

GENES

- A gene is a portion of chromosome that determines a character or phenotype
- Can a single gene be expressed into multiple gene products?
- Coding and noncoding sequences in genes
 - Introns
 - Exons

Transposons

- Constitute almost half of the genome
- Ranging from few hundred to several thousand base pairs (bp_s)
- Move from one location to another in the genome.
- Composed of :
 - Long interspersed elements (LINE_s)
 - Short interspersed elements (SINE_s)

MITOCHONDRIAL DNA

- Apart from the nucleus, eukaryotic cells also have other organelles such as mitochondria and chloroplasts, which contain DNA. Mitochondrial DNA is capable of encoding certain proteins and RNA in mitochondria. The synthesis of about 13 proteins of the respiratory chain, are encoded by mtDNA.
- **mtDNA is inherited only from the mother!**
- **Leber's hereditary optic neuropathy**

CENTROMERES AND TELOMERES

- The nucleoproteins which link the chromosome to the mitotic spindle during cell division are anchored to a specific region on the DNA known as the *centromere*.
- This ensures an equal distribution of chromosome sets to daughter cells.
- The guanine-rich sequences at the ends of eukaryotic chromosomes are known as *telomeres*.

- Telomeric DNA is synthesised and maintained by an enzyme known as ***telomerase***. The somatic cells of multicellular organisms lack telomerase activity (however their germ cells have active telomerase function). The loss of telomerase activity allows the gradual shortening of chromosomes with each cycle of DNA replication and cell division until they reach *senescence* (a stage at which there will be no more division). ***Perhaps this is the basis of ageing.***

NUCLEASES

Nucleases are enzymes that are capable of degrading nucleic acids.

- Endonucleases
- Exonucleases
- Restriction endonucleases

Unusual structures in DNA

- Hoogsteen pairing or non Watson & Crick pairing:

When N^7, O^6, N^6 of purines participate in unusual binding

- Triplex DNAs
- Tetraplex (rich in guanosine residue)
- Palindromes

DNA v/s RNA

Features

DNA

RNA

Strands

Double

Usually single

Bases

AGCT

AGCU

Pentose

Deoxyribose

Ribose

Alkali denat'n

Never

Yes because of 2'-OH group

Location

Mainly nucleus small amount mitochondria

Mainly cytoplasm

Chargaf's rule

Obeys

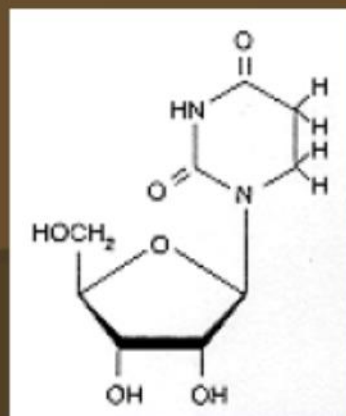
Doesn't obey

Role

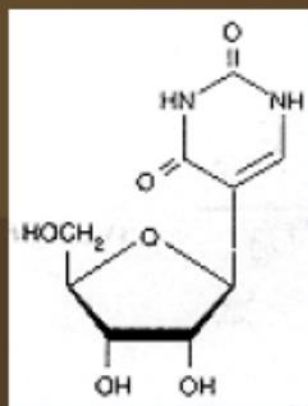
Protein synthesis & catalytic property

Genetic repository

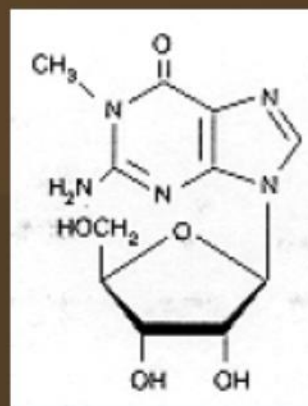
Examples of modified bases found in RNA



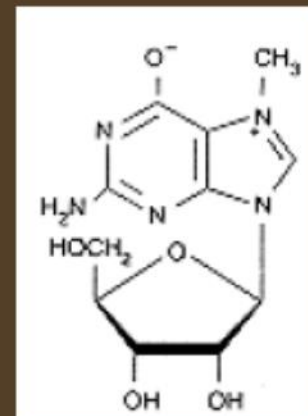
Dihydrouridine



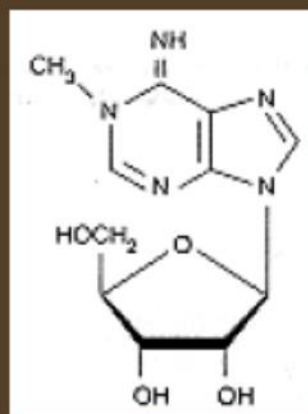
Pseudouridine



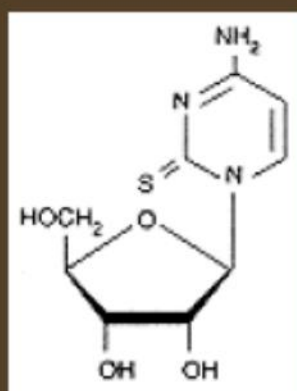
1-methylguanosine



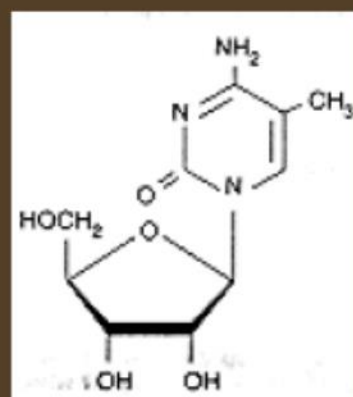
7-methylguanosine



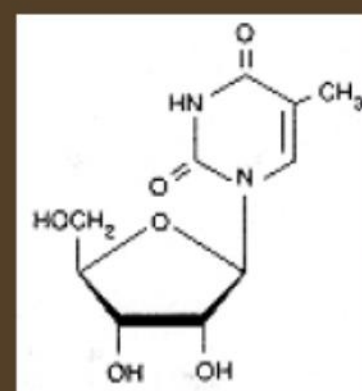
1-methyladenosine



2-thiocytidine



5-methylcytidine



Ribothymine

RNA functions

Storage/transfer of genetic information

- **Genomes**

- many viruses have RNA genomes
 - single-stranded (ssRNA)
 - e.g., retroviruses (HIV)
 - double-stranded (dsRNA)

- **Transfer of genetic information**

- mRNA = "coding RNA" - encodes proteins

RNA functions

Structural

- e.g., rRNA, which is a major structural component of ribosomes
BUT - its role is *not* just structural, also

Catalytic

RNA in the ribosome has *peptidyltransferase* activity

- Enzymatic activity responsible for peptide bond formation between amino acids in growing peptide chain
- Also, many small RNAs are enzymes
"ribozymes"

RNA types & functions

Types of RNAs	Primary Function(s)
mRNA - messenger	translation (protein synthesis) regulatory
rRNA - ribosomal	translation (protein synthesis) <catalytic>
t-RNA - transfer	translation (protein synthesis)
hnRNA - heterogeneous nuclear	precursors & intermediates of mature mRNAs & other RNAs

Types of RNAs	Primary Function(s)
scRNA - small cytoplasmic	signal recognition particle (SRP) tRNA processing
snRNA - small nuclear	mRNA processing, poly A addition catalytic rRNA processing /maturation /methylation
regulatory RNAs (siRNA, miRNA, etc.)	regulation of transcription and translation, other??

TYPES OF RNA

1. Messenger RNA (m-RNA)

Messenger RNA is located in the cytoplasm and transfers genetic information from the DNA to the protein-synthesising machinery on ribosomes.

2. Transfer RNA (t-RNA)

It also occurs in cytoplasm, it translates the information carried by m-RNA into a specific sequence of amino acids that are incorporated into protein.

3. Ribosomal RNA (r-RNA)

It is a component of ribosomes which are the sites for protein biosynthesis.

4. Heterogenous nuclear RNA (hnRNA)

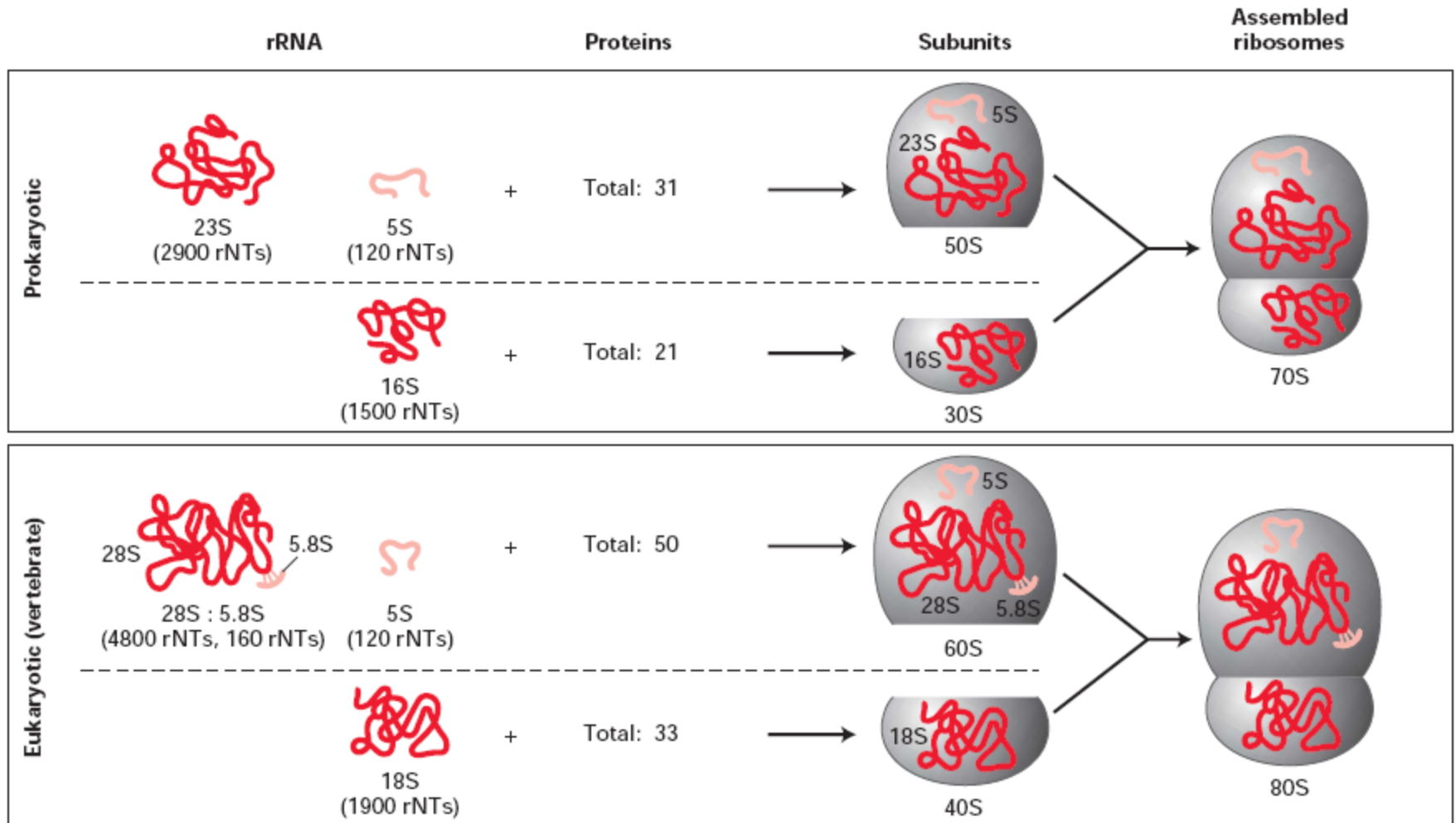
It is the primary form of RNA in nucleus processed into mature m-RNA.

MESSENGER RNA (m-RNA)

- Messenger RNA is located in the cytoplasm and transfers genetic information from the DNA to the protein-synthesising machinery on ribosomes.
- Messenger RNA is synthesised as the primary transcript from the template strand of DNA and later processed to m-RNA.
- 5' capping
- Poly 'A' tail
- Heterogeneous nuclear RNA (hnRNA)

Ribosomal RNA

- Present in cytoplasm and nucleoprotein
- It is on the ribosome that m-RNA and r-RNA interact during protein synthesis.
- Prokaryotic cell: 23s, 16 s and 5s
- Eukaryotic cell :28s,18s,5.8s,5s(“S” Svedberg unit)
- Ribosomes have sedimentation coefficient of 80s.
- Ribosomes
 - 60 s subunit : 60% of r RNA (28s,5s,5.8s)
 - 40s subunit : 18s r-RNA



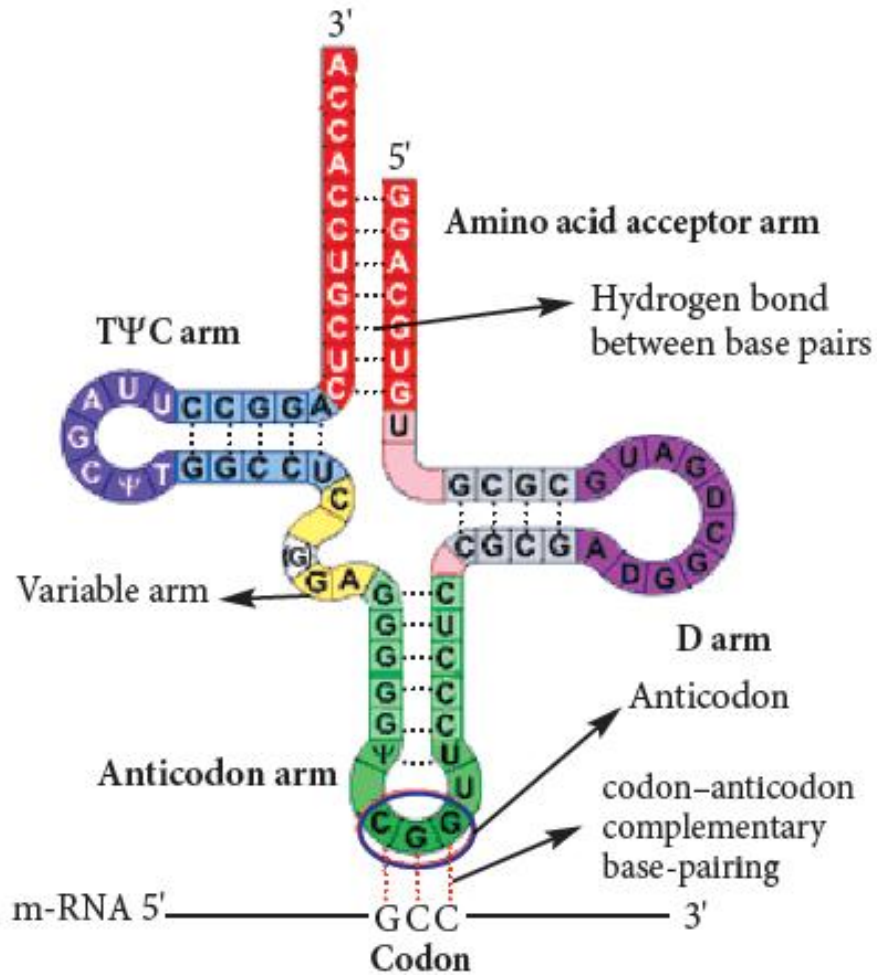
TRANSFER RNA (t-RNA)

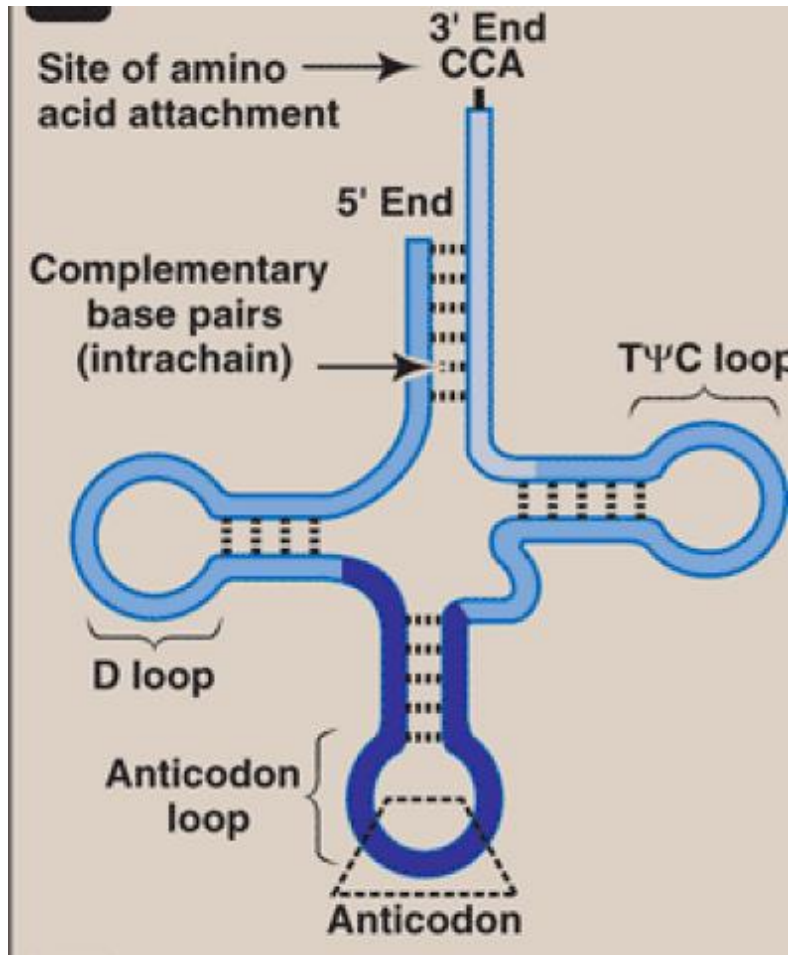
Transfer RNA is the adapter molecule that translates the information carried by m-RNA into specific sequences of amino acids.

tRNA contains mainly four arms

- Acceptor arm
- Anticodon arm
- D arm
- T Ψ C arm

STRUCTURE OF t-RNA





Acceptor arm

D arm

Anticodon arm

TΨC arm

Variable extra arm

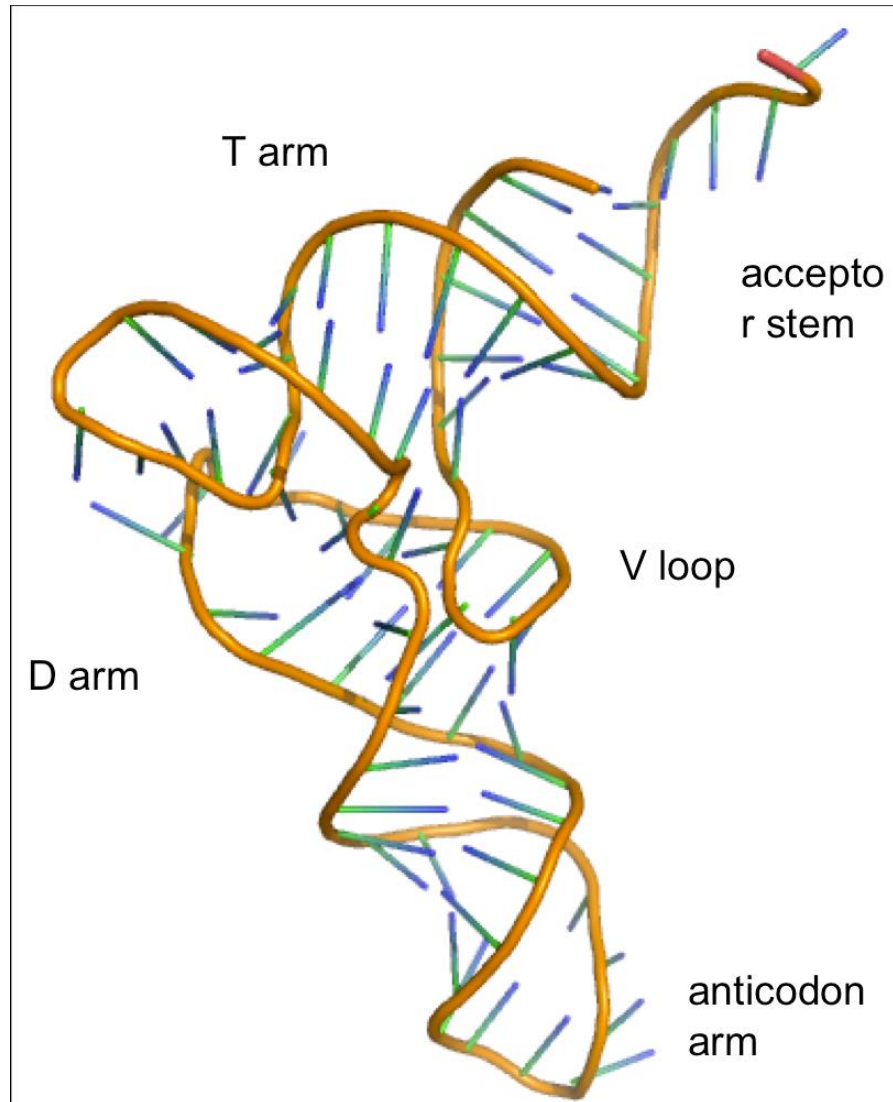
Clover leaf model

- Acceptor arm :Unpaired sequence of CCA
- 3OH group binds with α COOH group of specific amino acid “aminoacyl-t-RNA complex”
- Acceptor stem: 7 base pairs

Clover leaf model

- Anticodon arm: Unpaired non-bonded loop, carrying specific sequences of three bases constituting “Anticodon”.
- Bases of anticodon form hydrogen bonds with complementary bases of codon of m-RNA
- Anticodon stem 5bp
- D arm contains dihydrouridine serves as recognition site for enzyme which adds amino acids
- TΨC contains thymine pseudouridine and cytosine : binding t-RNA to ribosome

L-shaped tertiary structure



Central Dogma

- DNA is the repository of genetic information it is present in nucleus and _____.
- RNA is synthesized from _____ this process is called _____.
- RNA begets proteins this process is called _____.