DNA Structure and Function

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1 What Do Genes Do, and What Are They Made of?

- By the 1920s it was clear that the genetic material resided on chromosomes
- Within the next decade, the location of some genes on fruit fly chromosomes had been determined
  - Chromosomes contain both DNA and protein
  - Which component was the genetic material was not initially apparent
- The function of genes was determined in the late 1930s and early 1940s
  - Genes bring about the production of proteins
  - Griffith's work
- In the mid 1940s and early 1950s it was clearly determined that DNA was the genetic material
  - Genes are composed of DNA

- By the early 1950s, investigations focused on how DNA carried out its genetic function
  - Determining of the structure became critically important
  - The determination of the structure of DNA was a watershed event in biology
    - Understanding the function of genetics at its most fundamental level became possible
      - "Molecular biology"

2 Watson and Crick: The Double Helix

- In 1953, James Watson and Francis Crick presented the three-dimensional structure of DNA to the world
  - Watson was a 23 year-old American
  - Crick was a 35 year-old Englishman
  - Working together at Cambridge University in England

- DNA was too small to see through the most powerful microscopes of the time
  - Direct viewing of DNA was not possible
  - DNA must be viewed indirectly
    - Looking at the moon as it's entering an eclipse
    - Identifying finer features of something from its shadow

- Portions of DNA's structure could be inferred through a technique called X-ray diffraction
  - Purified DNA was bombarded with X rays
  - The way these rays scatter upon impact provides information about its structure

- **Rosalind Franklin** was one of a very small number of experts on X-ray diffraction
  - Also trying to determine the structure of DNA
  - Worked at King's College in London, England
  - Working with **Maurice Wilkins**

- Franklin's x-ray diffraction data was made available to Watson and Crick
  - Critically important in allowing Watson and Crick to determine DNA's structure

- Watson, Crick, and Wilkins were awarded the 1963 Nobel Prize in Medicine or Physiology
  - Rosalind Franklin did not share in this Nobel Prize
    - She died of cancer in 1958 at the age of 37
    - Nobel prizes are not awarded posthumously

3 The Components of DNA and Their Arrangement

- DNA consists of two intertwined polymers of subunits called nucleotides
  - "DNA double helix"
  - Each nucleotide consists of
    - The sugar "deoxyribose"
    - A phosphate group – covalently bonded to the sugar
    - A nitrogen-containing base – covalently bonded to the sugar
      - Four types: A, T, G, and C

- A DNA double helix looks like a spiral staircase
  - The "handrails" consist of long chains of alternating phosphates and sugars
    - P-S-P-S-P-S-P-S-P-S-P-S-P-S (covalent bonds phosphates-to-sugars)
  - The "steps" lying between the handrails consist of DNA's bases
    - Each "step" consists of two bases – the bases are hydrogen-bonded to each other

- Bases on opposing strands are connected by hydrogen bonds
  - "A" is always connected to "T"
  - "G" is always connected to "C"
  - "Base pairs"

    - Opposing bases are “complementary”

- The order of bases on one strand of DNA dictates the order of bases on the complementary strand
  - The second strand is repetitious and redundant
  - Why is the second strand even there?

- DNA’s structure suggested to Watson and Crick the method by which DNA is copied
  - “DNA replication”

- The two strands of a DNA double helix separate
- Each strand serves as a “template” for the production of its complementary strand
  - “A” on the old strand specifies “T” on the new strand
  - “G” on the old strand specifies “C” on the new strand, etc.

3 The Components of DNA and Their Arrangement

- Replication produces two double helices from one original double-helix DNA molecule
  - Semi-conservative replication
  - Each resulting double helix consists of
    - One strand from the original DNA molecule (“semi-conserving” half of the original DNA)
    - One newly existing strand
- These two double helices resulting from DNA replication form sister chromatids
  - Separate during cell division