is a carbon ring structure that contains one or more atoms of nitrogen.

In DNA, there are four possible nitrogenous bases: adenine (A), guanine (G), cytosine (C), and thymine (T).



The structure of nucleotides

Thus, in DNA there are four possible nucleotides, each containing one of these four bases.

The structure of nucleotides

Nucleotides join together to form long chains, with the phosphate group of one nucleotide bonding to the deoxyribose sugar of an adjacent nucleotide.

The phosphate groups and deoxyribose molecules form the backbone of the chain, and the nitrogenous bases stick out like the teeth of a zipper.

The structure of nucleotides

In DNA, the amount of adenine is always equal to the amount of thymine, and the amount of guanine is always equal to the amount of cytosine.

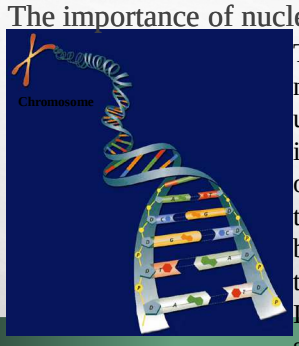
The structure of DNA

In 1953, Watson and Crick proposed that DNA is made of two chains of nucleotides held together by nitrogenous bases.

Watson and Crick also proposed that DNA is shaped like a long zipper that is twisted into a coil like a spring.

Because DNA is composed of two strands twisted together, its shape is called double helix.

The importance of nucleotide sequences



The sequence of nucleotides forms the unique genetic information of an organism. The closer the relationship is between two organisms, the more similar their DNA nucleotide sequences will be.

END OF SLIDE

The importance of nucleotide sequences

Scientists use nucleotide sequences to determine evolutionary relationships among organisms, to determine whether two people are related, and to identify bodies of crime victims.

III. DNA REPLICATION

- HOW DOES DNA MAKE MORE OF ITSELF?

A. DEFINITION

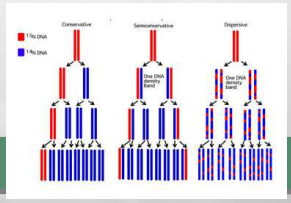
- DNA REPLICATION IS THE PROCESS IN WHICH DNA CODES FOR AND PRODUCES AN EXACT COPY OF ITSELF.

B. WATSON/CRICK MODEL

- THEIR MODEL PROVIDED A FRAMEWORK FORM WHICH TO WORK , BUT DID NOT DESCRIBE THE ACTUAL PROCESS.

C. MESLSON/STAHL (1958)

- IN 1958 THESE SCIENTISTS WERE THE FIRST TO DESCRIBE THE PROCESS OF REPLICATION, THEY DEDUCED THAT IT WAS SEMICONSERVATIVE.



1. SEMICONSERVATIVE REPLICATION

- IN SEMICONSERVATIVE REPLICATION AS A NEW DNA FRAGMENT IS BEING PRODUCED IT IS ATTACHED TO A PART OF THE OLD FRAGMENT.
- THEREFOR IN EACH NEW DNA MOLECULE PART OF THE OLD DNA MOLECULE IS RETAINED.

Mutations

Organisms have evolved many ways to protect their DNA from changes.

In spite of these mechanisms, however, changes in the DNA occasionally do occur.

Any change in DNA sequence is called a mutation.

Mutations can be caused by errors in replication, transcription, cell division, or by external agents.

Mutations in reproductive cells

Mutations can affect the reproductive cells of an organism by changing the sequence of nucleotides within a gene in a sperm or an egg cell.

If this cell takes part in fertilization, the altered gene would become part of the genetic makeup of the offspring.

Mutations in reproductive cells

The mutation may produce a new trait or it may result in a protein that does not work correctly.

Sometimes, the mutation results in a protein that is nonfunctional, and the embryo may not survive.

In some rare cases a gene mutation may have positive effects.

Mutations in body cells

What happens if powerful radiation, such as gamma radiation, hits the DNA of a nonreproductive cell, a cell of the body such as in skin, muscle, or bone?

If the cell's DNA is changed, this mutation would not be passed on to offspring.

However, the mutation may cause problems for the individual.

Mutations in body cells

Damage to a gene may impair the function of the cell.

When that cell divides, the new cells also will have the same mutation.

Some mutations of DNA in body cells affect genes that control cell division.

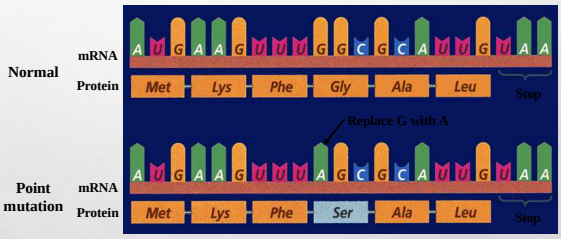
This can result in the cells growing and dividing rapidly, producing cancer.

The effects of point mutations

A point mutation is a change in a single base pair in DNA.

A change in a single nitrogenous base can change the entire structure of a protein because a change in a single amino acid can affect the shape of the protein.

The effects of point mutations



The Genetic Code

The Messenger RNA Genetic Code

First Letter	Second Letter U	Second Letter C	Second Letter A	Second Letter G	Third Letter
U	Phenylalanine (UUU)	Serine (UCU)	Tyrosine (UAU)	Cysteine (UGU)	U
	Phenylalanine (UUC)	Serine (UCC)	Tyrosine (UAC)	Cysteine (UGC)	C
	Leucine (UUA)	Serine (UCA)	Stop (UAA)	Stop (UGA)	A
	Leucine (UUG)	Serine (UCG)	Stop (UAG)	Tryptophan (UGG)	G
C	Leucine (CUU)	Proline (CCU)	Histadine (CAU)	Arginine (CGU)	U
	Leucine (CUC)	Proline (CCC)	Histadine (CAC)	Arginine (CGC)	C
	Leucine (CUA)	Proline (CCA)	Glutamine (CAA)	Arginine (CGA)	A
	Leucine (CUG)	Proline (CCG)	Glutamine (CAG)	Arginine (CGG)	G
A	Isoleucine (AUU)	Threonine (ACU)	Asparagine (AAU)	Serine (AGU)	U
	Isoleucine (AUC)	Threonine (ACC)	Asparagine (AAC)	Serine (AGC)	C
	Isoleucine (AUA)	Threonine (ACA)	Lysine (AAA)	Arginine (AGA)	A
	Methionine: Start (AUG)	Threonine (ACG)	Lysine (AAG)	Arginine (AGG)	G
G	Valine (GUU)	Alanine (GCU)	Aspartate (GAU)	Glycine (GGU)	U
	Valine (GUC)	Alanine (GCC)	Aspartate (GAC)	Glycine (GGC)	C
	Valine (GUA)	Alanine (GCA)	Glutamate (GAA)	Glycine (GGA)	A
	Valine (GUG)	Alanine (GCG)	Glutamate (GAG)	Glycine (GGG)	G

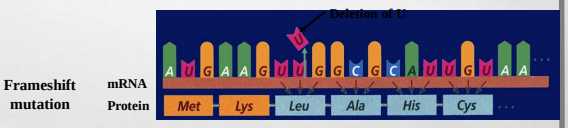
Frameshift mutations

What would happen if a single base were lost from a DNA strand?

This new sequence with the deleted base would be transcribed into mRNA. But then, the mRNA would be out of position by one base.

As a result, every codon after the deleted base would be different.

Frameshift mutations



Frameshift mutations

This mutation would cause nearly every amino acid in the protein after the deletion to be changed.

A mutation in which a single base is added or deleted from DNA is called a frameshift mutation because it shifts the reading of codons by one base.

Chromosomal Alterations

Changes may occur in chromosomes as well as in genes.

Alterations to chromosomes may occur in a variety of ways.

Structural changes in chromosomes are called chromosomal mutations.

Chromosomal Alterations

Chromosomal mutations occur in all living organisms, but they are especially common in plants.

Few chromosomal mutations are passed on to the next generation because the zygote usually dies.

Chromosomal Alterations

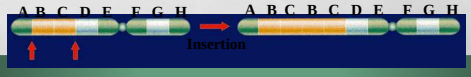
In cases where the zygote lives and develops, the mature organism is often sterile and thus incapable of producing offspring.

When a part of a chromosome is left out, a deletion occurs.

Chromosomal Alterations

When part of a chromatid breaks off and attaches to its sister chromatid, an insertion occurs.

The result is a duplication of genes on the same chromosome.

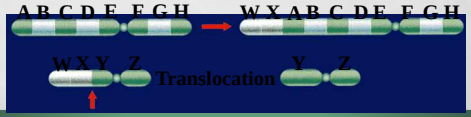


Chromosomal Alterations

When part of a chromosome breaks off and reattaches backwards, an inversion occurs.

Chromosomal Alterations

When part of one chromosome breaks off and is added to a different chromosome, a translocation occurs.



Causes of Mutations

Some mutations seem to just happen, perhaps as a mistake in base pairing during DNA replication.

These mutations are said to be spontaneous.

However, many mutations are caused by factors in the environment.

Causes of Mutations

Any agent that can cause a change in DNA is called a mutagen.

Mutagens include radiation, chemicals, and even high temperatures.

Forms of radiation, such as X rays, cosmic rays, ultraviolet light, and nuclear radiation, are dangerous mutagens because the energy they contain can damage or break apart DNA.

Causes of Mutations

The breaking and reforming of a double-stranded DNA molecule can result in deletions.

Chemical mutagens include dioxins, asbestos, benzene, and formaldehyde, substances that are commonly found in buildings and in the environment.

Chemical mutagens usually cause substitution mutations.

Repairing DNA

Repair mechanisms that fix mutations in cells have evolved.

Enzymes proofread the DNA and replace incorrect nucleotides with correct nucleotides.

These repair mechanisms work extremely well, but they are not perfect.

The greater the exposure to a mutagen such as UV light, the more likely is the chance that a mistake will not be corrected.