DNA, RNA, TRANSCRIPTION, TRANSLATION AND DNA REPLICATION

DNA is a polymer of nucleotides.
Each nucleotide is formed of 1. Deoxyribose sugar 2. Phosphate 3. One of any 4 N-bases
a) adenine b) guanine c) cytosine d) thymine
DNA molecule has:
  a) The sides of the ladder are formed of sugar and phosphate molecules forming 2 anti-parallel chains 5→3
     3←5 Rungs are formed of N-bases held together by H-bonds.
     Adenine and thymine form 2 H-bonds. Cytosine and guanine form 3 H-bonds
  b) The 2 chains are twisted around each other, resulting into
c) A double-helix

RNA is a single chain molecule. RNA is a polymer of nucleotides. Main chain is formed of
Ribose sugar and phosphates. Side-chains are formed of N-bases.
RNA has Uracil instead of Thymine. The other 3 N-bases, Adenine, Guanine and Cytosine are
same.

3-kinds of RNA: 1 messenger RNA or m-RNA 2 ribosomal RNA or r-RNA 3 transfer RNA or t-RNA

m-RNA carries information from DNA (Gene) to ribosomes about the arrangement of amino-
acids in protein. A triplet of N-bases is called CODON.

r-RNA is formed inside nucleolus and combines with ribosomal proteins to form 2 halves of
Ribosomes called larger and smaller subunits.

t-RNA picks up specific amino-acid from cytoplasm and carries it to ribosomal—m-RNA
complex. A triplet of N-bases is called ANTI-CODON.

<table>
<thead>
<tr>
<th>Transcription</th>
<th>Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNA ---------- → m-RNA ----------------→ polypeptide (protein)</td>
<td></td>
</tr>
</tbody>
</table>

Transcription: Only one chain of DNA acts as template. It is called Sense Strand of DNA.
AAT CGA CCC AAA TCT ------- DNA
UUA GCU GGG UUU AGA ------- m-RNA
Translation: consists of 3 steps. 1 Initiation, 2 Elongation, 3 Termination.

Initiation takes place when m-RNA, smaller subunit of ribosome and t-RNA with 1st amino-acid,
combine with one another. Then larger subunit also combines to complete the complex. The
chain initiator codon is AUG and 1st t-RNA carries amino-acid Methionine and has the anti-
codon UAC.

Elongation consists of adding amino-acids to polypeptide chain. 2 t-RNA’s are attached to larger
subunit. The first t-RNA carries the chain already synthesized. 2nd t-RNA, with
complementary anti-codon to the next codon, carries the amino-acid to be added to the chain.
A peptide bond is formed between last amino-acid, at the base of chain already formed, and
the new amino-acid. The chain is shifted to new t-RNA and Ribosome now moves one codon
forward. These steps are repeated till the complete chain is synthesized.
Termination is achieved by a releasing factor. It occupies the last codon, called terminator codon (UGA, or UAA or UAG). It causes the separation of 2 ribosomal subunits, m-RNA, releasing factor and polypeptide chain.

The polypeptide chain usually forms an alpha-helix and gets folded in a unique way to form 3 dimensional molecule called protein.

DNA- replication: Both chains separate from each other (Helicase enzyme) and act as template. 2 new chains are synthesized. Each daughter DNA molecule has one new and one old chain. This is called semi-conservative replication. DNA-polymerase is used to synthesize fragments of DNA from nucleotides. DNA-ligase seals the fragments together.

Genetic Engineering: We can manipulate genes of organisms. We can produce identical copies of genes and place them inside bacteria or viruses or some eukaryotes (yeast, peanut and cows etc). These organisms called Transgenic Organisms, in turn produce hormones, vitamins, vaccines and many other natural chemicals. This modified DNA is called Recombinant DNA. It consists of a Vector DNA (like a Plamid of bacteria) and foreign DNA (like insulin gene). Recombinant DNA is placed inside bacteria. Within hours thousands of copies of insulin, foreign DNA, are produced by binary fission of bacteria. We can extract the chemical from medium. We use Restriction Enzymes as genetic scissors to cut DNA. It is called Splicing. We use DNA Ligase enzyme to seal strands of DNA. It is called Ligation.

The production of many identical copies by asexual reproduction is called CLONING. It can be cloning of a gene or an organism (Dolly sheep was the first mammal produced by cloning). Recombinant-DNA and Polymerase Chain Reaction are 2 methods of DNA Cloning.

Polymerase Chain Reaction: PCR is utilized to increase the small quantity of DNA available, like at a crime scene, thousands or million times. It requires DNA polymerase, a set of primers and a supply of DNA nucleotides. It consists of 3 steps repeated time and again.

1 Denaturation of DNA is done by heating it at 94C for 5 minutes. It separates the 2 chains.
2 Cooling at 50C—60C for 2 minutes allows the attachment of primers to base pair with target DNA.
3 Moderate heating at 72C for 2—5 minutes stimulates the synthesis of DNA between primers. This cycle of 3 steps is repeated thousands times to produce large amount of target DNA. It can be used for identification of criminal.

DNA Fingerprinting: Each individual has small sequences (2-5 bases) of DNA repeated a unique number of times. It can be isolated and cut into segments by Restriction enzymes. The segments are separated by Gel Electrophoresis. The DNA from crime scene and DNA of suspects or DNA of child and DNA of possible parents can be run simultaneously and easily compared and identified. Like fingerprints, this technique helps in identification of individuals. Hence, it is called DNA fingerprinting.