Biochemistry

-PASSION BATCH-

Lec no: 1

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وَقُل رَّبِّ زِدْنِي عِلْمًا

Outline of biochemistry course

Topic	Likely number of lectures
Enzymes	5
Bioenergetics	1
Electron transport chain	1
Protein metabolism	4
Introduction to metabolism	With first CHO lecture
Carbohydrate metabolism	5
Lipid metabolism	3
Integration of metabolism	1-2

Aim: understand key (simplified) principles (important clinical correlations)

Topic	Lecture outline
Introduction	1. What is biochemistry? 2. Outlines of biochemistry application in medicine

What is biochemistry?

Answers "How?"

Update Slide 11

→ Biochemistry explains the chemistry (chemical processes) that occur inside the living organisms (cells)

→ Biochemistry fills the gap between Chemistry & Biology

- **Biochemistry:** science of the chemical basis of life (Gk bios "life")
- It forms a bridge between biology and chemistry
- The cell is the structural unit of living systems
  - → biochemistry can also be described as the science of the chemical constituents of living cells & reactions and processes they undergo
- By this definition, biochemistry encompasses large areas of:
  - cell biology
  - molecular biology
  - molecular genetics

الدكتورة ماركزت على التفاصيل ،
highlight نعرف بس الأشياء إلي عليها

Biochemistry applications in medicine

- The biochemistry of the nucleic acids lies at the heart of **genetics**;
- The use of **genetic** approaches has been critical for elucidating many areas of biochemistry
- **Physiology**, the study of body function, overlaps with biochemistry almost completely
- **Immunology** employs numerous biochemical techniques, and many immunologic approaches have found wide use by biochemists

Biochemistry applications in medicine

- **Pharmacology** rest on a sound knowledge of biochemistry & physiology;
  - most drugs are metabolized by enzyme-catalyzed reactions
- Poisons act on biochemical reactions or processes; this is **toxicology**
- Biochemical approaches are being used increasingly to study basic aspects of **pathology** (the study of disease), such as inflammation, cell injury, and cancer
- Many workers in **microbiology**, **zoology**, and **botany** employ biochemical approaches almost exclusively

Enzymes I	1.Understanding enzymes a catalyst 2.The catalytic cycle 3. How enzymes accelerate cellular reactions? 4. The basis of enzyme classifications 5. Exploring the factors affecting the rate of enzymic reaction

Enzymes

Biochemical reactions ال جميع

الجسم بحاجة إلى

With enzymes ← Protein Synthesis → Without enzymes *

With enzymes ↓ seconds

Without enzymes ↓ millions of years

- **Definition:** Enzymes are specific biocatalysts [mainly proteins in nature] that regulate (accelerate) the rate of biochemical reactions

↳ A question worth considering:

If enzymes are proteins that are required for protein synthesis, then what came first (protein OR enzymes)?

- Proteins can be hydrolyzed with hydrochloric acid by boiling for a very long time; but inside the body, with the help of enzymes, proteolysis takes place within a short time at body temperature

- **Enzyme catalysis is very rapid;** usually 1 molecule of an enzyme can act upon about 1000 molecules of the substrate per minute

A single enzyme is capable of accelerating thousands of biochemical processes.

- Lack of enzymes will lead to block in metabolic pathways → **inborn errors of metabolism**

example :

إنزيم الـ lactase (المسؤول عن تكسير الـ lactose)

في حال عدم توافره في الجسم

مشاكل في الـ metabolism

Why?

كان أي عملية في الجسم تحتاج لـ enzyme ، عدم توافر lactase ← تراكم الـ lactose ← مشاكل في الهضم

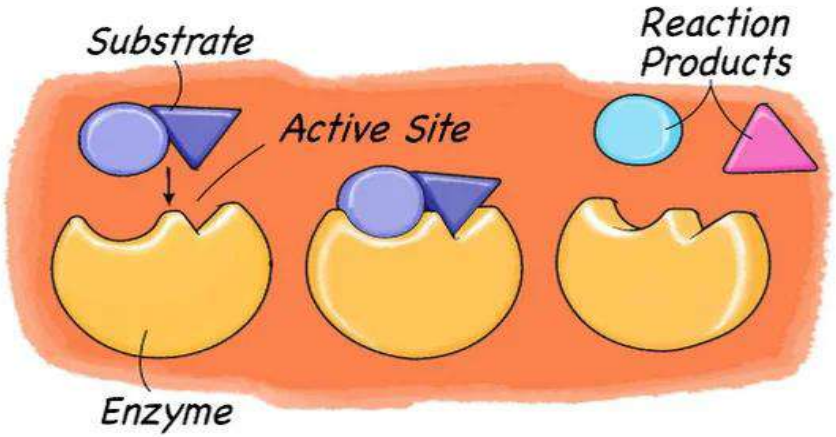
Enzymes

- The substance upon which an enzyme acts, is called the **substrate**

  Substrates are also called <u>reactants</u> because they are the molecules undergoing the reaction

Substrate = reactant

- The enzyme will convert the substrate into the product or **products**



Nomenclature of enzymes

- Most commonly used enzyme names have the suffix "-ase" attached to the substrate of the reaction (e.g. glucosidase, urease, sucrase)

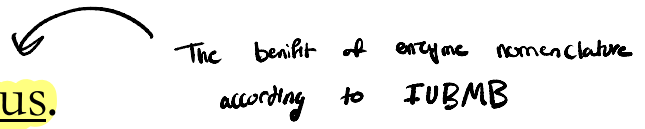
or

- A description of the action performed (e.g. lactate dehydrogenase and adenylyl cyclase)

- Some enzymes retain their original trivial names, which give no hint of the associated enzymatic reaction, e.g. trypsin and pepsin

The basis of enzyme classifications

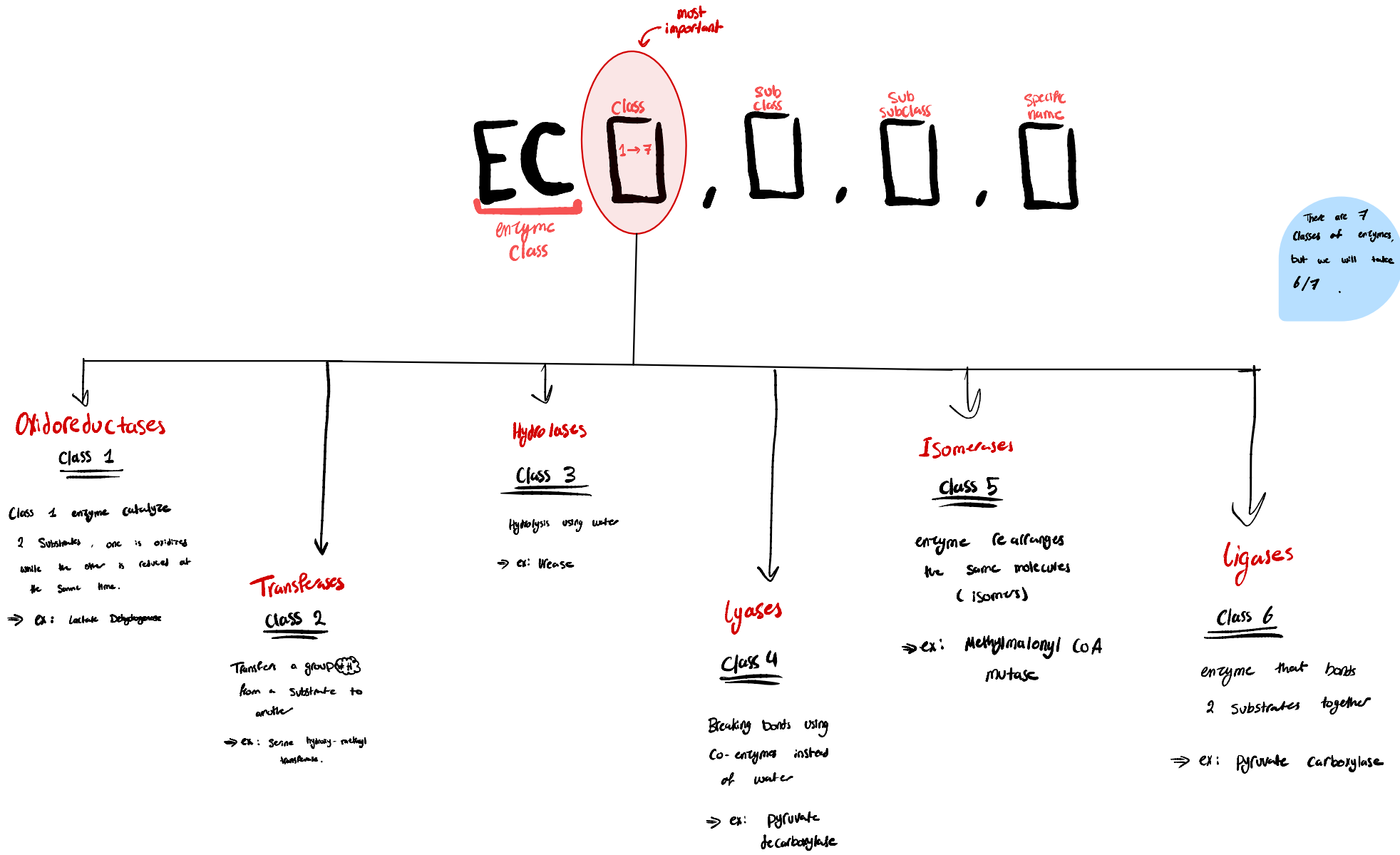
- International Union of Biochemistry and Molecular Biology (IUBMB) developed a system of nomenclature for enzymes
- It is complex and cumbersome; but unambiguous.



- The name starts with EC (enzyme class) followed by 4 digits:
  - **First digit represents the class (6 classes)**
  - Second digit stands for the subclass
  - Third digit is the sub-subclass or subgroup
  - Fourth digit gives the number of the particular enzyme in the list

https://www.enzyme-database.org/class.php

Enzyme nomenclature according to IUBMB

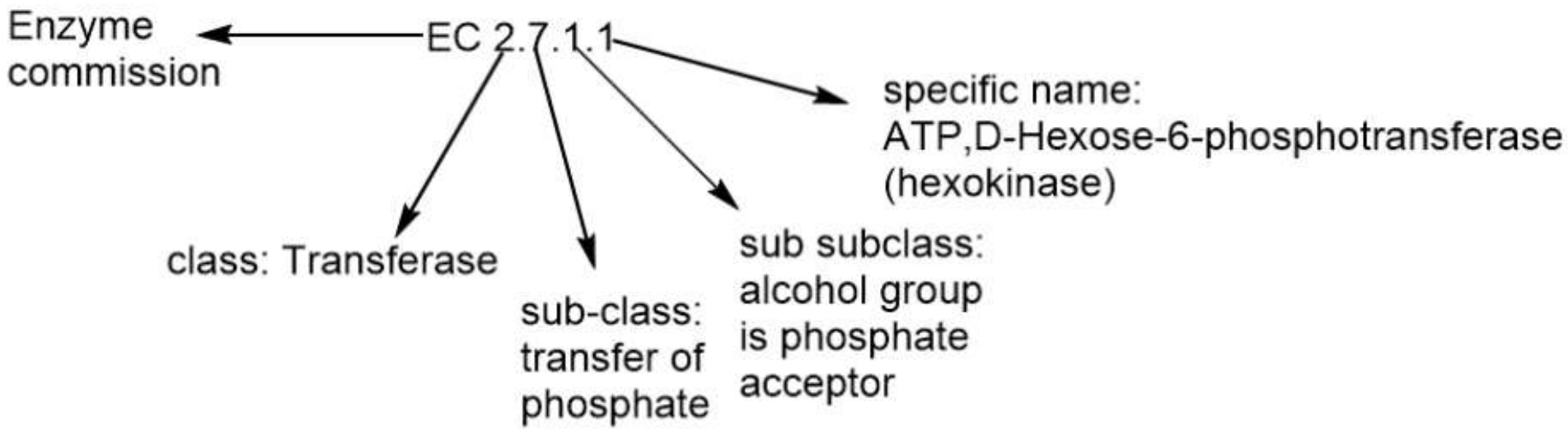


Note :

Names

Structure

صح نكون متذكرين ال Amino acids من ناحية

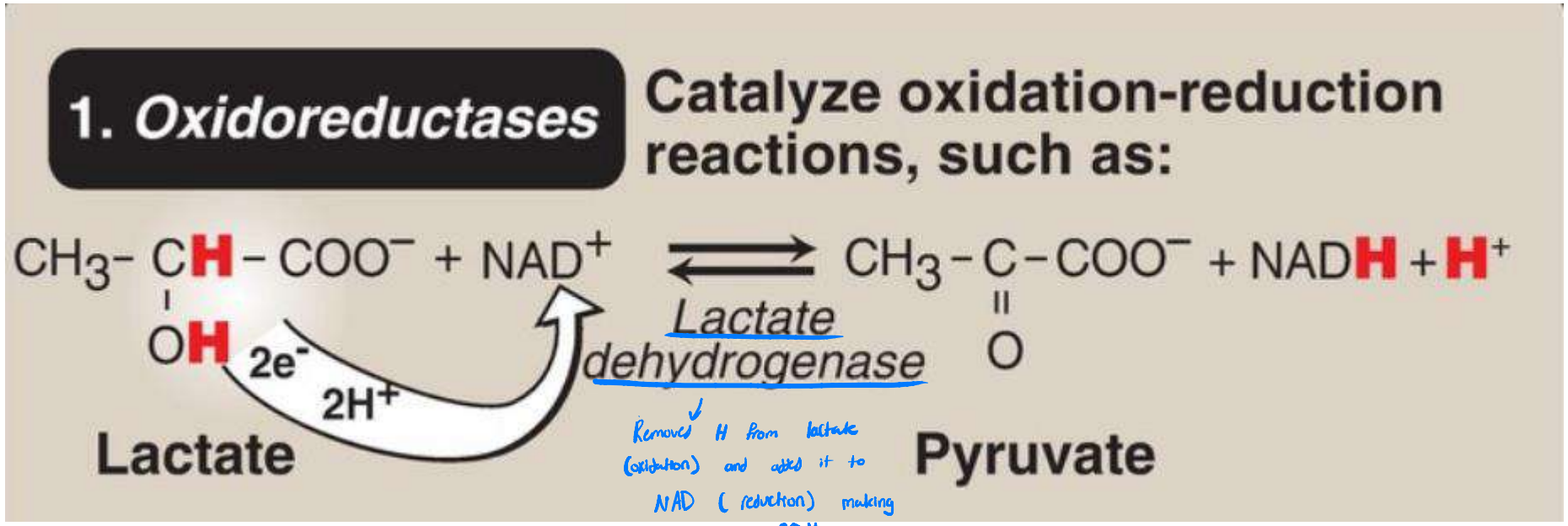

Enzyme commission
EC 2.7.1.1
class: Transferase
sub-class: transfer of phosphate
sub subclass: alcohol group is phosphate acceptor
specific name: ATP,D-Hexose-6-phosphotransferase (hexokinase)

The 6 classes are important for the exam

Class 1: Oxidoreductases

ex : lactate dehydrogenase

- This group of enzymes will catalyze oxidation of one substrate with simultaneous reduction of another substrate or co-enzyme
  - AH2 + B → A + BH2

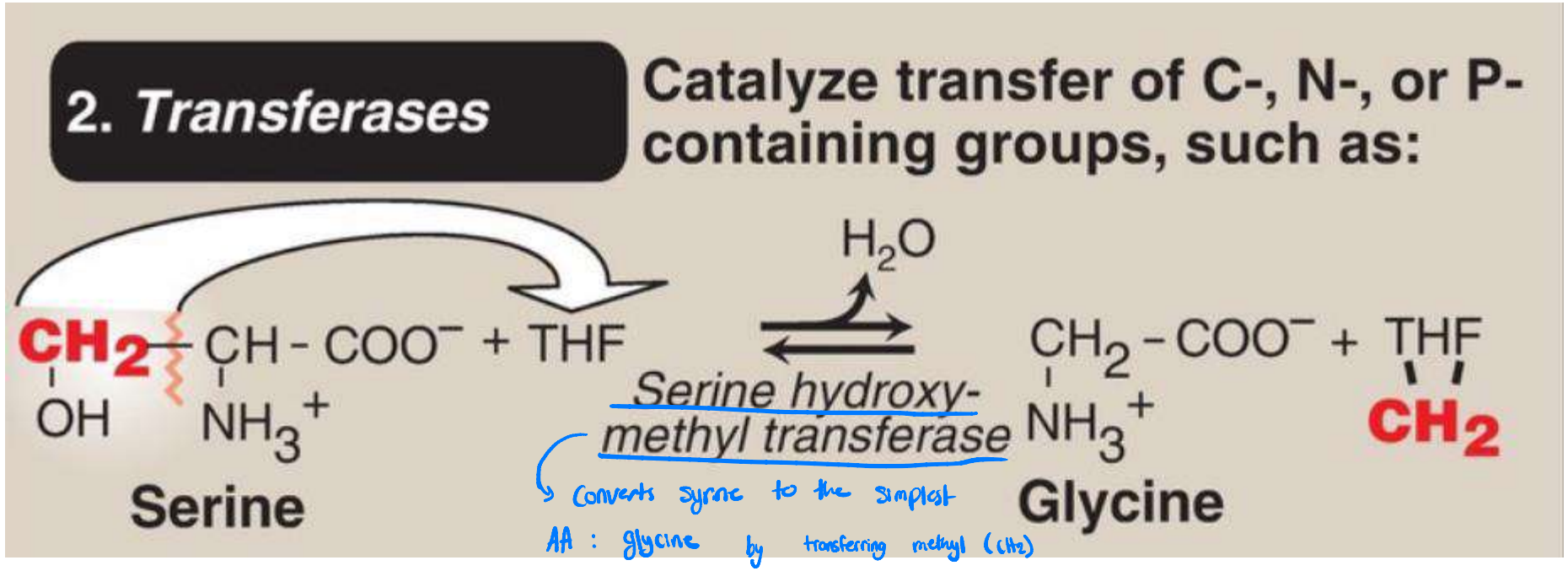


Class 2: Transferases (transfers a group from one substrate to another)

The group must NOT be hydrogen.

ex: serine - hydroxy-methyl transferase

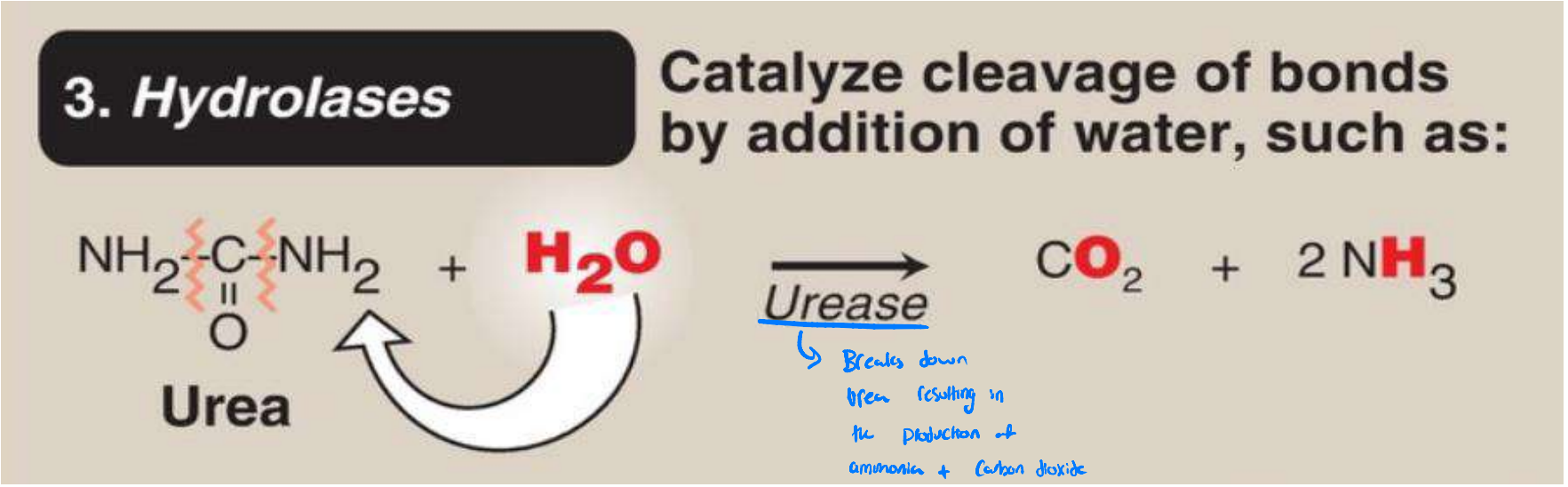
- This class of enzymes transfers one group (other than hydrogen) from the substrate to another substrate
  - This may be represented as:
    - A-R + B → A + B-R



Class 3: Hydrolases

water breaking bonds = Breaks bonds using H_2O

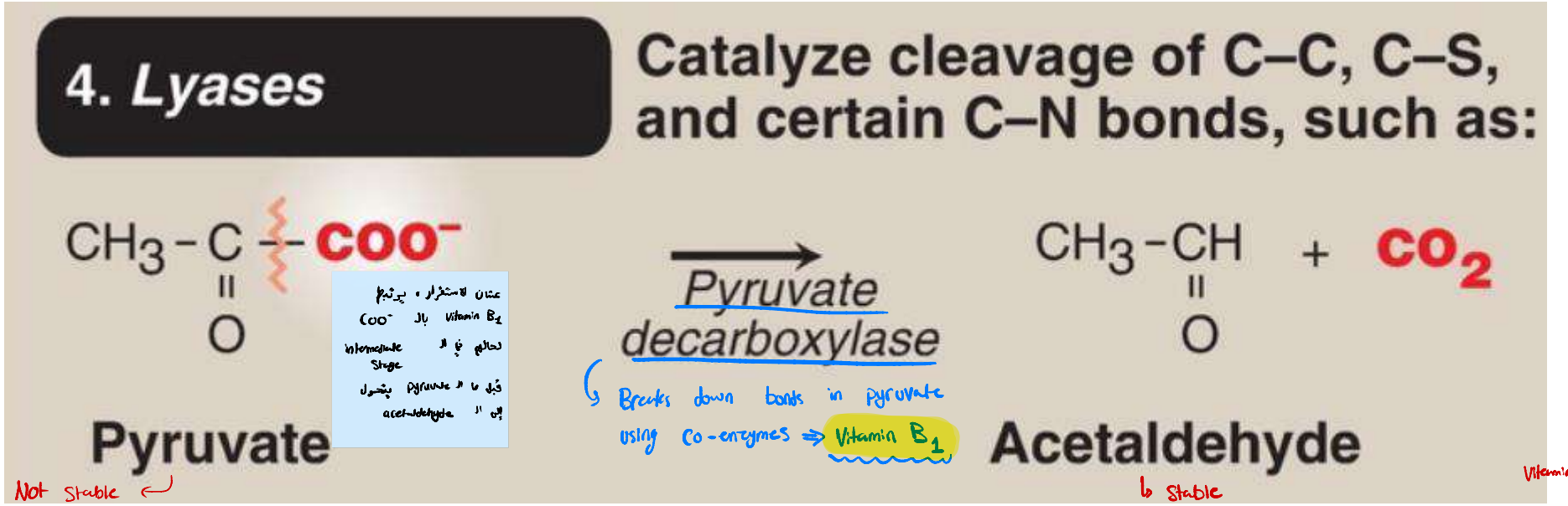
- This class of enzymes can hydrolyze ester, peptide or glycosidic bonds by adding water and then breaking the bond
- All digestive enzymes are hydrolases
- $A–B + H_2O \rightarrow A–OH + B–H$



Class 4: Lyases = Breaking down bonds using methods other than H_2O

- These enzymes can remove groups from substrates or break bonds by mechanisms other than hydrolysis
- ATP → cAMP + PPi

Lyases use Co-enzymes
ex : Vitamin B



Remember :
Histidine decarboxylase
Co-enzyme uses ⇒ V.B_6

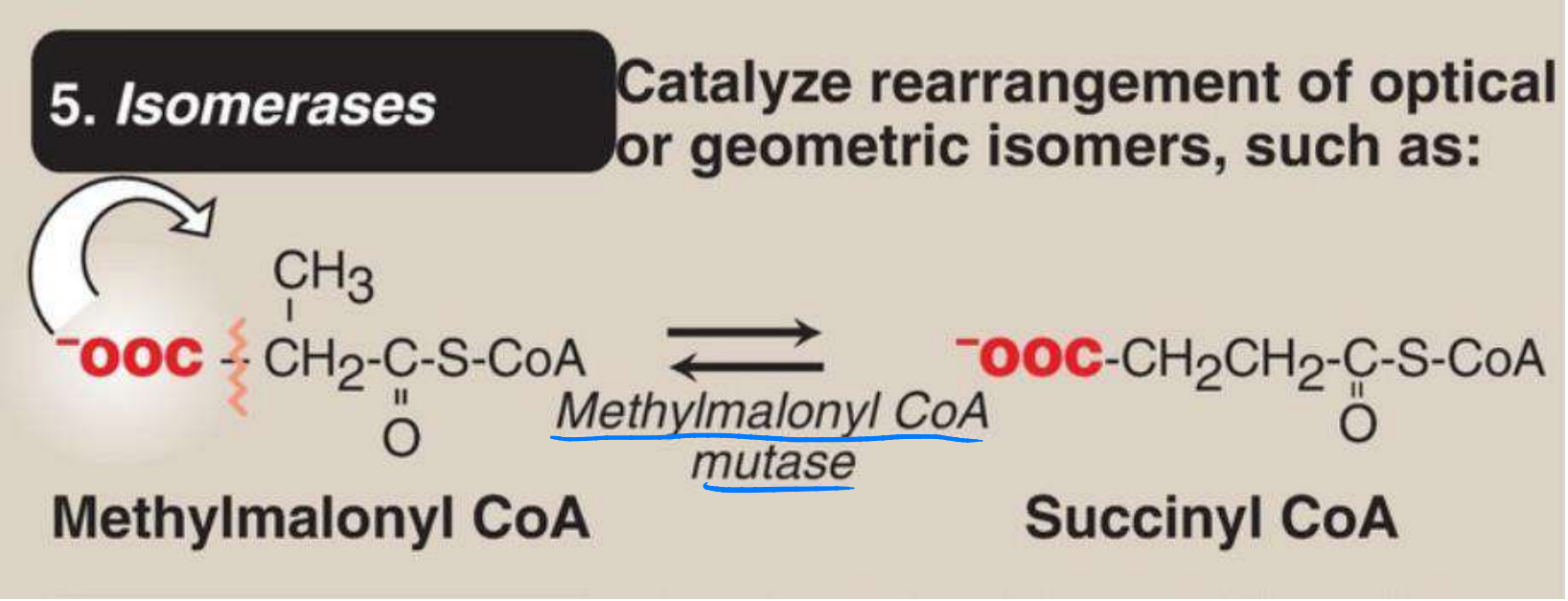
* Vitamin B هو نوع أي نعرف ما
enzyme لكل .

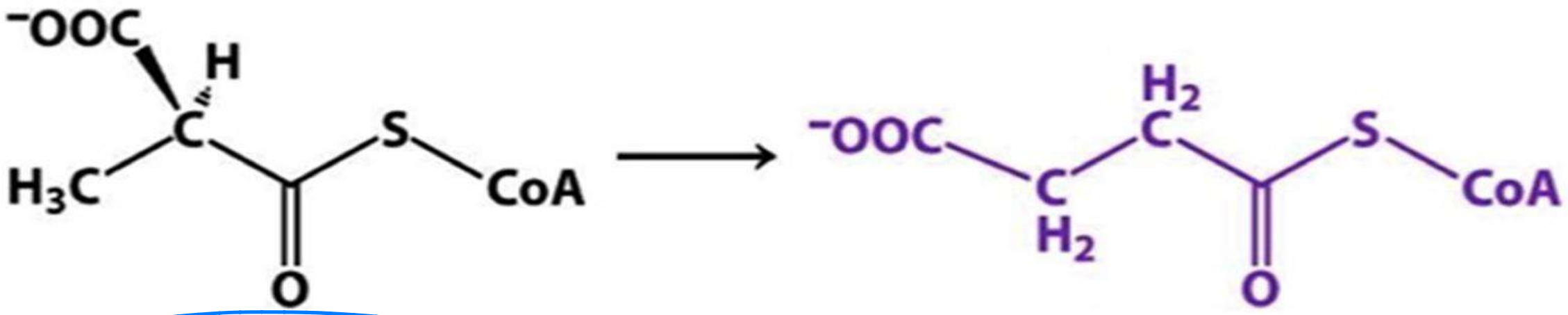
EC 1 [+] **Oxidoreductases**
EC 2 [+] **Transferases**
EC 3 [+] **Hydrolases**
EC 4 [–] **Lyases**
EC 4.1 [–] Carbon-carbon lyases
EC 4.1.1 [–] Carboxy-lyases

- EC 4.1.1.1 pyruvate decarboxylase
- EC 4.1.1.2 oxalate decarboxylase
- EC 4.1.1.3 oxaloacetate decarboxylase. Now recognized to be two enzymes EC 7.2.4.2 [oxaloacetate decarboxylase (Na^+ extruding)] and EC 4.1.1.112 (oxaloacetate decarboxylase).
- EC 4.1.1.4 acetoacetate decarboxylase
- EC 4.1.1.5 acetolactate decarboxylase
- EC 4.1.1.6 *cis*-aconitate decarboxylase
- EC 4.1.1.7 benzoylformate decarboxylase
- EC 4.1.1.8 oxalyl-CoA decarboxylase
- EC 4.1.1.9 malonyl-CoA decarboxylase
- EC 4.1.1.10 aminomalonate decarboxylase. Now included with EC 4.1.1.12, aspartate 4-decarboxylase
- EC 4.1.1.11 aspartate 1-decarboxylase
- EC 4.1.1.12 aspartate 4-decarboxylase
- EC 4.1.1.13 carbamoylaspartate decarboxylase
- EC 4.1.1.14 valine decarboxylase
- EC 4.1.1.15 glutamate decarboxylase
- EC 4.1.1.16 hydroxyglutamate decarboxylase
- EC 4.1.1.17 ornithine decarboxylase
- EC 4.1.1.18 lysine decarboxylase
- EC 4.1.1.19 arginine decarboxylase
- EC 4.1.1.20 diaminopimelate decarboxylase
- EC 4.1.1.21 phosphoribosylaminoimidazole carboxylase
- EC 4.1.1.22 histidine decarboxylase
- EC 4.1.1.23 orotidine-5'-phosphate decarboxylase
- EC 4.1.1.24 aminobenzoate decarboxylase
- EC 4.1.1.25 tyrosine decarboxylase
- EC 4.1.1.26 DOPA decarboxylase. Now included with EC 4.1.1.28 aromatic-L-amino-acid decarboxylase
- EC 4.1.1.27 tryptophan decarboxylase. Now included with EC 4.1.1.28 aromatic-L-amino-acid decarboxylase
- EC 4.1.1.28 aromatic-L-amino-acid decarboxylase
- EC 4.1.1.29 sulfinoalanine decarboxylase
- EC 4.1.1.30 pantothenoylcysteine decarboxylase
- EC 4.1.1.31 phospho*enol*pyruvate carboxylase
- EC 4.1.1.32 phospho*enol*pyruvate carboxykinase (GTP)

Class 5: Isomerases = enzyme that rearranges the same molecules to produce isomers

- These enzymes can produce isomers of substrates
- Racemases, epimerases, cis-trans isomerases are examples
- A–B → B–A





Methylmalonyl CoA → **Succinyl CoA**

كم isomers عندهم (4 hydrogens) شكلهم لكون واضح ليس بالصورة راح قبل الترتيب ممكن خربطنا

Class 6: Ligases = an enzyme that Bonds 2 things together using ATP

- These enzymes link two substrates together, usually with the simultaneous hydrolysis of ATP (Latin, Ligare = to bind)
- A-OH + B-H → A–B + H_2O