BHARATHIDASAN UNIVERSITY

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Programme: M.Sc., Biomedical Science

Course Code: BM35C5
Course Title: Molecular Biology

Unit-III

Transcription

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Unit III:

Transcription: Concept of transcription, RNA polymerases, transcriptional factors, regulatory elements, Mechanism of transcription in Prokaryotes and eukaryotes, Distinction between prokaryotic and eukaryotic transcription. Concept and mechanism of post transcriptional modification- 5‟ capping, polyadenylation, splicing of nuclear pre-mRNA, nuclear export of mRNA-mRNA stability

PRESENTATION: 2

Post-Transcriptional Modifications

- Post-transcriptional modifications refer to the chemical changes and structural alterations that RNA molecules undergo after transcription but before they are functional in the cell.
- These modifications are crucial for RNA maturation, stability, and functionality.

Pre-mRNA Processing

In bacterial cells, transcription and translation take place simultaneously

while the 3‘ end of an mRNA is undergoing transcription, ribosomes attach to the Shine-Dalgarno sequence near the 5‘ end and begin translation.

little opportunity for the bacterial mRNA to be modified before protein synthesis.

In eukaryotic cells:

- transcription and translation are separated in both time and space

- Transcription takes place in the nucleus, whereas most translation takes place in the cytoplasm; this separation provides an opportunity for eukaryotic RNA to be modified before it is translated.

Eukaryotic mRNA is extensively altered after transcription.

Changes are made to the 5‘ end, the 3‘ end, and the protein-coding section of the RNA molecule.

The initial transcript of protein-encoding genes of eukaryotic cells is called pre-mRNA, whereas the mature, processed transcript is mRNA.

We will reserve the term mRNA for RNA molecules that have been completely processed and are ready to undergo translation.

1. Capping of mRNA

•**Process**: A 7-methylguanosine (m^7G) cap is added to the 5' end of eukaryotic pre-mRNA during transcription.

•**Enzymes**: RNA triphosphatase, guanylyltransferase, and methyltransferase.

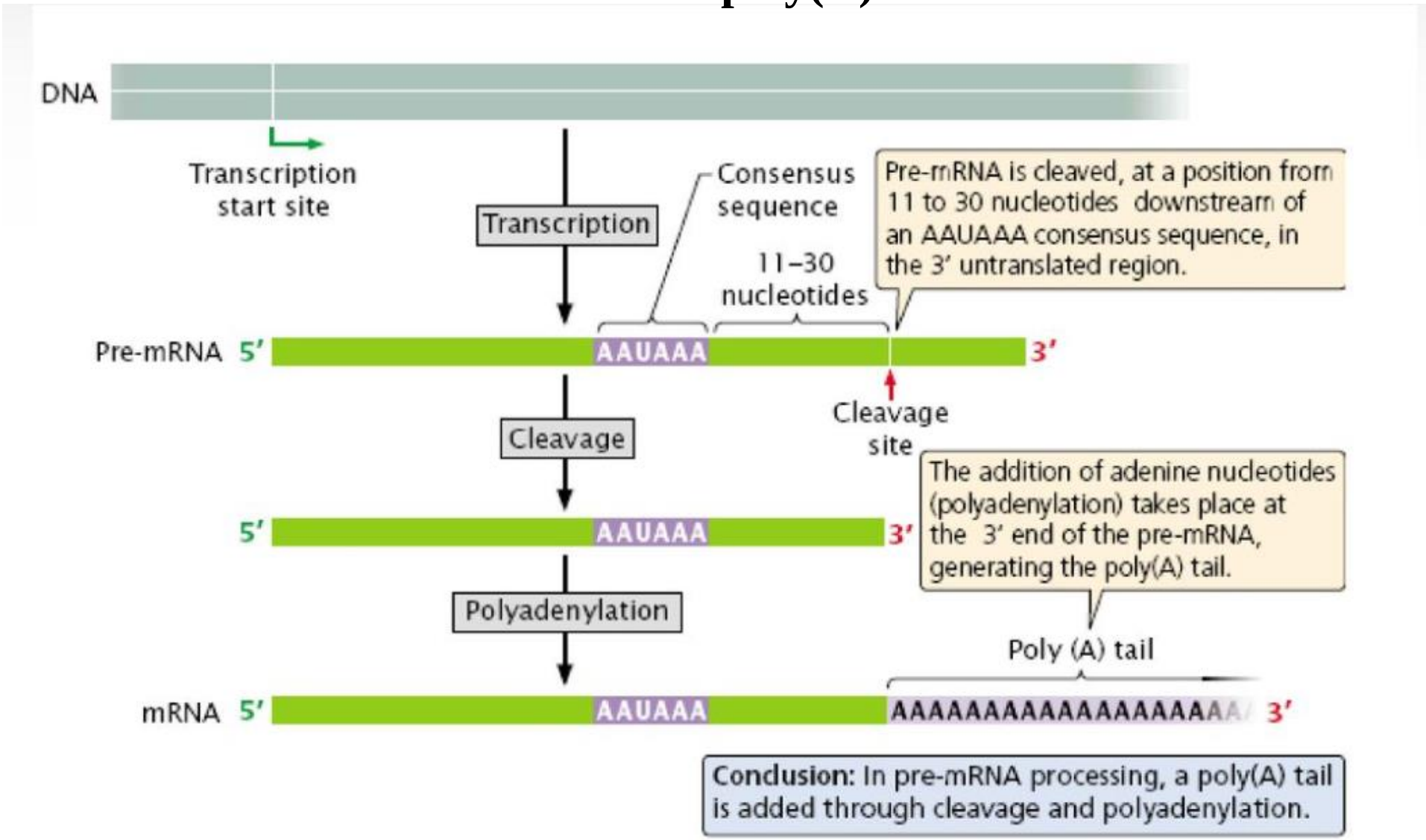
•**Functions**:

- Protects mRNA from degradation by exonucleases.
- Facilitates ribosome binding during translation.
- Assists in nuclear export of the mRNA.

2. Polyadenylation

- **Process**: Addition of a poly(A) tail (a stretch of adenine nucleotides) to the 3' end of pre-mRNA.
- **Enzymes**: Poly(A) polymerase and associated cleavage factors.
- **Functions**:
  - Enhances mRNA stability.
  - Aids in transcription termination.
  - Promotes efficient translation.

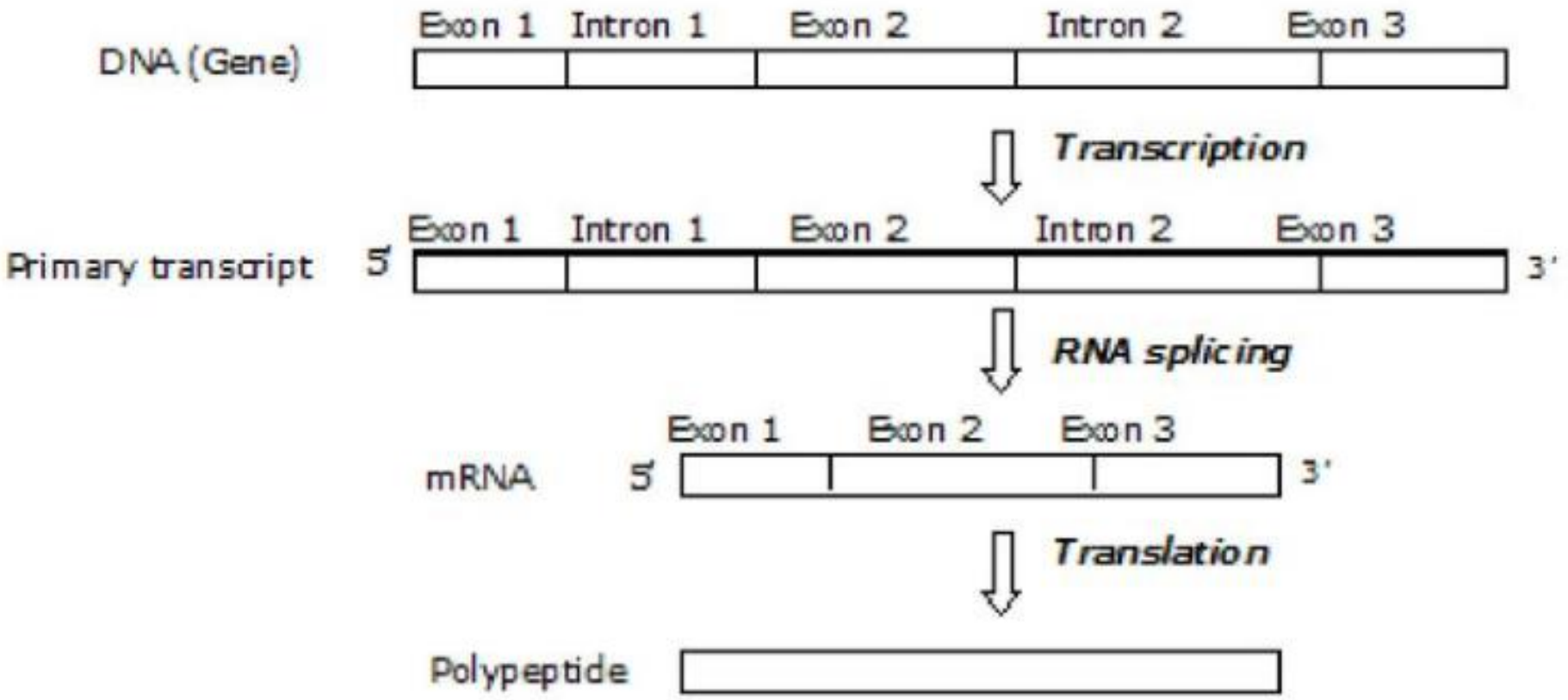
Addition of a poly(A) tail



3. Splicing

- **Process**: Removal of non-coding introns from pre-mRNA and joining of coding exons.
- **Mechanism**: Mediated by the spliceosome, a complex of small nuclear RNAs (snRNAs) and proteins.
- **Types**:
  - Constitutive splicing: Occurs in all cells.
  - Alternative splicing: Generates multiple protein isoforms from a single gene.
- **Functions**:
  - Produces mature mRNA for translation.
  - Increases genetic diversity and proteome complexity.

RNA Splicing



4. RNA Editing

- **Process**: Post-transcriptional alteration of nucleotide sequences in RNA.
- **Types**:
  - Substitution editing (e.g., adenosine-to-inosine [A-to-I] editing).
  - Insertion or deletion editing.
- **Enzymes**: Adenosine deaminases acting on RNA (ADARs) and others.
- **Functions**:
  - Diversifies protein products.
  - Regulates gene expression and function.

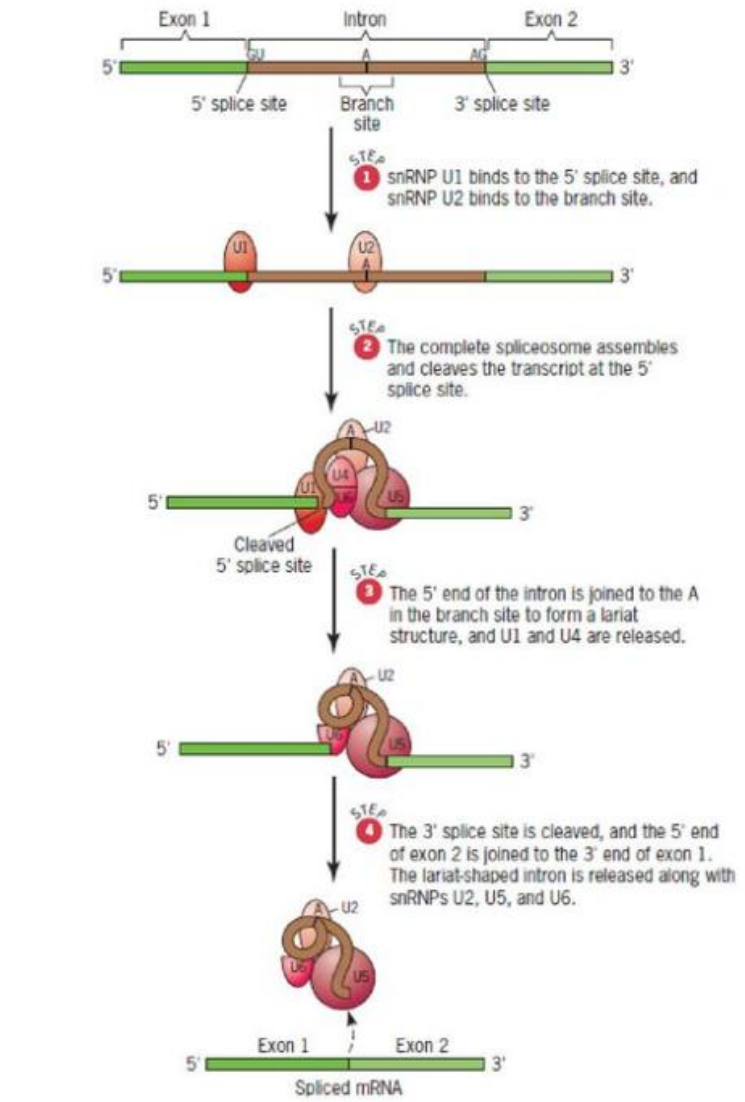
5. RNA Modifications

- **Types**:
  - Methylation (e.g., N6-methyladenosine [m^6A] modification).
  - Pseudouridylation (conversion of uridine to pseudouridine).
- **Enzymes**: Methyltransferases, pseudouridine synthases.
- **Functions**:
  - Affects RNA stability, localization, and translation efficiency.
- **6. RNA Transport and Localization**
- After modifications, RNAs are transported from the nucleus to the cytoplasm through nuclear pore complexes.
- Specific localization signals ensure that RNAs reach the correct cellular compartments.

7. Non-Coding RNA Processing

- **rRNA and tRNA modifications**:
  - Cleavage and trimming of precursor molecules.
  - Chemical modifications like methylation and pseudouridylation.
  - Essential for the functionality of ribosomes and translation machinery.
- **miRNA processing**:
  - Involves Drosha and Dicer enzymes to generate mature microRNAs.
  - Regulates gene expression post-transcriptionally.

Post Transcriptional Modification



Importance of Post-Transcriptional Modifications

- **Gene Regulation**: Fine-tunes gene expression levels.
- **RNA Stability**: Protects RNA from premature degradation.
- **Protein Synthesis**: Ensures accurate and efficient translation.
- **Diversity**: Creates functional diversity from a limited number of genes.
- **Adaptation**: Allows cells to respond dynamically to environmental changes.

ACKNOWLEDGEMENT

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