NUCLEIC ACID METABOLISM AND RELATED DISEASES I

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Advance Clinical Biochemistry II (MA 416)

Summer Semester

Lecture 1

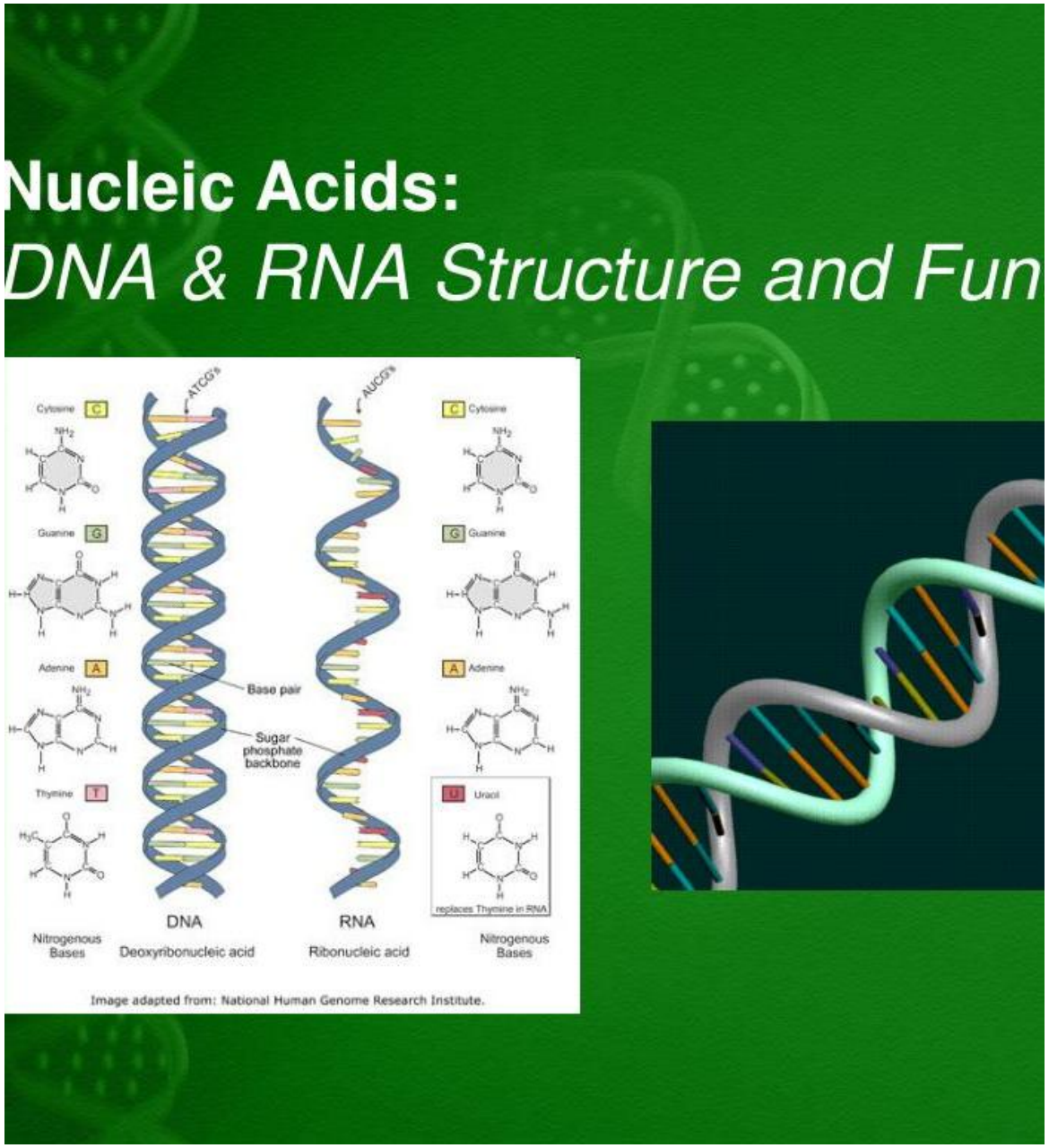
10/08/2026

Topics to be covered this semester

- Nucleic Acid metabolism and associated diseases I & II
- Biochemistry of the nervous system and cerebrospinal fluid I & II
- Enzymes in clinical diagnosis I & II
- Cancer Biochemistry (malignancy and tumor markers) I & II
- Biochemistry in pregnancy and antenatal screening I & II
- Biochemistry of aging and related diseases I & II

Objectives

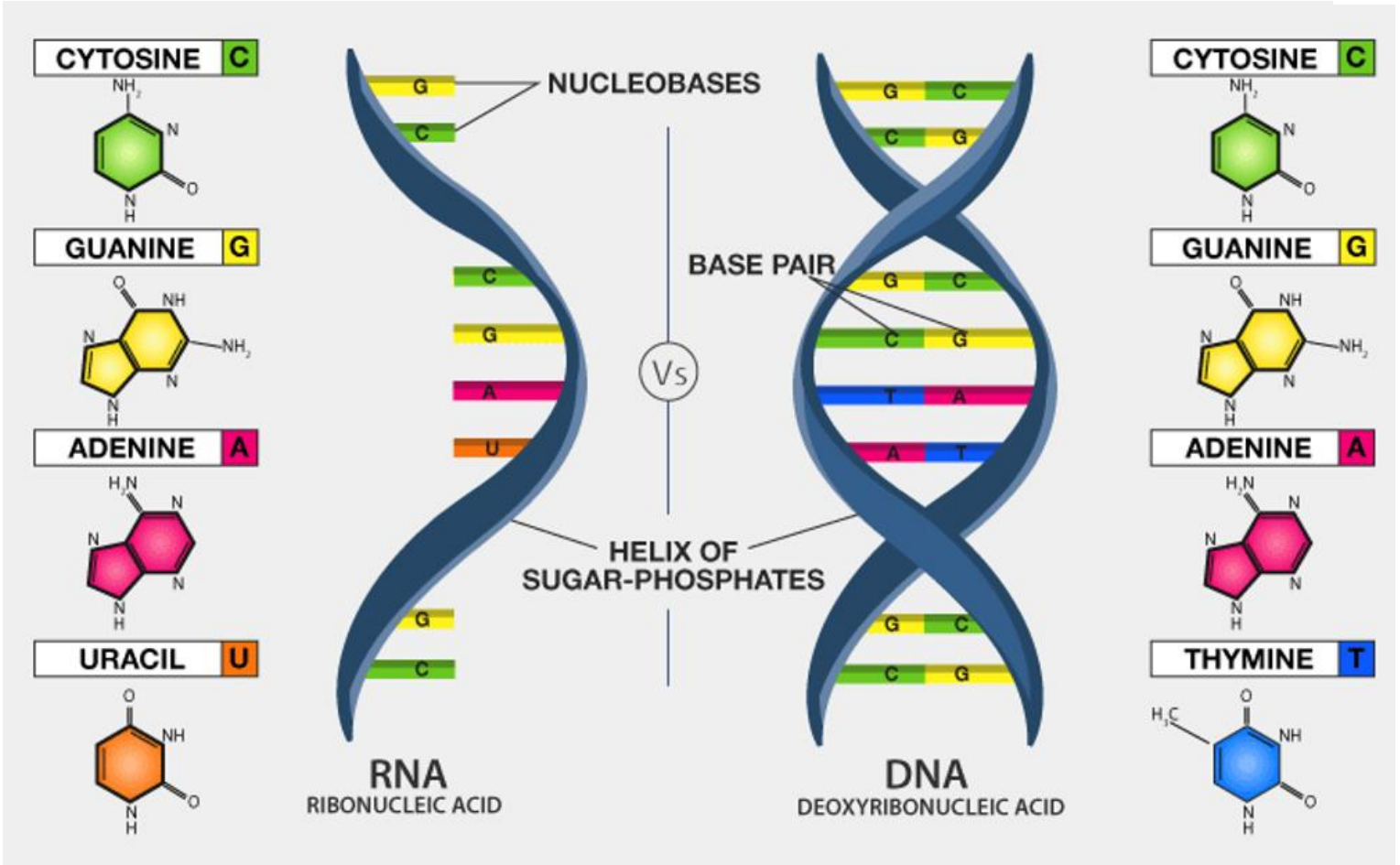
- **At the end of this lesson, the students should be able to:**
- Understand the underline principle of purine metabolism
- Familiarize themselves with the terminologies involved
- Understand the molecules at different levels.
- Understand the biomedical importance of purine and its metabolism.



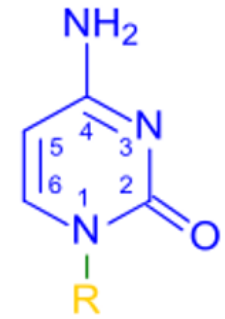
Nucleic acid

- DNA: A polynucleotide primary genetic material of all cells, consisting of a poly sugar-phosphate backbone with purine and pyrimidine bases.
- RNA: A polynucleotide that is unique among biological macromolecules in that it can encode genetic information and serve as an abundant structural component of cells.

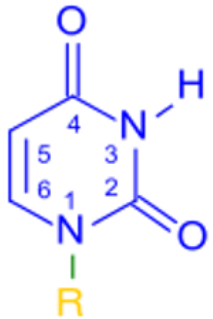
- The large molecules required for life.
- Built from smaller organic molecules.
- There are four major biological macromolecules.
- Together, these molecules form most of a cell's mass.



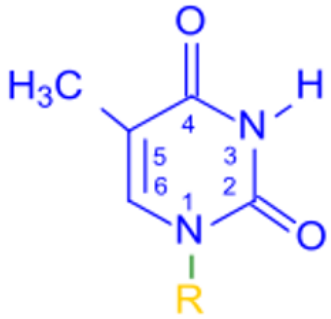
Pyrimidines



Cytosine



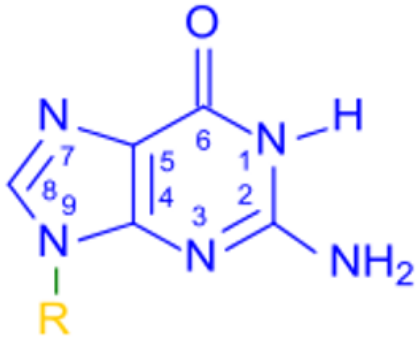
Uracil



Thymine

Purines

Adenine



Guanine

Nitrogenous bases

- Purines and pyrimidines are heterocyclic aromatic compounds.
- They form an important component of nucleotide when combined with sugar and phosphate groups.
- Purines include adenine and guanine, while pyrimidines include thymine (DNA), uracil (RNA), and cytosine in both.

Cont.

- **Purine:** Adenine (A) & Guanine (G)
- **Pyrimidine:** Thymine (T), Uracil (U), & Cytosine (C)
- **Other minor bases:** Hypoxanthine & Xanthine
- **Nucleosides:** 2 components (Base + Sugar):

- A nitrogenous base: **(**Adenine, guanine, thymine, or cytosine) + Pentose sugar (Deoxyribose) in DNA.
- A nitrogenous base: **(**Adenine, guanine, cytosine or uracil) + Pentose sugar (Ribose) in RNA

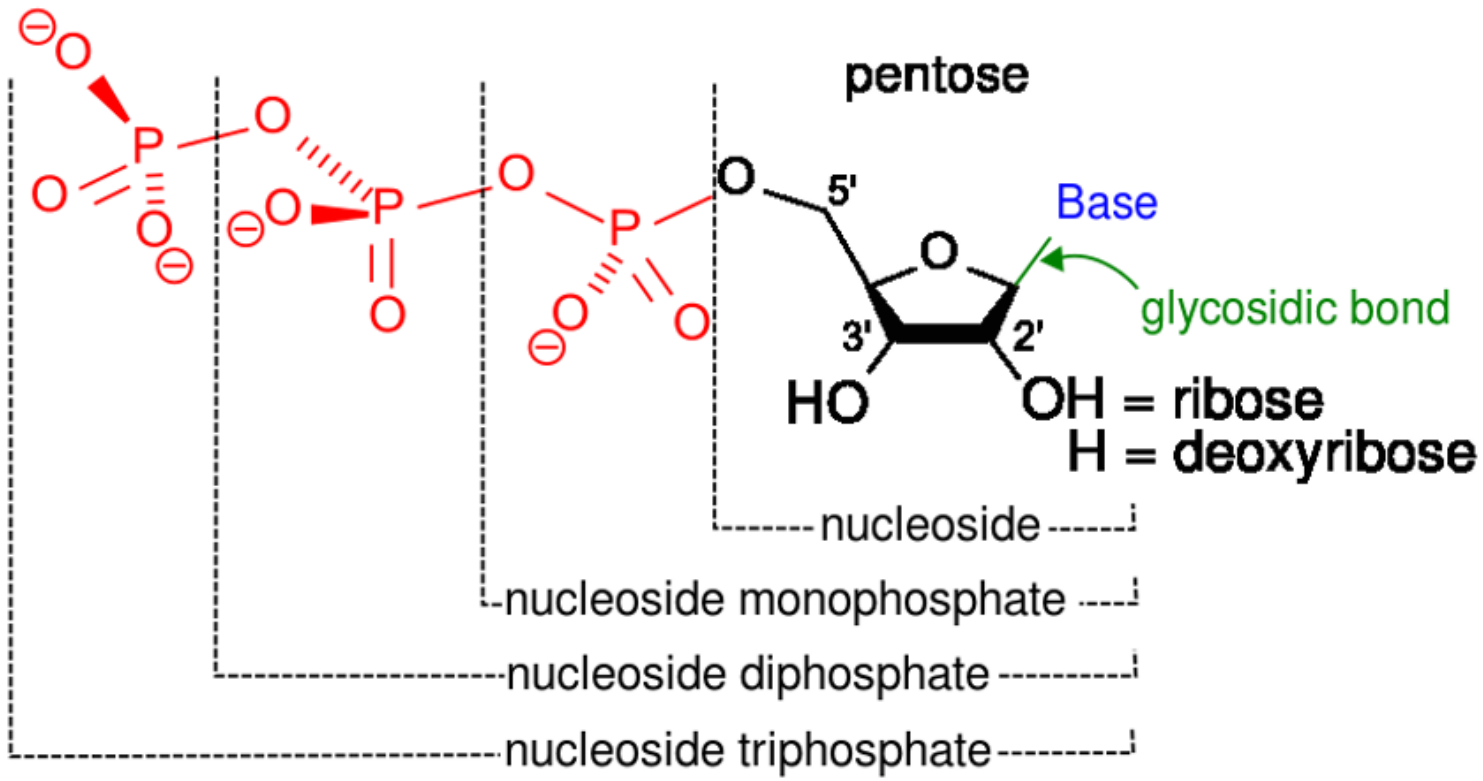
Cont.

- A beta-*N*-glycosidic bond links the carbon one of the pentose sugar and N9 of a purine or N1 of a pyrimidine (e.g., A, G, C, T, U, & I).

- **Nucleotides:** 3 main components: A nitrogenous base, Pentose sugar & Phosphate groups.

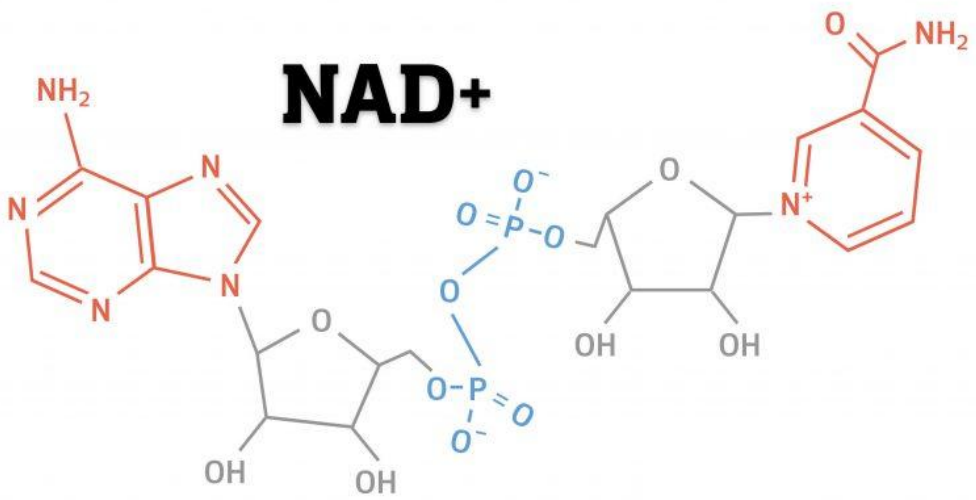
- These molecules form the DNA backbone (e.g., AMP, GMP, CMP)

- **> 1 phosphate groups:** Esterification of the phosphate groups forms the corresponding nucleoside diphosphates and triphosphates (e.g., ATP & ADP.



- Nucleo**S**ide:
- base + **S**ugar

- Nucleo**T**ide:
- base + sugar + phospha**T**e

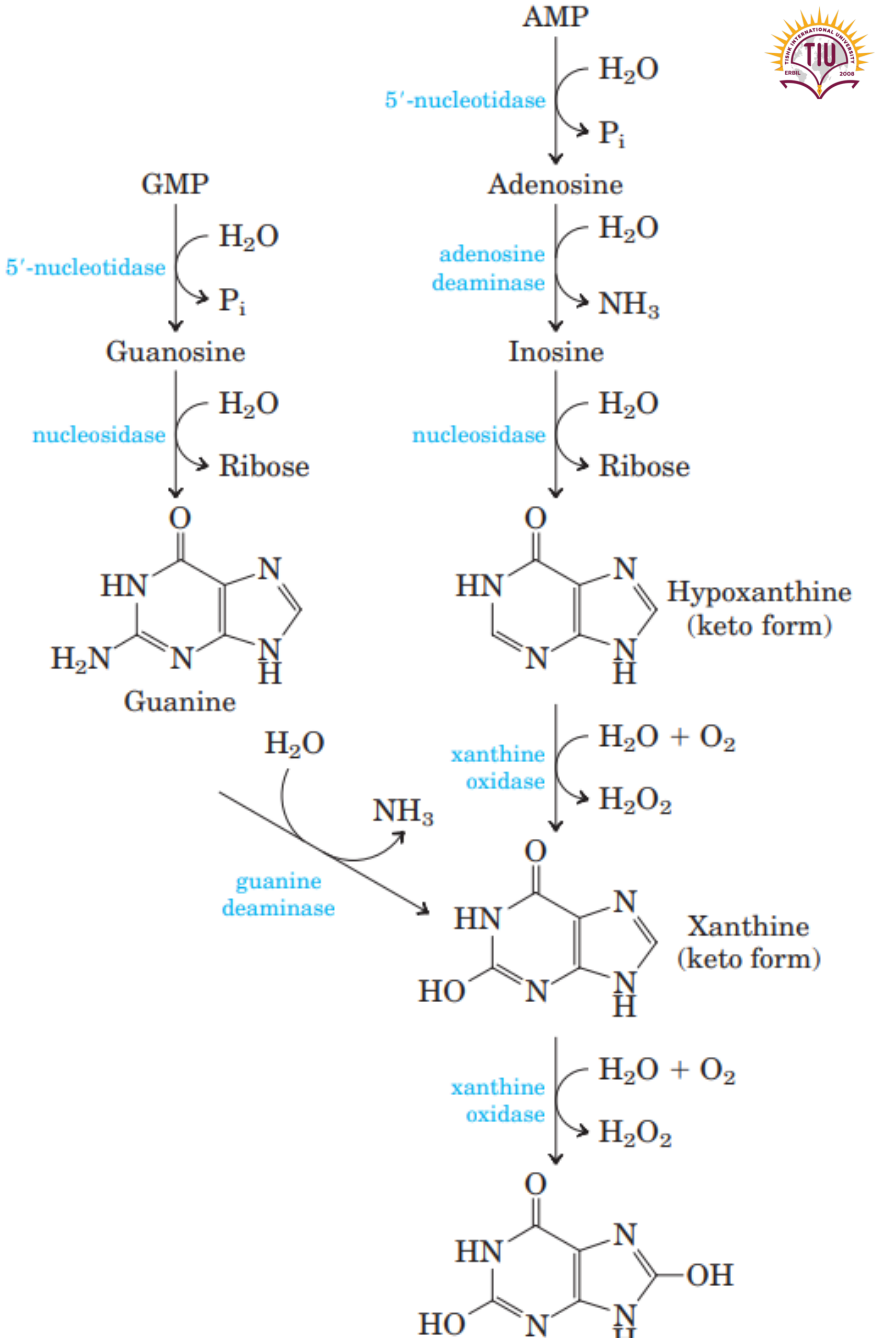


Biomedical importance nucleotides

- The main functions of nucleotides: Form the building blocks of nucleic acids.
- Act as co-substrates and coenzymes in biochemical reactions Involved in cell signaling pathways.
- Also act as intracellular second messengers.
- Provide chemical energy in the form of nucleoside triphosphates such as ATP.

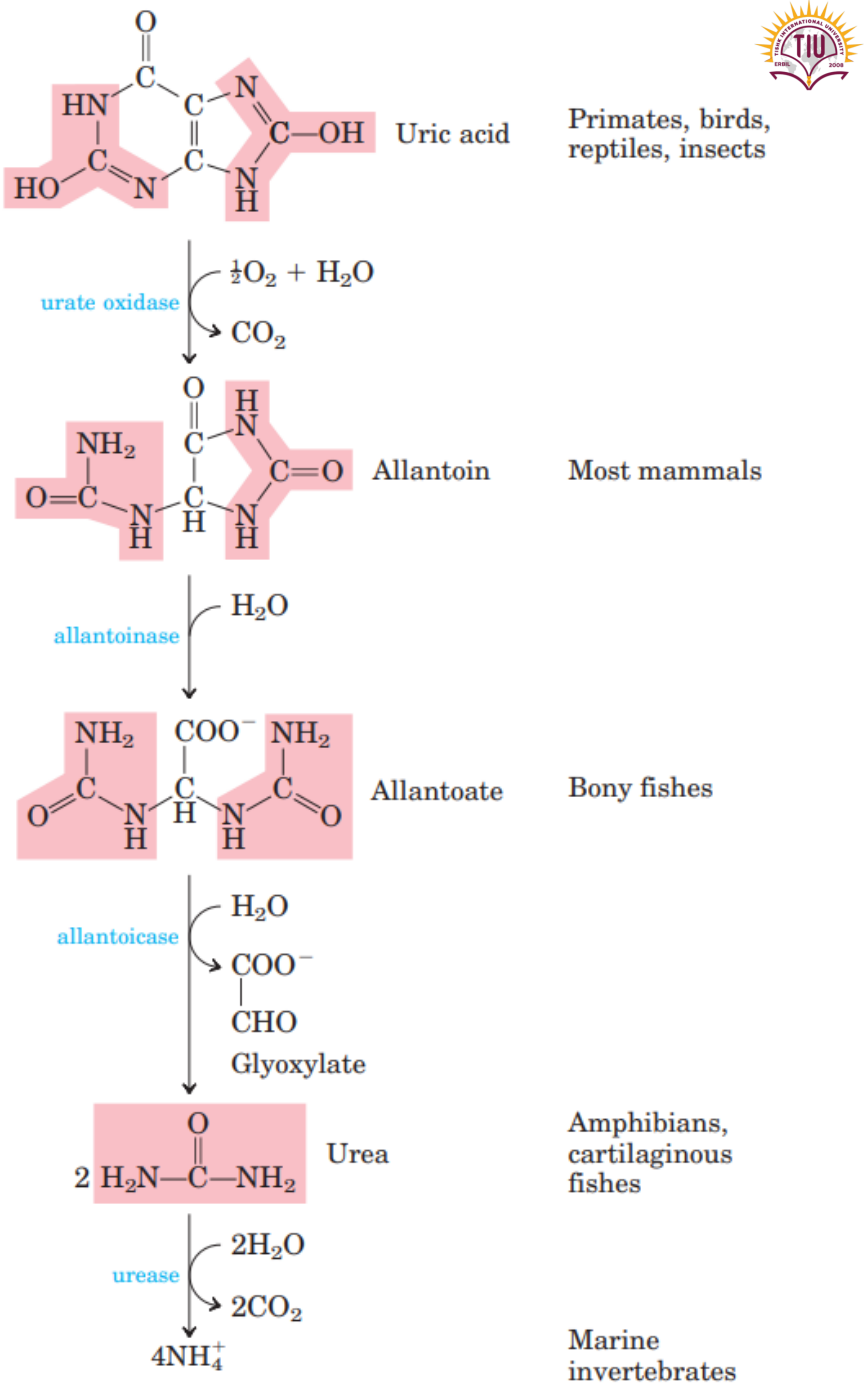
Purine's Degradation

- Purine nucleotides are degraded through a pathway in which they lose their phosphate by the action of **5-nucleotidase** to produce adenosine.
- Adenosine is deaminated to inosine by **adenosine deaminase**, and inosine is hydrolyzed to hypoxanthine (its purine base) and D-ribose by **nucleosidase**.
- Hypoxanthine is further oxidized to xanthine and then uric acid by xanthine oxidase.
- Molecular oxygen is the electron acceptor in this complex reaction.



Excretion of purine products

- Uric acid is the excreted product of purine catabolism in primates, birds, and some other animals.
- A healthy adult human excretes uric acid at a rate of about 0.6 g/24 h.
- The excreted product arises in part from ingested purines and in part from the turnover of the purine nucleotides.
- In most mammals and many other vertebrates, uric acid is further degraded to allantoin by the action of urate oxidase.
- In other organisms the pathway is further extended to urea and ammonium.



Summary

- **Nitrogenous Bases: Purines**; A and G. **Pyrimidines**: T, U, and C. **Minor Bases**; Hypoxanthine and Xanthine.

- These bases combine with sugars and phosphate groups to form **nucleotides** and **nucleosides**: (**Nucleoside**: Base + Sugar) and **Nucleotide**: (Base + Sugar + Phosphate group).

- **Biomedical Importance of Nucleotides: Building blocks of nucleic acids** (DNA & RNA), **Co-substrates and coenzymes** in biochemical reactions, **Involvement in cell signaling pathways** as intracellular messengers, **Energy carriers** e.g., ATP.

Cont.

- **Purine degradation pathway involved the following enzymes:** 5′-nucleotidase removes phosphate groups to form adenosine, Adenosine deaminase converts adenosine to inosine, Nucleosidase hydrolyzes inosine to hypoxanthine, Xanthine oxidase oxidizes hypoxanthine to xanthine and subsequently to uric acid, and the molecular oxygen serves as the electron acceptor during oxidation.

- Excretion of purine products: humans and primates (uric acid). is the final excretion product of purine metabolism.

- A healthy adult excretes around 0.6 g of uric acid per day, derived from both dietary purines and nucleotide turnover.

Class activities

- DNA and RNA are both composed of purine and pyrimidine bases. **True**
- A nucleoside consists of a nitrogenous base, a sugar, and a phosphate group. **False**
- ATP is a nucleoside triphosphate that provides energy for cellular processes. **True**
- Purine metab. results in the production of uric acid as the final excretory product in humans. **True**
- Hypoxanthine is a pyrimidine base involved in nucleic acid structure. **False**
- Adenosine deaminase converts adenosine to inosine during purine degradation. **True**
- In humans, uric acid is further broken down into allantoin by urate oxidase. **False**
- Purines include A and G, while pyrimidines include C, T, and U. **True**
- The sugar in DNA nucleotides is ribose. **False**
- Molecular oxygen acts as an electron acceptor in the conversion of hypoxanthine to uric acid. **True**
- Nucleotides function as intracellular second messengers in cell signaling pathways. **True**
- A healthy adult human excretes approximately 0.6 g of uric acid per day. **True**

NUCLEIC ACID METABOLISM AND RELATED DISORDERS II


Questions
Comments
Feedback

References

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- Barile, F.A., 2010. Clinical Toxicology. *Principles and Mechanisms. New York, Informa Healthcare*, *467*.

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