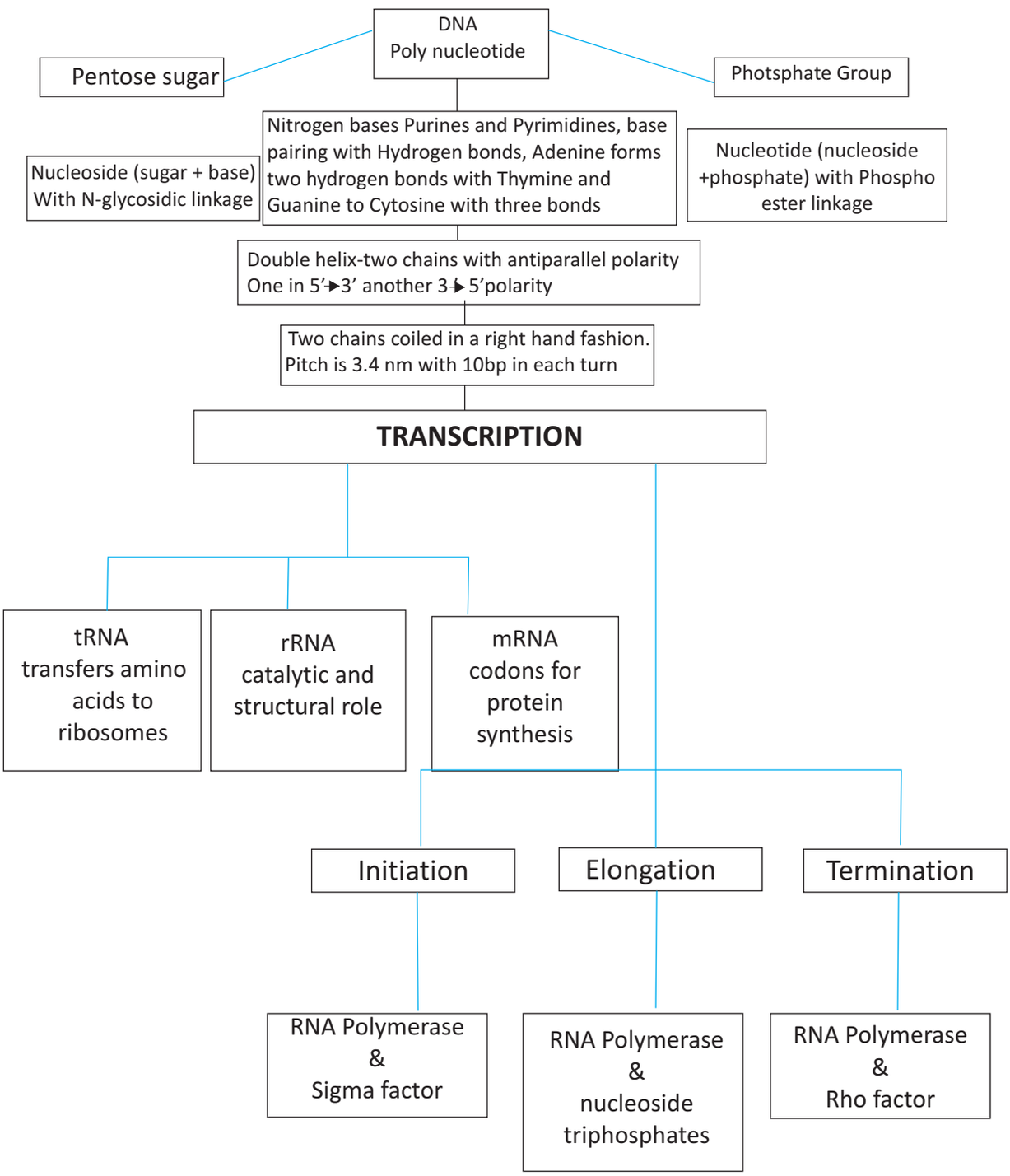
CHAPTER : 6 MOLECULAR BASIS OF INHERITANCE (FLOW CHART)

1 - STRUCTURE OF DNA



2 - SEARCH FOR GENETIC MATERAL

Search for Genetic Material
Experiments

Transformation experiment by Frederick Griffith

DNA is the Genetic material Proof by Alfred Hershey and Martha Chase (1952)

Transformation – Griffith's experiment
Frederick Griffith - 1928
Streptococcus pneumonia (bacteria)
Smooth shiny colonies Rough colonies
Virulent non-virulent
Pathogenic non-pathogenic

S strain injected into mice Mice died	R strain injected into mice Mice live

S strain (heat killed) injected into mice -----Mice live

S strain (heat killed)+ R strain(live) injected into mice -----Mice die

Conclusion

Transforming principle is transferred from the heat-killed S Strain had enabled the R strain to synthesise a smooth polysaccharide coat and become virulent

Bio chemical nature of transforming principle was proved to be DNA by Owald Avery, Colin Mecleod and Myclyn McCarty

Bacteriophages (viruses that infect

Radioactive phages were allowed to attach to E.

As the infection proceeded, the viral coats were removed from the bacteria by agitating them in a blender

The virus particles were separated from the bacteria by spinning them in a rifuge.

Bacteria which was infected with viruses that had radioactive DNA were radioactive, indicating that DNA was the material that passed from the virus to the bacteria.

Bacteria that were infected with viruses that had radioactive proteins were not radioactive proving that not the protein, DNA is a genetic material.

3 SALIENT FEATURES OF GENETIC CODE

- Triplet
- Unambiguous and specific
- Code is degenerate
- contiguous No. punctuations
- Universal
- AUG Daul functions

4 - DNA Replication

METHODS

- Semi Conservative
  - One stand parental (Conserved)
  - The other satand is newly synthesized

PROOF

- E coil was grown in a medium containing $^{15}NH_4Cl$ for several generations.
- As a result ^{15}N got incorporated into the newly synthesized
- These cells were then transferred to normal $^{14}NH_4Cl$ containing medium
- First generation collected after 20mins /had hybrid DNA (1 heavy & 1 normal stand)
- Second generation collected after 40mins /had equal amounts of hybrid DNA and light DNA
- Proving that DNA replication is semi conservative

5 **Goals of HGP**

- **Identify** genes in human DNA
- **Determine** the sequences of the 3 billion chemical base pairs
- **Store** the information in databases
- **Improve tools** for data analysis
- **Transfer related technologies** to other sectors, such as industries
- **Address**

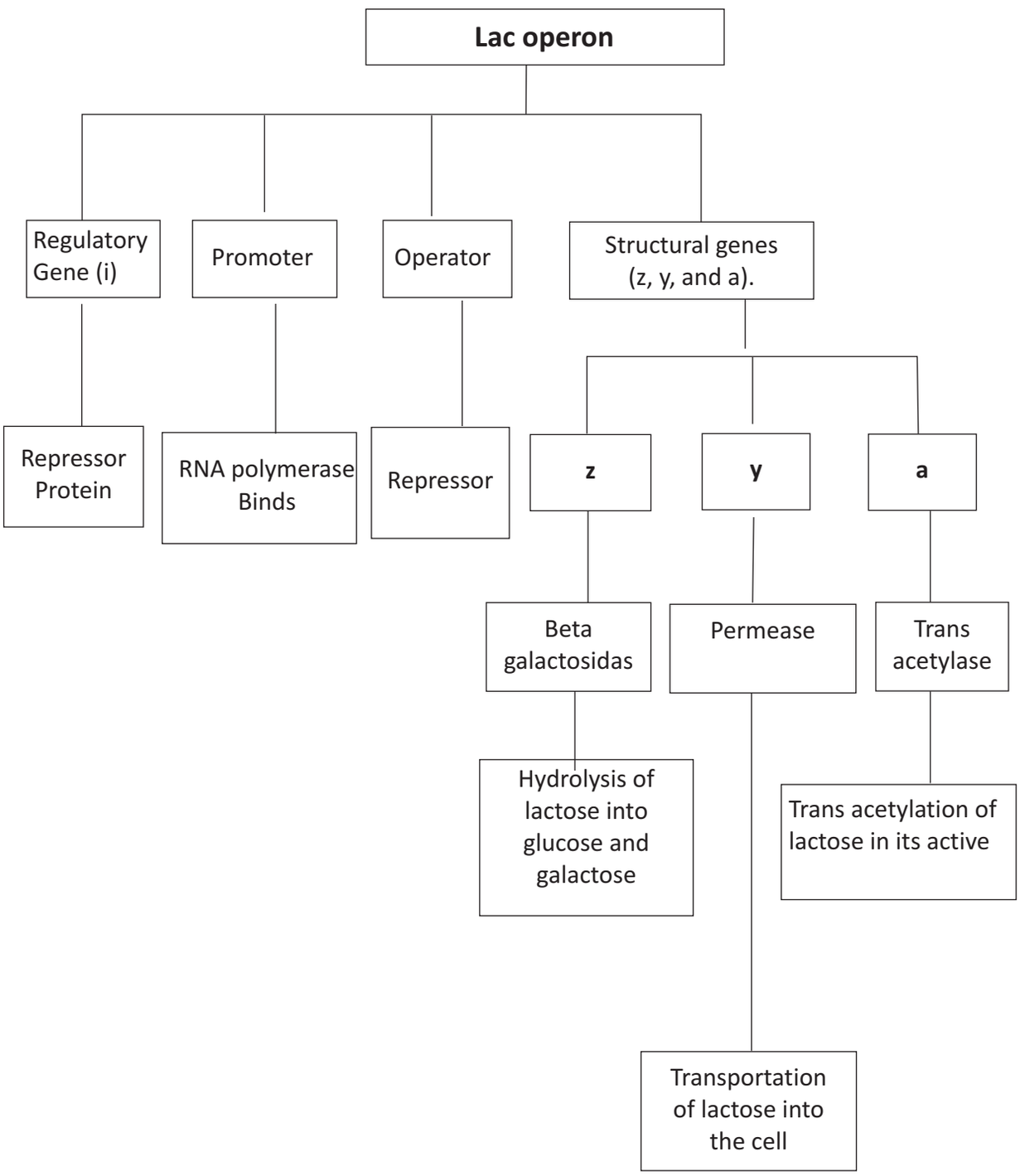
  Address the ethical, legal, and social issues (ELSI)

6 **DNA Fingerprinting** developed by **Alec Jeffreys**

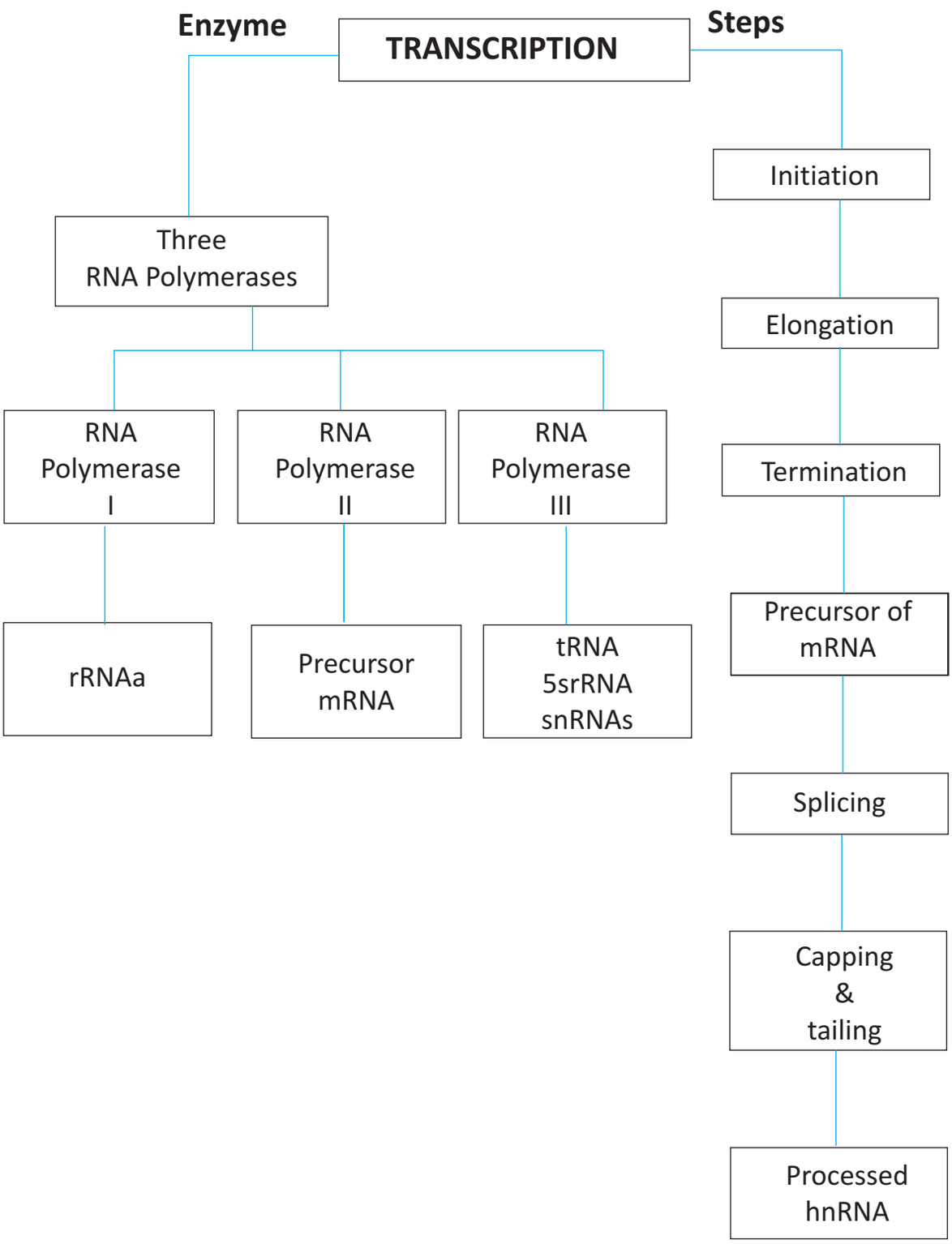
Steps

- I — **Isolation** of DNA
- D — **Digestion** of DNA
- E — Separation of DNA by **Electrophoresis**
- T — Transferring separated DNA fragments to synthetic membranes,
- H — Hybridisation using labeled VNTR probes
- A — **Detection of hybridized DNA fragments by Autoradiography**

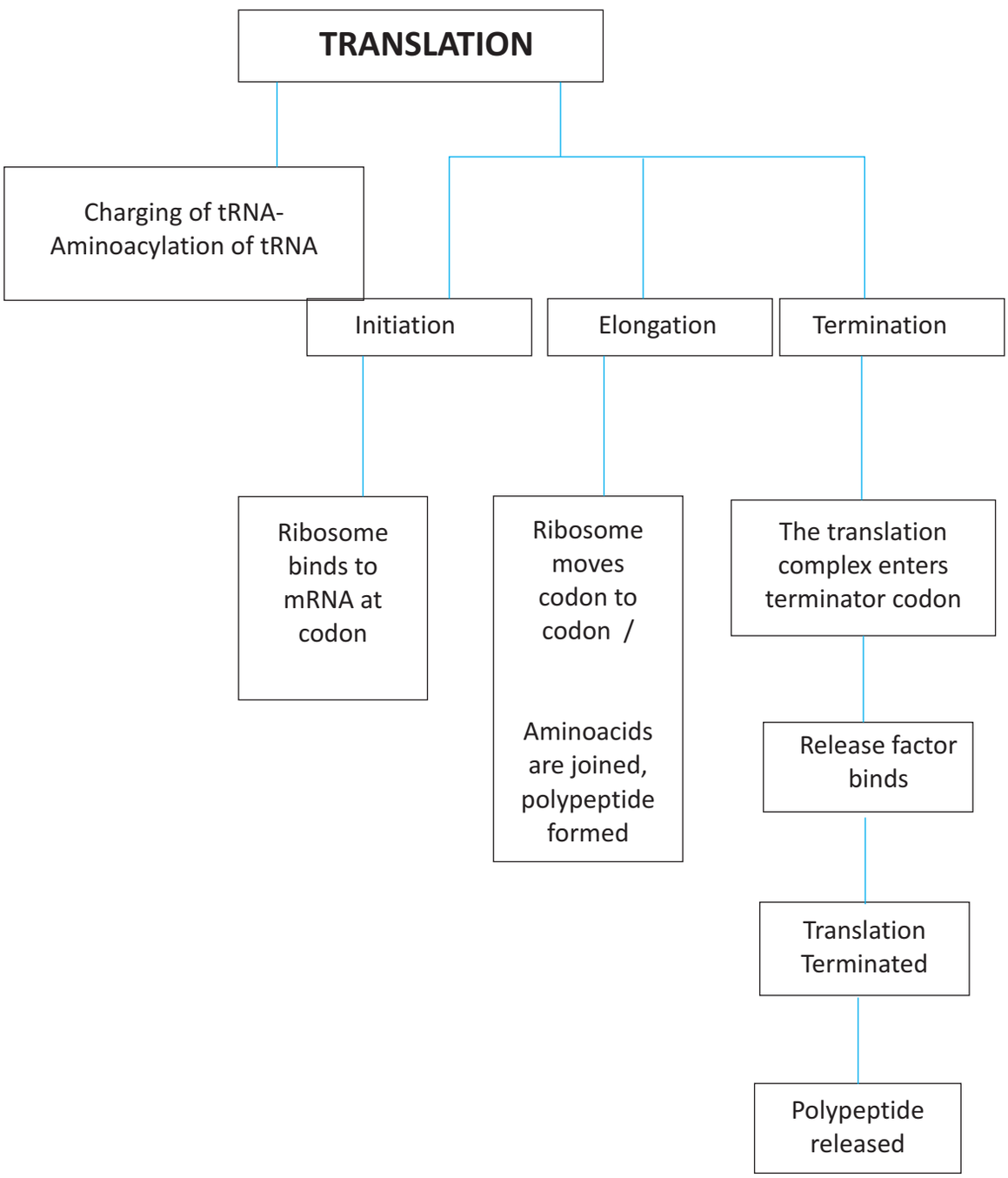
7 GENE REGULATION



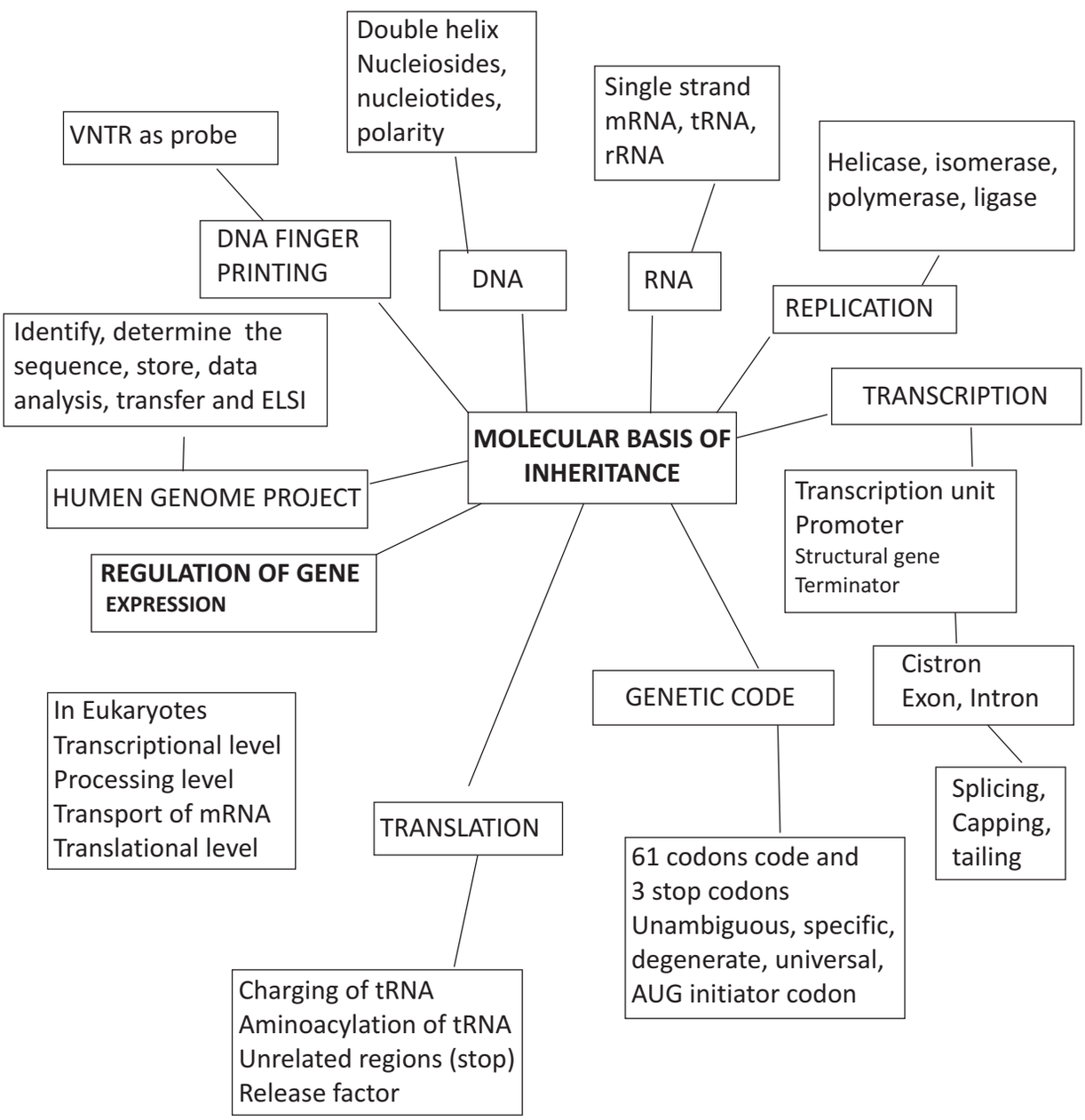
8 TRANSCRIPTION IN EUKARYOTES



9 PROTEIN SYNTHESIS



CHAPTER : 6 MOLECULAR BASIS OF INHERITANCE
(CONCEPT MAP)



CHAPTER: 6 MOLECULAR BASIS OF INHERITANCE

(QUESTION BANK)

1. If adenine constitutes 30% of an isolated DNA fragment, then what is the expected % of the base cytosine in it?
2. How does the flow of genetic information in HIV deviate from the central dogma proposed by Francis Crick?
3. How does HIV differ from a bacteriophage?
4. What is a nucleoid?
5. Name two amino acids that provide **+ve** charge to histone proteins.
6. Why do RNA viruses undergo mutation and evolution faster than most of the other viruses?
7. Name the enzyme involved in the continuous replication of DNA strand. Mention the polarity of the template strand.
8. What is a cistron?
9. Which one out of Rho factor and sigma factor, acts as initiation factor during transcription in prokaryote?
10. Write the function of RNA polymerase II.
11. What is meant by hnRNA?
12. (a) .Differentiate between euchromatin and heterochromatin.
    (b) What is the function of non-histone chromosomal proteins?
13. Why is DNA a better genetic material when compared to RNA?
14. Answer the following questions based on Meselson and Stahl's experiment:
    a) Write the name of the chemical substance used as a source of nitrogen in the experiment by them.
    b) Why did the scientists synthesize the light and the heavy DNA molecules in the organism in the experiment?
    c) How did the scientists synthesize make it possible to distinguish the heavy DNA molecule from the light DNA molecule? Explain.
    d) Write the conclusion the scientists arrived at, after completing the experiment.
15. Monocistronic structural genes in eukaryotes have interrupted coding sequences, Explain. How are they different in prokaryotes?
16 Describe the initiation process of transcription in bacteria?
17 Explain the elongation process of transcription in bacteria?
18 Describe the termination process of transcription in bacterium?
19 Explain the role of ^{35}S and ^{32}P in the experiments conducted by Hershey and chase?
20 It is established that RNA is the first genetic material. Explain giving three reasons?
21 (a) What are the transcriptional products of RNA polymerase III?
    (b) Differentiate between 'capping' and 'tailing'?
    (a) Expand hnRNA.
22. DNA is the genetic material in most of the organisms, while RNA is the genetic material in a few viruses/ What are the four general/common functions performed by RNA in other organisms?
23 Write short notes on RNA polymerases of eukaryotic cells?
24 How do histones acquire positive charge?
25 Explain the role of RNA polymerase in transcription in bacteria.
26. Identify giving reasons, the salient features of genetic code by studying the following nucleotide sequences of mRNA strand and the polypeptide translated from it?
27. Ratan was a known sportsman in his school. While returning home he found some unknown miscreants beating a young fellow. He tried to drive them off but by that time the fellow died of injury. The police arrested Ratan and he was put on trial. The judge being convinced by Ratan's plea, ordered for DNA finger printing reports.
    a) Ratan's fingerprints on the dead body were sufficient to convict him but the judge asked for authentic proof? What values can be observed?
    b) What is the basis of DNA finger printing?
    c) Explain the steps in DNA finger printing.

CHAPTER : 6 MOLECULAR BASIS OF INHERITANCES

(MARKING SCHEME)

<table>
<tr><th>Q.NO.</th><th>Value points</th><th>Marks</th></tr>
<tr><td>1</td><td>20%</td><td>1</td></tr>
<tr><td>2</td><td>HIV shows reverse transcription, i.e., formation of DNA on RNA template.</td><td>1</td></tr>
<tr><td>3</td><td>HIV has RNA as its genome, while bacteriophage has double-stranded DNA as its genome.</td><td>1</td></tr>
<tr><td>4</td><td>Nucleoid is the region in prokaryotic cells where DNA is held with prositively-charged proteins</td><td></td></tr>
<tr><td>5</td><td>Lysine and Arginine</td><td>1</td></tr>
<tr><td>6</td><td>The 2' OH-group in the nucleotides of RNA is a reactive group,that makes RNA labile and easily degradable</td><td>1</td></tr>
<tr><td>7</td><td>DNA polymerase.
Template strand has 3'→5' polarity.</td><td>1</td></tr>
<tr><td>8</td><td>A ciston is a segment of DNA, coding for a polypeptide.</td><td>1</td></tr>
<tr><td>9</td><td>Sigma factor.</td><td>1</td></tr>
<tr><td>10</td><td>It transcribes hnRNA, the precursor of mRNA, in eukaryotes.</td><td>1</td></tr>
<tr><td>11</td><td>The precursor of mRNA or the primary transcript transcribed by RNA polymerase II is called Heterogenous nuclear RNA.</td><td>1</td></tr>
<tr><td>12a</td><td>
<table>
<tr><th>Euchromation</th><th>Heterochroma</th></tr>
<tr><td>- These are the regions where chromatin is loosely packed.
- It stains lighter.
This is transcriptionally more active.</td><td>- These are the regions where chromatin is highly packed.
- It stains darker. It is transcriptionally less active or inert.</td></tr>
<tr><td colspan="2">(b). non-histone chromosomal proteins are involved in the packaging of chromatin fibers at the higher levels.</td></tr>
</table>
</td><td>2</td></tr>
<tr><td>13</td><td>DNA is a better genetic material for the following reasons:
(I) The genetic material should be stable and should not change with age or change in physiology; this stability is given to DNA by its
(b) Double stranded nature,
(c) Presence of thymine.
(ii) Because the 2'- OH group of RNA nucleotid3es is a reactive group that makes RNA labile and easily degradable
.(iii) RNA (23S RNA) is also catalytic, i.e., it is reactive.</td><td>2</td></tr>
<tr><td>14</td><td>a) NH4Cl (ammonium chloride).
(b) It was done to show that after on generation of Escherichia coli with 15N-DNA, in medium of 14 N, the DNA was of intermediate density between the lightly and heavy DNAs; it shows that of the two strands, only one strand is synthesized newly, using the 14N-nitrogen source in the medium.
(c)The heavy and light DNA molecules can be distinguished by centrifugation in a cesium chloride (Cycle) density gradient; the 15N-DNA was heavier than 14N-DNA and the hybrid 15N-14N-DNA was intermediate between the two.
(d) They concluded that DNA replication is semiconservative, i.e., of the two strands of DNA, one is the parental strand while the other is synthesized new.</td><td>2</td></tr>
</table>

<table>
<tr><td>15</td><td>In eukaryotes, the hnRNA (primary transcript of mRNA) has coding sequences, called exons as well as non-coding sequences, called introns, i.e., the information is split
- If undergoes a process, called splicing, in which the introns are remove and the exons are joined together in a particular manner, to form the functional mRNA.
- In prokaryotes, the mRNA is polycistronic, i.e., codes for more than one polypeptide.
- The information is continuous and no splicing is required.</td><td>2</td></tr>
<tr><td>16</td><td>Initiation process of transcription in bacteria
- The RNA polymerase binds transiently to an initiation factor (sigma σ factor) and binds to a specific sequence on the DNA, called promoter, to initiate transcription.
-The DNA strand with 3'→5' polarity acts as the template.</td><td>2</td></tr>
<tr><td>17</td><td>Elongation process of Transcription in bacteria
- After binding to the promoter, the RNA polymerase facilitates the opening of the DNA.
- It uses nucleoside triphosphates as substrate and polymerises the nucleotides in a templatdependent fashion following complementarity of bases in 5'→3 direction
The process continues till the RNA polymerase reaches the terminator region on the DNA stran</td><td>2</td></tr>
<tr><td>18</td><td>Once the RNA polymerase reaches the terminator sequences of the DNA, it binds transiently to the transiently to the termination factor (rho ρ)
-The RNA strand synthesized falls off, followed by the RNA polymerase, i.e termination has occurred</td><td>2</td></tr>
<tr><td>19</td><td>-The viruses/ bacteriophages grown on radioactive Sulphur (35S) contained radio active proteins but not radioactive DNA, because DNA does not contain Sulphur.
- When these viruses were allowed to infect bacteria, the bacteria did not contain radioactivity, because proteins did not enter the bacteria; hence protein is n0ot the genetic material.
- The viruses grown on radioactive phosphorous (32P) contained radioactive DNA, because DNA contains phosphorus and not proteins.
- When these viruses were allowed to infect the bacteria, the bacteria were radioactive, indicating that DNA is the genetic material that has passed from the virus into bacteria.</td><td>3</td></tr>
<tr><td>20</td><td>RNA is the first genetic material because:
(I) RNA can directly code for the synthesis of proteins and hence can easily express the character; it is the genetic material in many viruses.
(ii) RNA can also act as a catalyst; there are some important biochemical reactions in living systems that are catalyzed by RNAs and not proteins.
Many essential life processes like splicing, translation, etc. have evolved around RNA.</td><td>3</td></tr>
<tr><td>21</td><td>(a) RNA polymerase III transcribes tRNA, 5S rRNA and SnRNA, i.e., small nuclear RNA
<table><tr><td>capping</td><td>tailing</td></tr><tr><td>It is the process of addition of methyl guanousine triphosphate to the 5' end of hnRNA after splicing.</td><td>It is the process of addition of adenylate residues to the 3' end of hnRNA after splicing</td></tr></table>(b) Heterogenous nuclear ribonucleic acid (hnRNA).</td><td>3</td></tr>
</table>

22	Functions of RNA - It functions as a messenger. - It is an adapter. - It is a structural component of ribosome - It also acts as a catalysts.	3
23	- In eukaryotes, there are three RNA-polymerases - RNA-polymerase I catalyses transcription of r RNAs (28 S, 18 A and 5.8 S). - RNA-polymerase II catalyses transcription of precursor of mRNA; it is called hnRNA. - RNA-polymerase III catalyses tRNA, 5srRNA and hnRNA.	3.
24	- A proteins acquires a charge depending on the abundance of amino acid residues with charged side chains. - Histones are rich is basic amino acids, lysine's and arginine's, which carry positive charges in their side chains; hence histones are positively charged.	3
25	- A single DNA dependent RNA polymerase catalyses the formation of mRNA, tRNA and rRNA in bacteria. - The enzyme is capable of catalyzing only the elongation step of transcription - It combines transiently to the initiation or sigma factor and binds to the promoter and initiates transcription - It somehow facilitates the opening of the DNA helix and catalyses the polymerisation of ribonucleoside triphosphates in a template-depended fashion, i.e., elongation. - When it reaches the terminator sequence, the enzyme associates transiently with the termination or rho (p) factor and terminates transcription, the RNA and the enzyme fall off the template.	5
26	Prosperities of genetic code: - AUG is the initiation codon and codes for methionine; methionine is the first amino acid in the given polypeptide. - Genetic code is unambiguous and specific, i.e., each codon codes only for on particular amino acid. - Genetic code is degenerate, i.e., more than one codon code on one amino acid. - Each codon is a triplet, i.e., made of three nucleotides e.g., AUG, UUU, etc. - UAG does not code for any amino acid, it is a termination codon.	5
27	Ans-a) The judge showed wisdom and intention to search for the truth. Ans-b) 1. DNA fingerprinting involves identifying differences in some specific regions in DNA sequence called as repetitive DNA. 2. Depending on base composition (A: T rich or G:C rich), length of segment, and number of repetitive units, the satellite DNA is classified into many categories, (Micro-satellites, mini-satellites etc). 3. These sequences normally do not code for any proteins, but they form a large portion of human genome. These sequence show high degree of polymorphism and form the basis of DNA fingerprinting. Ans-c) (i) isolation of DNA, (ii) digestion of DNA by restriction endonucleases, (iii) separation of DNA fragments by electrophoresis, (iv) transferring (blotting) of separated DNA fragments to synthetic membranes, such as nitrocellulose or nylon, (v) hybridisation using labelled VNTR probe, and (vi) detection of hybridised DNA fragments by autoradiography.	1+1+2