Heredity, DNA, & Mutations

Thursday, October 14

Planetarium Show & Star Party

Planetarium Show: Tonight, at 7:30 pm (telescope viewing after, if clear).
Star Party: Friday night, 7:30 – 10:30 pm
Smith Lab, fifth floor (north end of building)

Heredity
Key Concepts

1) DNA stores and transmits the instructions for synthesis of proteins and other molecules.

2) RNA plays a key role in protein synthesis.

3) Mutations (changes in the DNA's structure) are the molecular basis of evolution.
Nucleic acids store and transmit hereditary information in all cells on Earth.

DNA: The Double Helix
Two helical sugar-phosphate backbones, connected by four “DNA bases” that come in pairs.

The “message” of DNA is written in the sequence of base pairs that runs along the helix.

- Adenine pairs with Thymine.
- Thymine pairs with Adenine.
- Guanine pairs with Cytosine.
- Cytosine pairs with Guanine.
Are you a man, or are you a mouse?

(short sequences of human and mouse DNA)

Human DNA contains nearly 3 billion base pairs.

Sequences of base pairs give instructions for various cell functions:
- protein synthesis
- RNA synthesis
- regulation of synthesis

Each sequence is a gene, coding for a single function.

DNA provides the "instruction manual" for building proteins out of amino acids.

"Words" can be built out of the four different bases.

There are 4 different one-letter words: A, C, T, G.

There are $4 \times 4 = 16$ different two-letter words:
- AA, AC, AT, AG, CA, CC, CT, CG, TA, TC, TG, GA, GC, GT, GG.

There are $4 \times 4 \times 4 = 64$ different three-letter words.

There are 22 different amino acids used by life.
Each 3-base “word” codes for a different amino acid.

The double helix structure allows for simple replication of DNA.

The helix “unzips”, splitting the base pairs.

Each single strand’s matching bases are added by an enzyme.

The result is a (usually) perfect copy of the DNA.

The replication of DNA inside a cell is the first step of cell division.

Each “daughter” cell inherits a copy of the DNA instruction manual.
RNA is a single-stranded helix with a different backbone than DNA, and with Uracil instead of Thymine.

RNA plays three roles:
It copies instructions for protein synthesis from DNA.
It transports amino acids to the synthesis site.
It catalyzes protein synthesis.

Copying errors during DNA replication permanently change base sequences.

<table>
<thead>
<tr>
<th>Original</th>
<th>The big dog bit the red fox</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Replacement</td>
<td>The big dog qit the red fox</td>
</tr>
<tr>
<td>Base Insertion</td>
<td>The big dfo gbi th ere dfo x</td>
</tr>
<tr>
<td>Base Deletion</td>
<td>The big dgb it her edf ox</td>
</tr>
<tr>
<td>Word Insertion</td>
<td>The big dog bit xyz the red fox</td>
</tr>
<tr>
<td></td>
<td>The big dog bxy zit the red fox</td>
</tr>
</tbody>
</table>

A change in the base sequences is called a mutation.

Some mutations have no effect.

Some make subtle changes in the organism (such as eye or hair color).

Some can make bigger changes, most of which are harmful.
Mutations are the source of the genetic variations that are crucial for evolution by natural selection.

Occasionally, a mutation confers an adaptive advantage.

These advantageous mutations tend to spread throughout the species in later generations.

Mutation is the molecular basis of evolution.

Tomorrow’s Lecture:

Extreme Life

This Week’s Reading:

Chapter 5