DNA Structure and Function

Cardboard Atoms and Bent-Wire Bonds

A. In 1868, Miescher first isolated deoxyribonucleic acid, or DNA, from cell nuclei.

B. In 1951, Linus Pauling deduced the structure of proteins, which were complicated enough, so some people thought, to code hereditary instructions.

C. In 1953, Watson and Crick put together a model of DNA, which turned out to be the *real* stuff of heredity.

I. Discovery of DNA Function

A. Early and Puzzling Clues

1. In 1928, Fred Griffith was working with S (virulent) and R (nonvirulent) strains of a pneumonia-causing bacterium. His experiments are summarized here:

a. Inject mice with R cells; mice lived.

b. Inject mice with S cells; mice died; blood samples contained many S cells.

c. S cells were killed, then injected into mice; mice lived.

d. Live R cells plus heat-killed S cells were injected into mice; mice died; live S cells were found in the blood.

e. Some substance from the S cells had transformed the harmless R cells into cells capable of causing death.

2. Oswald Avery showed (in 1944) that the "Griffith substance" was nucleic acid, not protein as some people had proposed.

B. Confirmation of DNA Function

1. Viruses called bacteriophages use bacterial cells for reproduction.

2. Because they consist of only a protein coat and a nucleic acid core, these viruses were used in experiments by Hershey and Chase to prove which of

these (DNA) was the heredity material.

II. DNA Structure

A. What Are the Components of DNA?

1. DNA is composed of four kinds of nucleotides, each of which consists of:

a. a five-carbon sugar (deoxyribose),

b. a phosphate group, and

c. one of four bases–adenine (A), guanine (G), thymine (T), cytosine (C).

2. The nucleotides are similar, but T and C are single-ring pyrimidines; A and G are double-ring purines.

3. Edwin Chargaff in 1949 showed that the amount of A = T and G = C.

4. Rosalind Franklin used X-ray diffraction techniques to produce images of DNA molecules.

a. DNA exists as a long, thin molecule of uniform diameter.

b. Nucleotides are joined along the molecule's length; sugar-phosphate linkages form a sort of "backbone."

B. Patterns of Base Pairing

1. DNA consists of *two* strands of nucleotides twisted into a *double* helix.

2. Base pairs are formed by the hydrogen bonding of A with T, and G with C; this is *constant* for all species.

3. The sequence of bases in a nucleotide strand is *different* from species to species.

III. *Focus on Bioethics:* Rosalind's Story

IV. DNA Replication and Repair

A. How Is a DNA Molecule Duplicated?

1. First, the two strands of DNA unwind and expose their bases.

2. Then unattached nucleotides pair with exposed bases.

3. Thus, replication results in DNA molecules that consist of one "old" strand and one "new" strand (semiconservative).

a. Unwinding requires many kinds of enzymes.

b. DNA polymerases assemble the nucleotides into nucleic acids.

B. Monitoring and Fixing the DNA

1. DNA polymerases, DNA ligases, and other enzymes engage in DNA repair when they "read" the complementary sequence on the other strand and restore it.

2. These same enzymes are responsible for the breaking and reattaching of DNA strands that occurs in crossing over.

V. *Focus on Science:* Dolly, Daises, and DNA

X. *Focus on Bioethics:* Prospects in Human Genetics