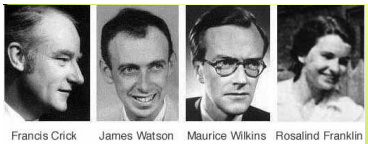
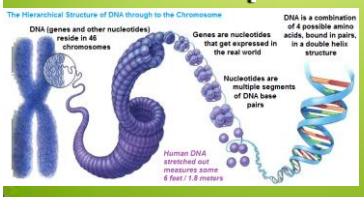
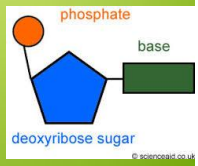

Francis Crick James Watson Maurice Wilkins Rosalind Franklin

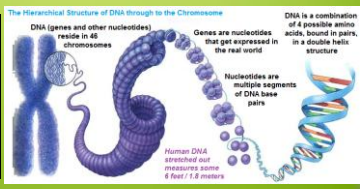
Molecular Biology
2.6- Structure of DNA and RNA





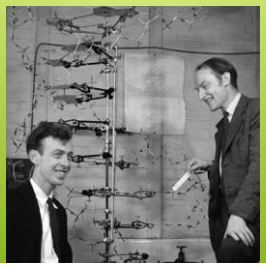
Essential idea:

- The structure of DNA allows efficient storage of genetic information.
  - 32 Billion base pairs, or sets of genetic "letters", make up the human genome.
  - Each uncoiled DNA strand is about 6 feet long
  - Do this for all your DNA, and the resulting strand would be 67 billion miles long—the same as about 150,000 round trips to the Moon.



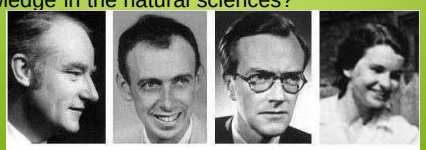
Nature of science:

- Using models as representation of the real world
  - Crick and Watson used model making to discover the structure of DNA. (1.10)



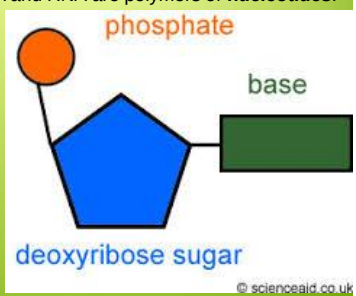
Theory of knowledge:

- The story of the elucidation of the structure of DNA illustrates that cooperation and collaboration among scientists exists alongside competition between research groups.
- To what extent is research in secret 'anti-scientific'?
- What is the relationship between shared and personal knowledge in the natural sciences?


Francis Crick James Watson Maurice Wilkins Rosalind Franklin

Nucleic Acids

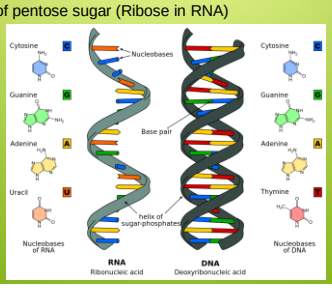
- The nucleic acids DNA and RNA are polymers of **nucleotides**.
  - Nitrogenous base
  - Pentose sugar
  - Phosphate group



Use circles, pentagons and rectangles to represent phosphates, pentoses and bases

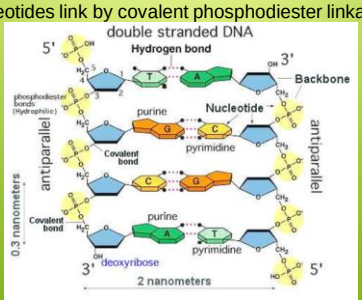
Nucleic Acids

- DNA differs from RNA
  - in the number of strands present (1 strand in RNA)
  - the nitrogen base composition (Uracil not Thymine in RNA)
  - the type of pentose sugar (Ribose in RNA)



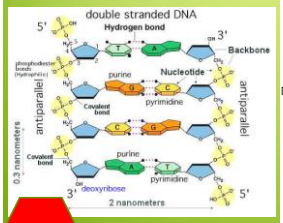
Nucleic Acids

- DNA antiparallel strands are linked by hydrogen bonding between complementary nitrogen base pairs.
- Nucleotides link by covalent phosphodiester linkages

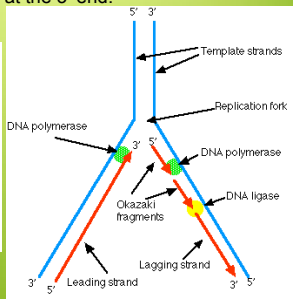


Nucleic Acid Directionality

- Nucleic acids have ends, defined by the 3' and 5' carbons of the sugar in the nucleotide
- Can only add nucleotides at the 3' end.
- Build from 5' to 3'.

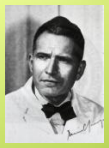


End



Historical Experiments on DNA

- Frederick Griffith
- Avery-MacLeod-McCarty
- Erwin Chargaff
- Hershey-Chase
- Franklin-Wilkins-Watson-Crick



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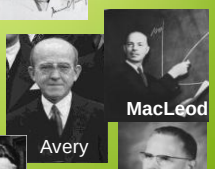
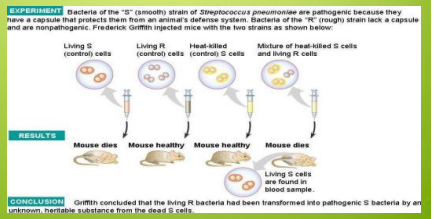


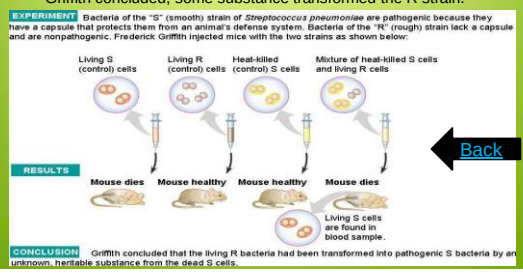
Frederick Griffith (1928)

- Something Can Transform Bacteria
- Conducted experiments with ***Streptococcus pneumoniae***
  - Injected mice with two strains: (S) strain and a (R) strain.
  - The S strain is virulent (mice died); it has a mucous capsule
  - The R strain is not virulent (mice lived); it has no capsule.



Frederick Griffith (1928)

- He injected mice with heat-killed S strain bacteria; the mice lived.
- He injected mice with a mixture of heat-killed S strain and live R strain bacteria; the mice died and living S strain pneumococcus were recovered from their bodies.
- Griffith concluded, some substance transformed the R strain.



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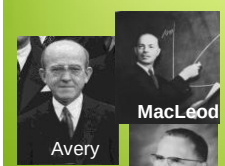
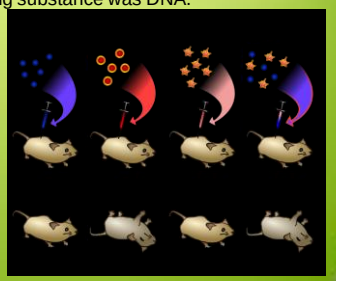
Oswald Avery, Colin MacLeod, Maclyn McCarty (1944)

- Used deoxyribonucleodepolymerase to make the Griffith extract non transformable
- Shows the transforming substance was DNA.





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Erwin Chargaff (1947)

- Performed detailed analysis of base content of DNA.
- Purine bases
  - double-ring structure
  - adenine (A) and guanine (G).
- Pyrimidine bases
  - single-ring structure
  - Thymine (T) and cytosine (C)
- **Chargaff's Rules**:
  - The amount of A, T, G, and C in DNA varies from species to species.
  - In each species, the amount of A=T and G=C.

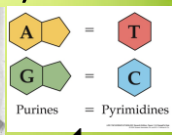

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Table 11-1. Molar Properties of Bases* in DNAs from Various Sources

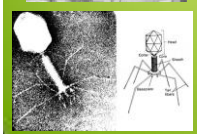
Organism	Tissue	Adenine	Thymine	Guanine	Cytosine
Escherichia coli (K12)	—	26.0	23.9	24.9	25.2
Diplococcus pneumoniae	—	29.8	31.6	20.5	18.0
Mycobacterium tuberculosis	—	15.1	14.6	34.9	35.4
Yeast	—	31.3	32.9	18.7	17.1
Paracentrotus lividus (sea urchin)	Sperm	32.8	32.1	17.7	18.4
Herring	Sperm	27.8	27.5	22.2	22.6
Rat	Bone marrow	28.6	28.4	21.4	21.5
Human	Thymus	30.9	29.4	19.9	19.8
Human	Liver	30.3	30.3	19.5	19.9
Human	Sperm	30.7	31.2	19.3	18.8

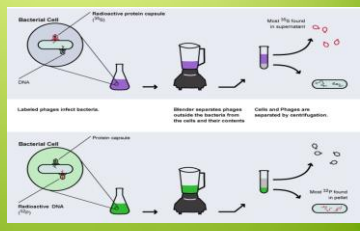
* Defined as moles of nitrogenous constituents per 100 g atoms phosphate in hydrolysate.

Source: E. Chargaff and J. Davidson, eds., *The Nucleic Acid*. Academic Press, 1955.

Alfred Hershey and Martha Chase(1952)

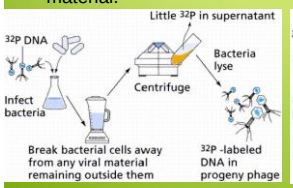
- Used bacteriophage T2 in their experiments.
- See if protein coat or DNA directed reproduction of virus.
- In two separate experiments, they labeled the protein coat with radioactive ^{35}S and the DNA with radioactive ^{32}P.

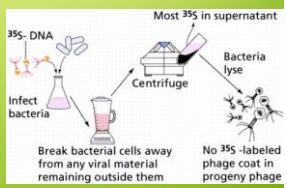




Alfred Hershey and Martha Chase(1952)

- Viral coats are sheared away from bacterial cells and are separated by centrifugation.
- Results: radioactive ^{32}P alone is taken up by bacterial host and incorporated in virus reproduction.
- Their results reinforced the notion that DNA is the genetic material.





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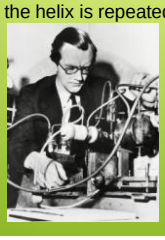
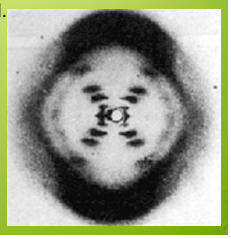
Rosalind Franklin and Maurice Wilkins (1953)

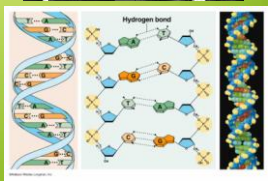
- Franklin produced X-ray diffraction photograph of DNA.
- Wilkins gave Watson/Crick photo without Franklin's knowledge.
- Photo provided evidence that DNA had the following features:
  - DNA is a helix.
  - One part of the helix is repeated.





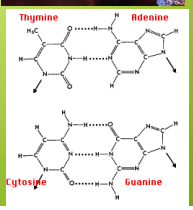
James Watson and Francis Crick(1953)

- Used information generated by Franklin
- Built a model of DNA as double helix
- Sugar-phosphate molecules on outside
- Paired bases on inside.
- Sugar-phosphate backbones are antiparallel.



James Watson and Francis Crick(1953)

- Using information generated by Chargaff.
  - Width is 2 nm.
  - Width of DNA due to purines paired to pyrimidines.
  - Chargaff's rules are consistent
    - A hydrogen-bonded to T
    - G hydrogen-bonded to C.
- Watson, Crick and Wilkins received the Nobel Prize in 1954 for their model of DNA.



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