Enzymes
The classification and nomenclature. Lyases and Transferases

The plan of lecture

- 1) The classification and nomenclature of enzymes
- 2) Transferases, representatives – structure and catalytic role
- 3) Lyases, representatives – structure and catalytic role

The classification of and nomenclature of enzymes

I. **Oxireductases (OR)** catalyze oxidative-reductive reactions (ORR);

II. **Transferases** catalyze the transfer of atoms groups from one substrate to another

III. Hydrolases catalyze the cleavage of complex substances to simple ones with participation of water (this process is called as hydrolysis)

IV. Lyases catalyze the reactions of cleavage without water or promote the addition of atoms groups in the site of double or triple bonds

V. Isomerases catalyze the isomerizm
ведут реакции изомеризации;

VI. Lygases, or synthetases catalyze the synthesis of some substances

The nomenclature of enzymes

Each class is divided into subclasses (from 4-13), subclass is divided into subsubclasses, each subsubclass contains a representative

Therefore the cipher of each enzyme consists of 4 numbers: first one shows the number of class; second one indicates number of subclass, third one represents the number of subsubclass, fourth one shows the place of a representative in subsubclass

For instance, the cipher for pancreatic lipase is 3.1.1.3., this is means that pancreatic lipase refers to hydrolases (3-rd class, that is catalyzes the hydrolysis)

To the 1-st subclass (esterase, that is catalyzes the hydrolysis of ester bonds), to the 1-st subsubclass (that is catalyzes the hydrolysis of ester bonds formed by carboxylic acids), the place in subsubclass is third one

General characteristic and classification of transferases

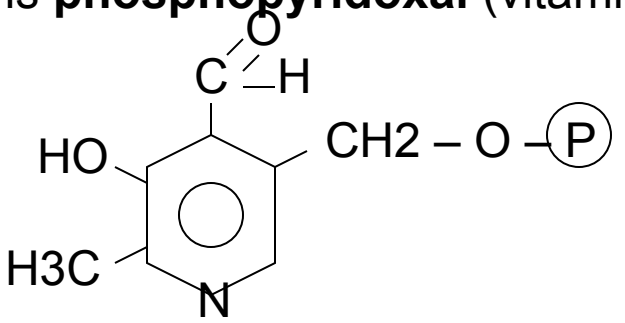
Transferases are enzymes which catalyze the reactions of transfer of groups of atoms from one substrate to another.

Almost all transferases are two-component enzymes. They are contained in the cells only.

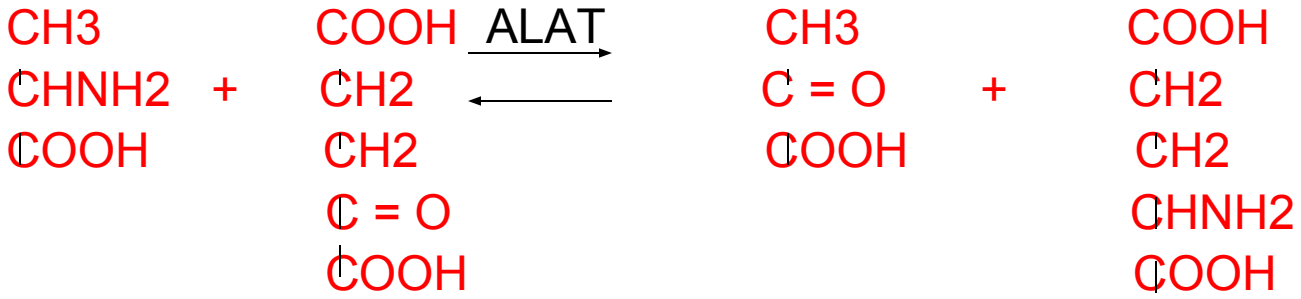
On the depend on character of transported groups there are some subclasses of transferases: amino-, methyl-, acyl- and phosphotransferases

The structure and catalytic role of aminotransferases

Coenzyme of aminotransferases is **phosphopyridoxal** (vitamin B6 + H3PO4)



Aminotransferases catalyze the reactions of transport of amino groups from amino acids to ketoacids that results in formation of non-essential amino acids (transamination)



ALA

α KG

Pyruvate

GLU

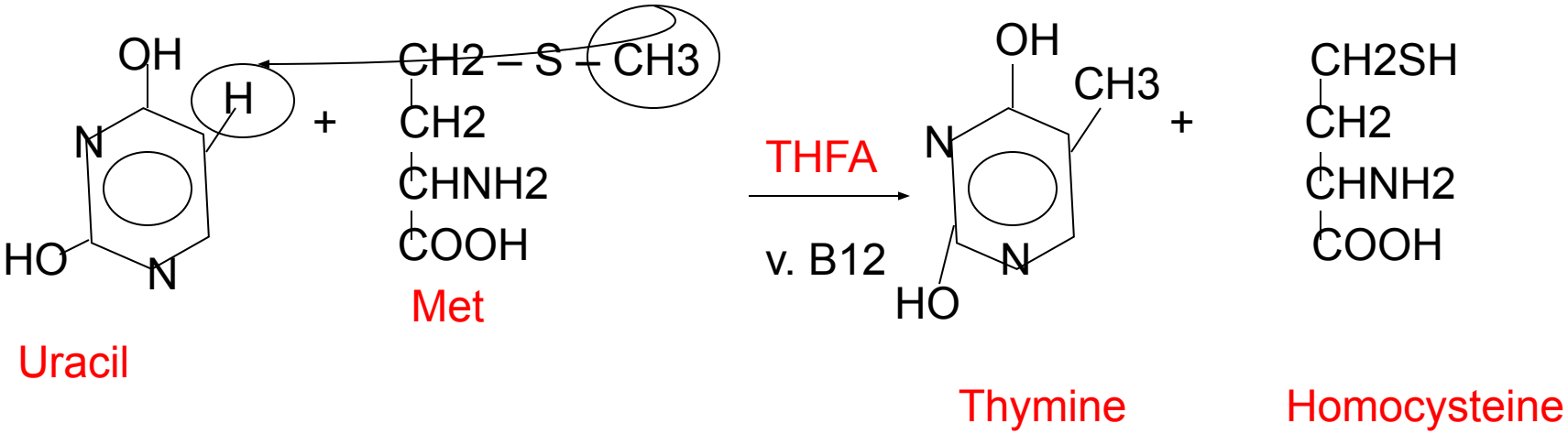
The importance of transamination

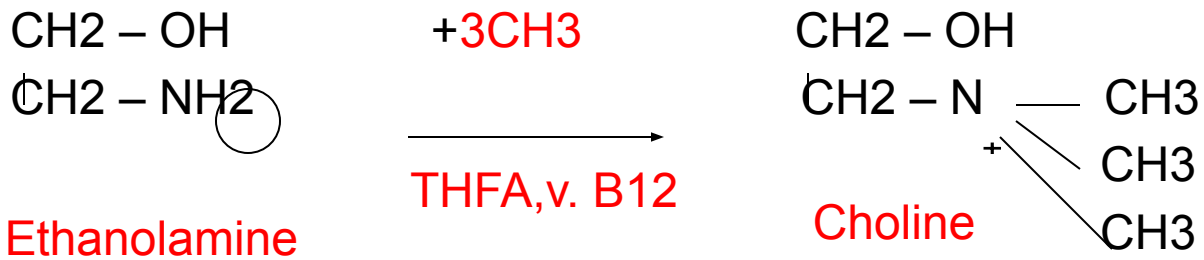
1) This is a pathway of synthesis of non-essential amino acids;
2) This is the way of integration of metabolism of carbohydrates and amino acids due to reversibility of transamination
3) This is initial state of amino acids catabolism
4) Aminotransferases are organospecific enzymes, e.g. alanine aminotransferase occurs mainly in liver; aspartate aminotransferase does in liver, myocardium, muscles. This has a diagnostic role, because in lesion of these organs and tissues the activity of these enzymes is increased in blood plasma. It is due to exit of them from corresponding cells into blood

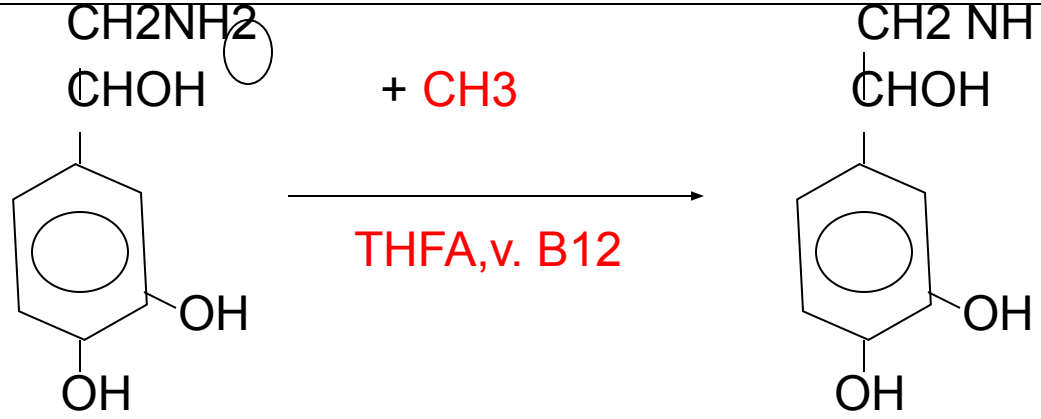
The structure and catalytic role of methyltransferases

Coenzyme is reduced form of **Folic Acid (vitamin Bc)** – tetrahydrofolic acid (THFA). It is reduced residue of **pteridine, para-aminobenzoic and glutamic acids.**

Methyltransferases catalyze the reactions of intermolecular transport of methyl- and other one-carbon groups (**methylation**). The source of methyl group is methionine (Met). In these reactions vitamin B12 is also necessary.


OH
H
N
HO
N
+
CH2 – S – CH3
CH2
CHNH2
COOH
Met
Uracil
THFA
v. B12
OH
CH3
N
HO
N
+
CH2SH
CH2
CHNH2
COOH
Thymine
Homocysteine

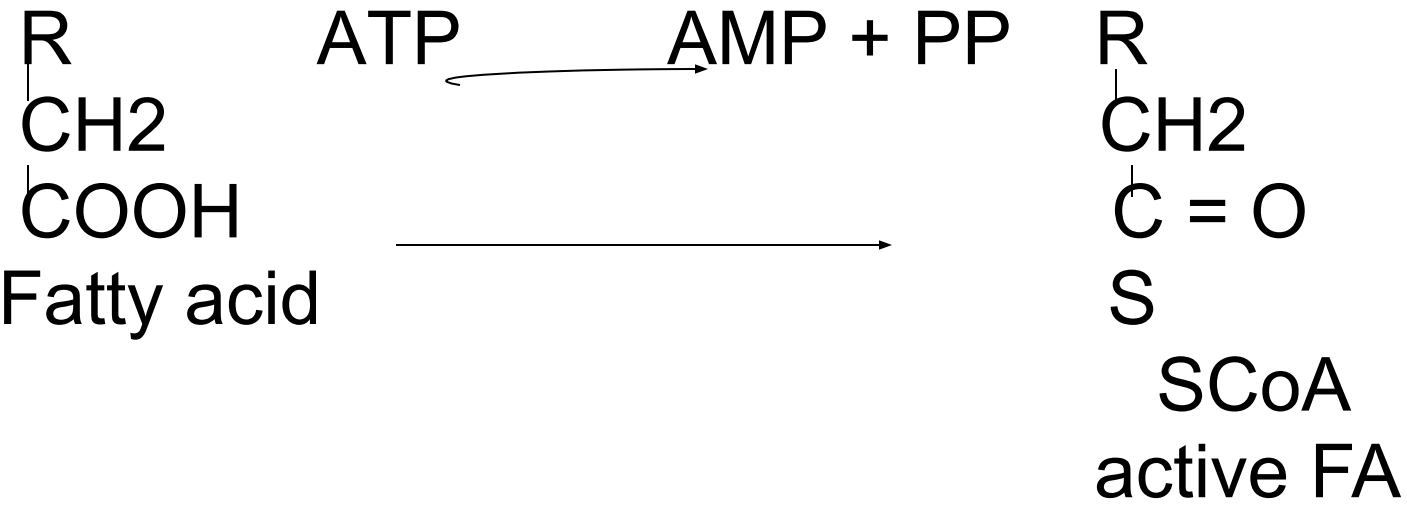

CH2 – OH
CH2 – NH2
+3CH3
THFA,v. B12
Ethanolamine
CH2 – OH
CH2 – N
+
CH3
CH3
CH3
Choline


CH2NH2
CHOH
+ CH3
OH
OH
THFA,v. B12
CH2 NH – CH3
CHOH
OH
OH
Noradrenalin
Adrenalin

The structure and catalytic role of acyltransferases

Coenzyme is HSCoA (**coenzyme of acylation**). It consists of **adenosine-3-monophosphate, 2 residues of phosphoric acid, pantothenic acid (vitamin B3) and thioethylamine**.

Acyltransferases catalyze the reactions of **transport of residues of carboxylic acids**, e.g. residues of acetic acid (hence, their name – acetyltransferases)



The structure and catalytic role of phosphotransferases

Phosphotransferases, or kinases are one-component enzymes, but consist of some subunits, i.e. these enzymes have quaternary structure.

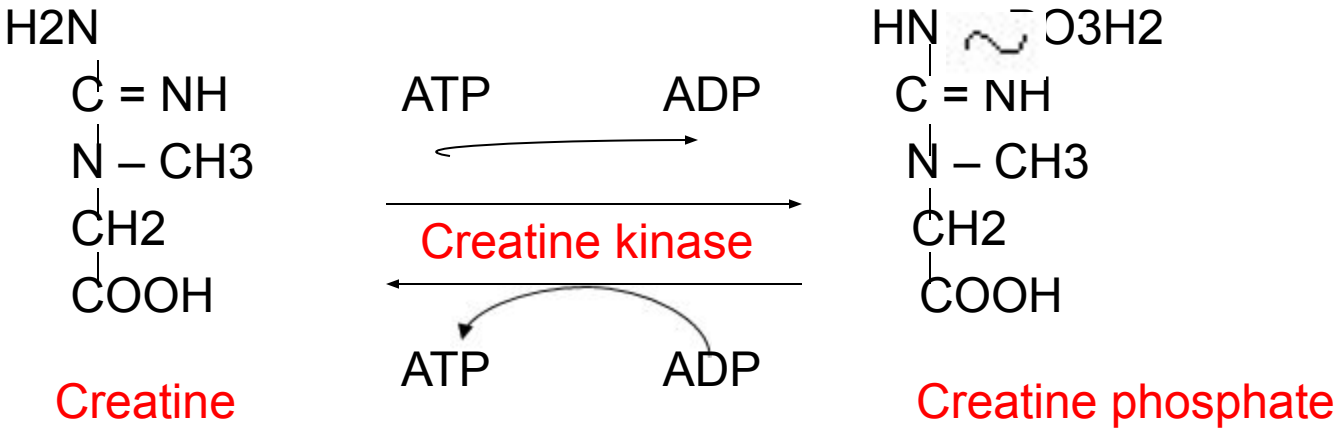
Phosphotransferases catalyze the reactions of transport of residues of phosphoric acid (**phosphorylation**).

When phosphoric acid is attached to substrate. The product becomes more active, therefore these enzymes are also named as **kinases**

The **sources of phosphoric acid** are:

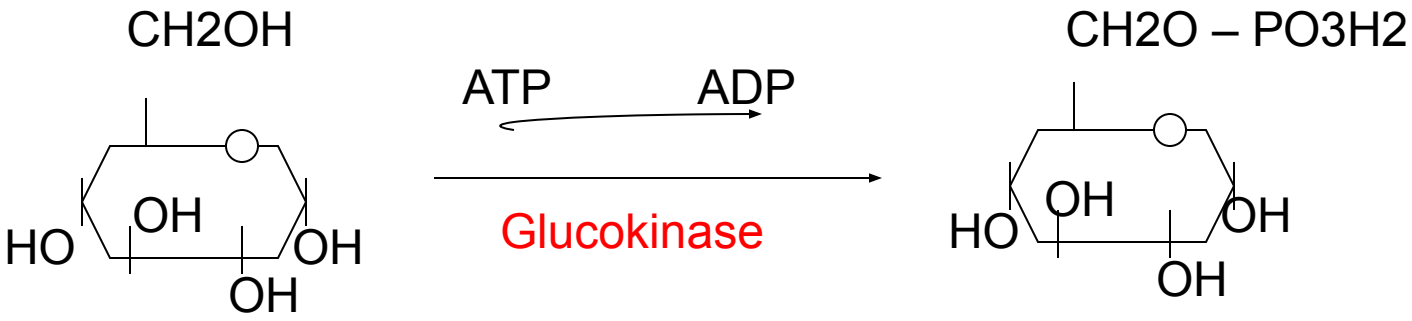
1) ATP;
2) High energetic phosphorus-containing substrates

ATP is more often source of phosphoric acid. The residue of phosphoric acid may be transported on substrate with conservation of macroergic bond (reversible phosphorylation) and without its (irreversible phosphorylation)



Creatine

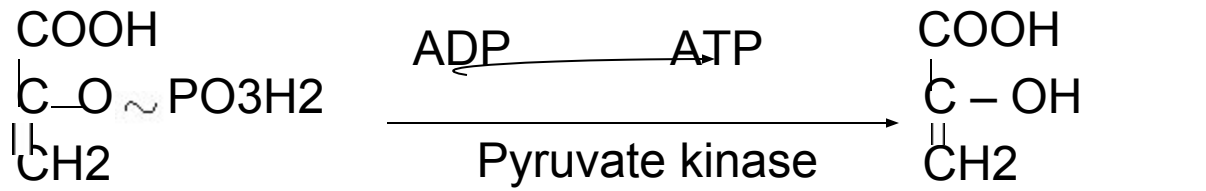
Creatine phosphate



Glucose

Glucose-6-phosphate

The source of phosphoric acid can be a ***phosphorus-containing high energetically substrate***. In this case the reaction will be named as ***substrate phosphorylation:***



Phosphoenolpyruvate

Enolpyruvate

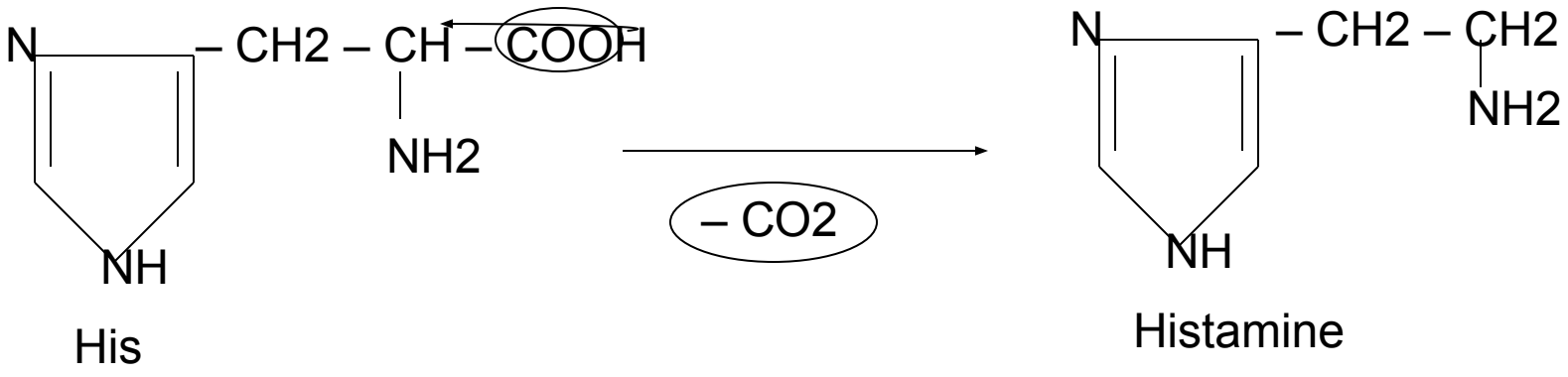
General characteristic and classification of Lyases

This class of enzymes includes enzymes which catalyze the reactions of cheeping off (**removal**) of some groups of atoms (CO2, NH2, etc) or addition of them to the place of multiple bonds. Accordingly to removed groups they're named (**decarboxylases**, deaminases, etc)

Subclass of decarboxylases includes two subsubclasses – decarboxylases of amino- and keto acids

The structure and catalytic role of decarboxylases of amino acids

Coenzyme of these enzymes is ***phosphopyridoxal*** (vitamin B6+H3PO4)

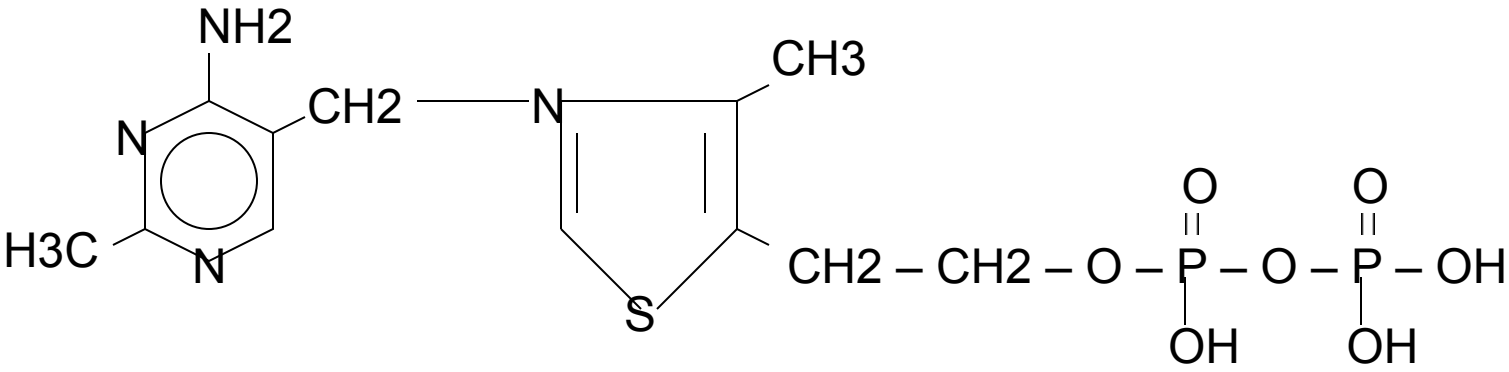


His

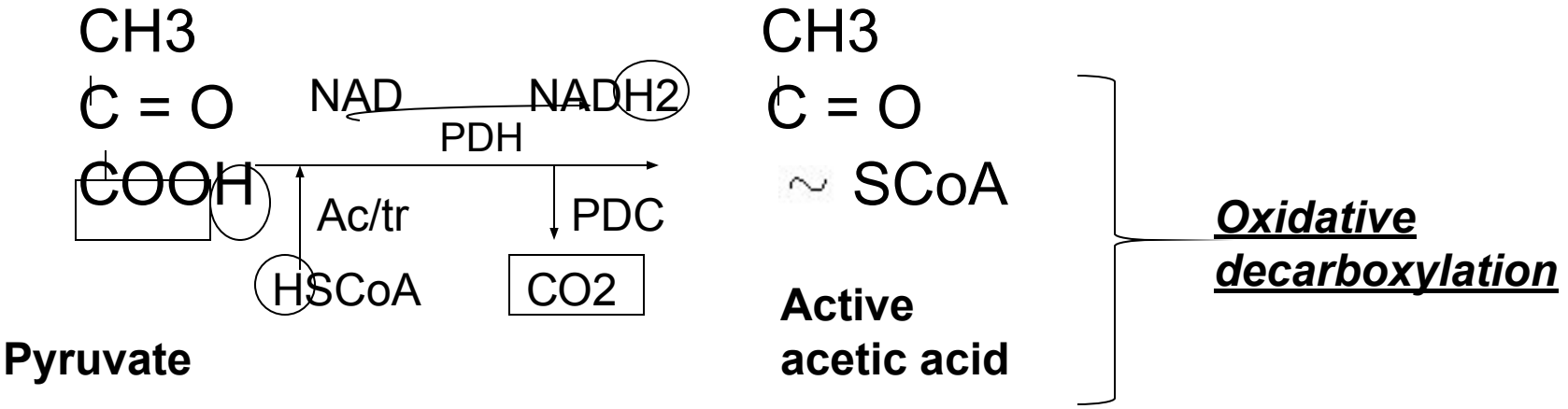
Histamine

The structure and catalytic role of decarboxylases of ketoacids

These are two-component enzymes. Coenzyme is thiamindiphosphate (vitamin B1 + 2H3PO4)



Pyruvate decarboxylase catalyzes the decarboxylation of pyruvate, which results in formation of active acetic acid



The structure and catalytic role of Carbonic anhydrase

This is a two-component enzyme. Zinc is a constituent of coenzyme. The enzyme catalyzes the reaction of synthesis and cleavage of carbonic acid:

$H_2O + CO_2 \rightleftharpoons H_2CO_3$

The direction of reaction depends on concentration of CO_2, therefore this enzyme takes part in regulation of respiratory center