



Dept. of Computer Science and Engineering
University of Rajshahi
www.ru.ac.bd

Dr. Shamim Ahmad

RNA

- It is formed of linear polynucleotide
- It is generally single stranded
- The pentose sugar is Ribose
- Uracile (U) replace Thymine (T) in the pyrimidine bases.

Although RNA is generally single stranded, **intra-molecular H-bond base pairing occur** between complementary bases on the same molecule (secondary structure)

Non-coding RNA (>90%)

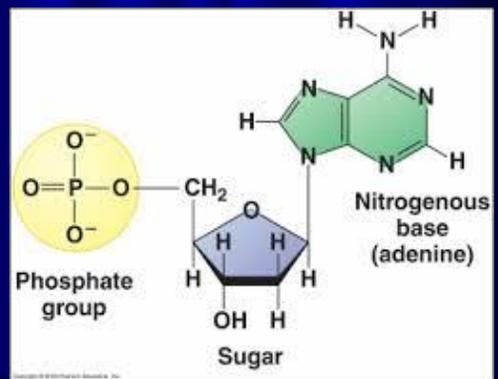
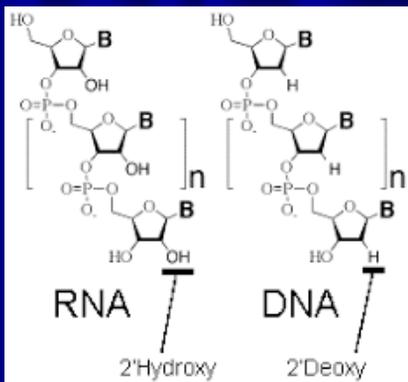
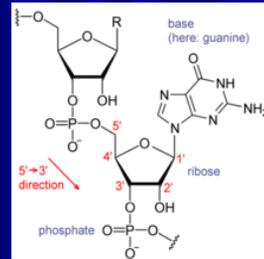
- Number within the human genome is unknown
- There are **thousands** of them
- Many of the newly identified ncRNAs have not been validated for their function
- Many **ncRNAs** are **non functional** (sometimes referred to as junk RNA)

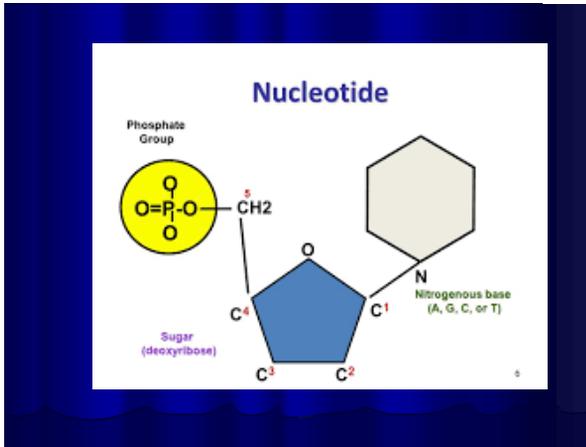
RNA structure

- RNA is a single stranded polynucleotide molecule.
- Length 200 nt
- It can take 3 levels of structure;
 - Primary: sequence of nucleotides
 - Secondary: hairpin loops (base pairing)
 - Tertiary: motifs and 3D foldings

RNA structure

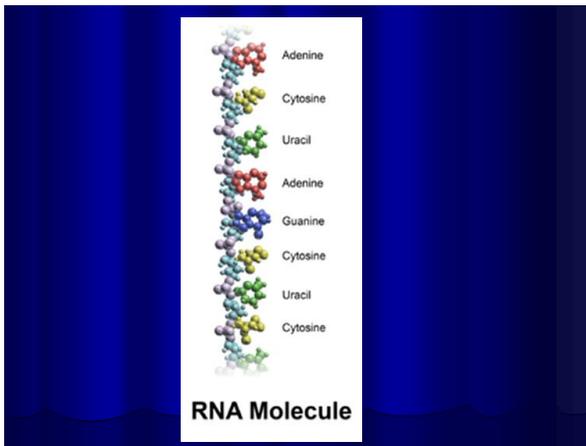
- RNA contains *ribose* instead. Ribose has a **hydroxyl** group attached to the pentose ring I
- The hydroxyl groups in the ribose backbone make RNA **less stable** than DNA because it is more prone to **hydrolysis**.





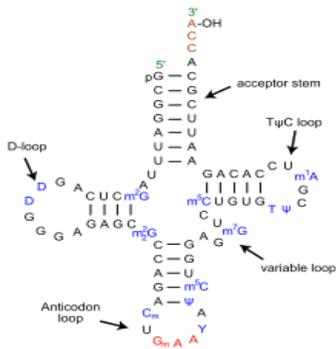
Roles of RNA

- Catalyze biological reactions
- Protein synthesis
- Controlling gene expression
- Sensing and communicating responses to cellular signals



The bases form hydrogen bonds

- Between cytosine and guanine
- Between adenine and uracil
- Between guanine and uracil



Sequence Manipulation Suite: IUPAC codes DNA:

Nucleotide Code: Base:

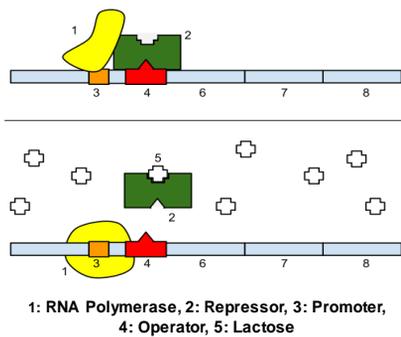
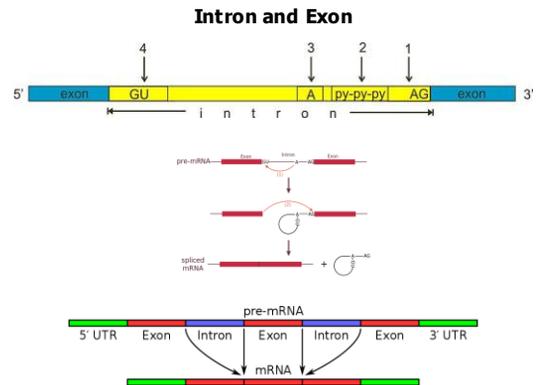
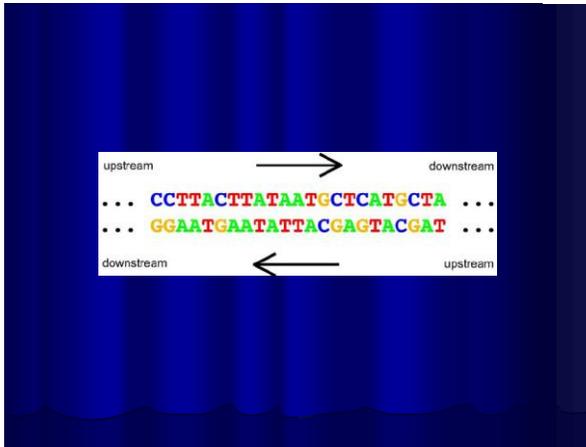
.....
 A Adenine
 C Cytosine
 G Guanine
 T (or U) Thymine (or Uracil)
 R A or G
 Y C or T
 S G or C
 W A or T
 K G or T
 M A or C
 B C or G or T
 D A or G or T
 H A or C or T
 V A or C or G
 N any base
 . or - gap

Types of RNA

- **Messenger RNA (mRNA):**
 - Carries genetic information copied from DNA in the form of a series of 3-base code, each of which specifies a particular amino acid.
- **Transfer RNA (tRNA):**
 - 90 nt long
 - 31-41 types
 - It is the key that reads the code on the mRNA.
 - Each amino acid has its own tRNA, which binds to it and carries it to the growing end of a polypeptide chain.

Types of RNA

-
- **Ribosomal RNA (rRNA):**
 - Associated with a set of proteins to form the ribosomes.
 - These complex structures, which physically move along the mRNA molecule, **catalyze the assembly of amino acids into protein chain.**
 - They also **bind tRNAs** that have the specific amino acids according to the code.



Turned off.

- There is no lactose to inhibit the repressor
- Repressor binds to the operator
- Obstructs the RNA polymerase from binding to the promoter and making lactase.

Turned on.

- Lactose is inhibiting the repressor
- RNA polymerase to bind with the promoter
- Express the genes
- Synthesize lactase
- Lactase will digest all of the lactose

Promoter

- A region of DNA
- It initiates transcription of a particular gene
- 100–1000 base pair long
- -100 base pairs upstream
- Its regulatory sequences typically bind proteins called **transcription factors**

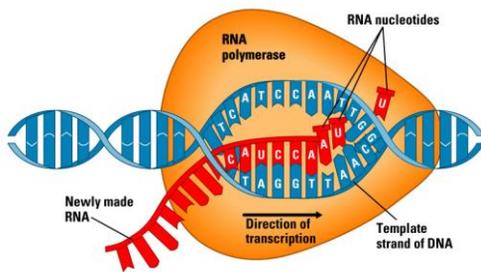
Transcription factors

Promoters contain specific DNA sequences

- Response elements
- A secure initial binding site
- RNA polymerase
- Proteins

Transcription factors

- Specific activator or repressor
- Sequences of corresponding Nucleotide
- Attach to specific promoters
- Regulate gene expression



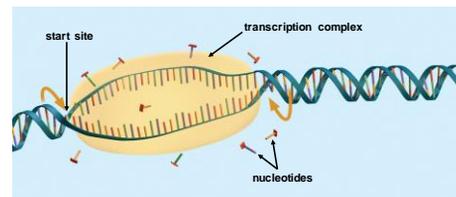
(a) A close-up view of transcription

Copyright © 2004 Pearson Education, Inc., publishing as Benjamin Cummings.

Fig 10.13a

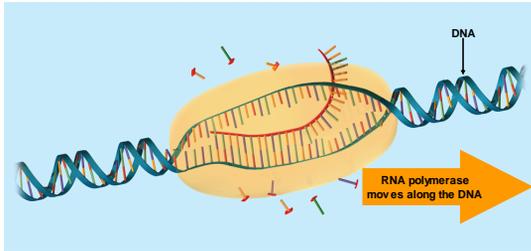
8.4 Transcription

- Transcription is catalyzed by **RNA polymerase**.
 - RNA polymerase and other proteins form a transcription complex.
 - The transcription complex recognizes the start of a gene and **unwinds** a segment of it.



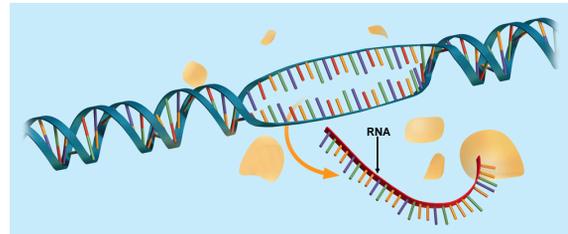
8.4 Transcription

- Nucleotides pair with one strand of the DNA.
- RNA **polymerase bonds the nucleotides** together.
- The **DNA helix winds again** as the gene is transcribed.



8.4 Transcription

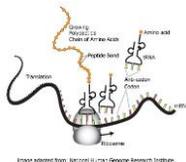
- The RNA strand **detaches from the DNA once the gene is transcribed.**



Translation

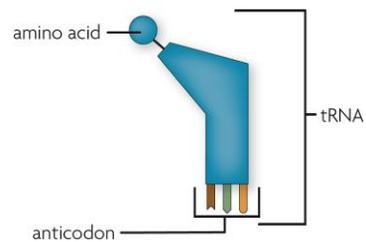
- mRNA is read as a series of **codons (three letters)** within the ribosome.
- tRNA molecules have an **anticodon sequence** of letters that are complements to the mRNA

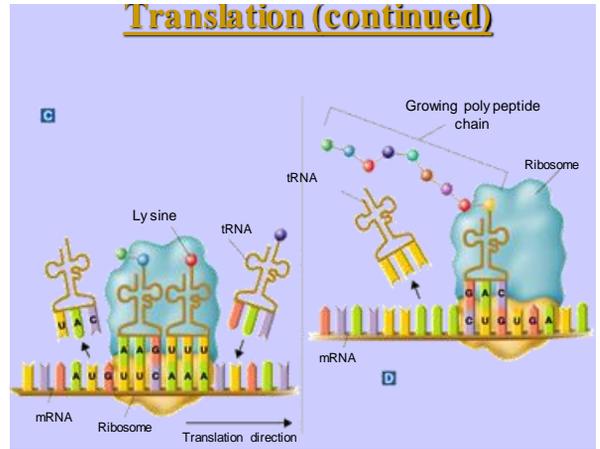
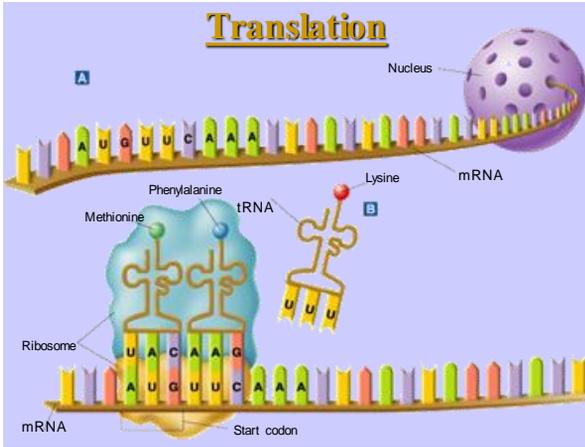
ex: mRNA CGA UCC (codon)
tRNA GCU AGG (anticodon)



8.5 Translation

- **Amino acids are linked to become a protein.**
- An **anticodon** is a set of three nucleotides that is complementary to an mRNA codon.
- An anticodon is carried by a tRNA.





5' AGGTGACACCGCAAGCCTTATATTAGC 3'

Illustration of possible reading frames:

AGG·TGA·CAC·CGC·AAG·CCT·TAT·ATT·AGC
 A·GGT·GAC·ACC·GCA·AGC·CTT·ATA·TTA·GC
 AG·GTG·ACA·CCG·CAA·GCC·TTA·TAT·TAG·C

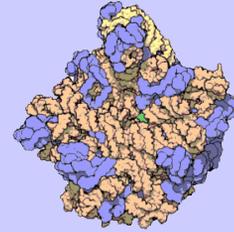
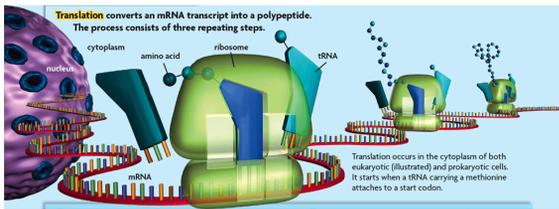
STOP CODON

in RNA:
 UAG ("amber")
 UAA ("ochre")
 UGA ("opal")

in DNA:
 TAG ("amber")
 TAA ("ochre")
 TGA ("opal" or "umber")

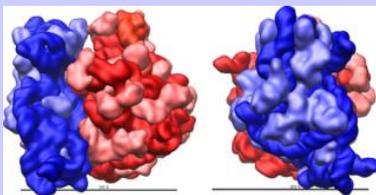
8.5 Translation

- For translation to begin, tRNA binds to a start codon and signals the ribosome to assemble.
- A complementary tRNA molecule binds to the exposed codon, bringing its amino acid close to the first amino acid.

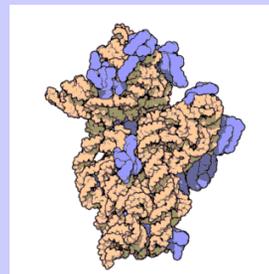


- Proteins are shown in blue
- The two RNA strands in orange and yellow.
- The small patch of green in the center of the subunit is the active site.

Ribosome



Large (red) and small (blue) subunit fit together

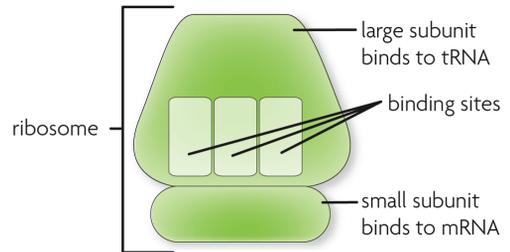


Atomic structure of the 30S subunit from *Thermus thermophilus*. Proteins are shown in blue and the single RNA chain in orange.

Amino Acid	SLC	DNA codons
Isoleucine	I	ATT, ATC, ATA
Leucine	L	CTT, CTC, CTA, CTG, TTA, TTG
Valine	V	GTT, GTC, GTA, GTG
Phenylalanine	F	TTT, TTC
Methionine	M	ATG
Cysteine	C	TGT, TGC
Alanine	A	GCT, GCC, GCA, GCG
Glycine	G	GGT, GGC, GGA, GGG
Proline	P	CCT, CCC, CCA, CCG
Threonine	T	ACT, ACC, ACA, ACG
Serine	S	TCT, TCC, TCA, TCG, AGT, AGC
Tyrosine	Y	TAT, TAC
Tryptophan	W	TGG
Glutamine	Q	CAA, CAG
Asparagine	N	AAT, AAC
Histidine	H	CAT, CAC
Glutamic acid	E	GAA, GAG
Aspartic acid	D	GAT, GAC
Lysine	K	AAA, AAG
Arginine	R	CGT, CGC, CGA, CCG, AGA, AGG
Stop codons	Stop	TAA, TAG, TGA

8.5 Translation

- Ribosomes consist of two subunits.
 - The large subunit has three binding sites for tRNA.
 - The small subunit binds to mRNA.



Protein synthesis

- Messenger RNA (mRNA) molecules direct the assembly of proteins on ribosomes.
- Transfer RNA (tRNA) molecules are used to deliver amino acids to the ribosome
- Ribosomal RNA (rRNA) then links amino acids together to form proteins.

