UG - sem - VI
paper - MJC (11) T
unit - 3

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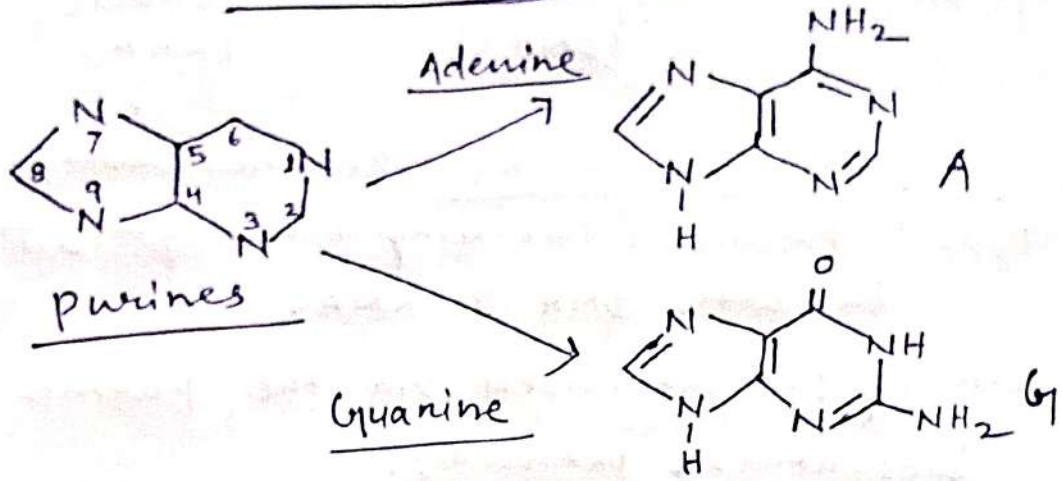
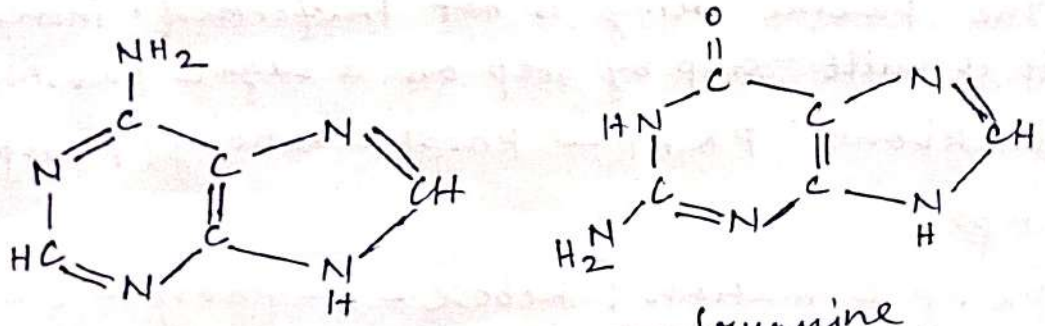
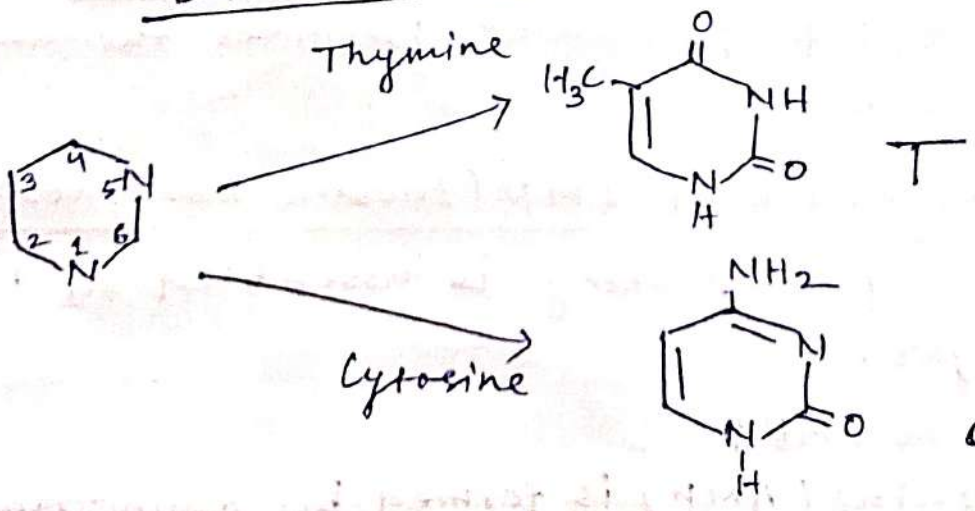
Structure and synthesis of Nucleotide

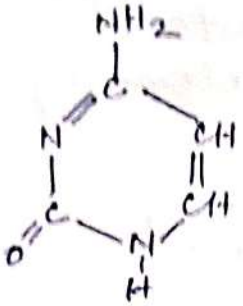
Bases — purines



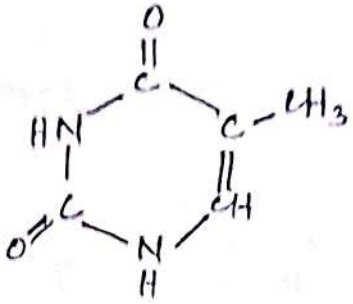


Bases — Pyrimidines

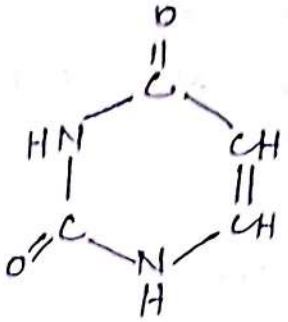




Cytosine



Thymine (DNA)



Uracil (RNA)

[1] Adenine & Guanine (Purines Bases)

Type: purines (two-ring heterocycle) found in both DNA & RNA.

Pathway :- synthesized via the purine biosynthesis pathway.

- The purine ring is not preformed; instead, it is built step by step on a sugar phosphate backbone (PRPP — Phosphoribosyl Pyrophosphate)

steps:

PRPP formation: Ribose-5-Phosphate ⟶ PRPP (activated sugar)

Formation of phosphoribosylamine:

PRPP + glutamine provides the amino group.

Formation of IMP (Inosine monophosphate):

The purine ring is assembled on the sugar.

From IMP:

Adenine (AMP) is formed by aminotransferase reactions.

Guanine (GMP) is formed after oxidation then amino substitution.

N.B. IMP is the branch point for both A and G.

Important conclusions:

- Adenine and Guanine synthesis share a common IMP intermediate.
- Purine synthesis requires many enzymes and is energetically costly.
- PRPP is a central activated intermediate linking both purine and pyrimidine pathways.

[2] Cytosine, Uracil & Thymine (Pyrimidine Bases)

Type: one ring heterocycle, Pyrimidines.

- Cytosine found in DNA & RNA
- Uracil in RNA only
- Thymine in DNA only

Pathway:

- Pyrimidine ring is synthesized first as a complete ring before attachment to PRPP (unlike purines).
- The key initial intermediate is orotate, formed from carbamoyl phosphate and aspartate.
- Orotate then reacts with PRPP ⟶ orotidine monophosphate (OMP) ⟶ decarboxylated to UMP (Uridine mono-phosphate).

Steps :

carbamoyl phosphate + Aspartate ⟶
carbamoyl aspartate ⟶ Orotate.

Orotate + PRPP ⟶ OMP (Orotodine mono-phosphate).

OMP decarboxylation ⟶ UMP (Uridine mono-phosphate).

Cytosine (CTP) is formed by amination of UTP

Thymine (dTMP) pathway involves methylation, usually using methyl group donors (e.g - 5,10 - methylene - tetrahydrofolate) in DNA metabolism.

(Uracil and cytosine are directly synthesized; thymine requires an extra methylation step.