# COURSE MSc (BIOTECHNOLOGY) III SEM

## PAPER CODE: MBT-304

## PAPER TITLE: ENZYMOLOGY AND ENZYME TECHNOLOGY

# ENZYME REGULATION

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- Reversible Inhibition- Competitive, Non Competitive, Uncompetitive, Mixed, Substrate, Allosteric and Product Inhibition. Irreversible Inhibition- Suicide inhibition. Mechanism of enzyme action;
- Examples and Mechanism of various Inhibitions like Penicillin, Iodoacetamide and DIPF

# ENZYME REGULATION

## CONTROL OF ENZYMATIC ACTIVITY

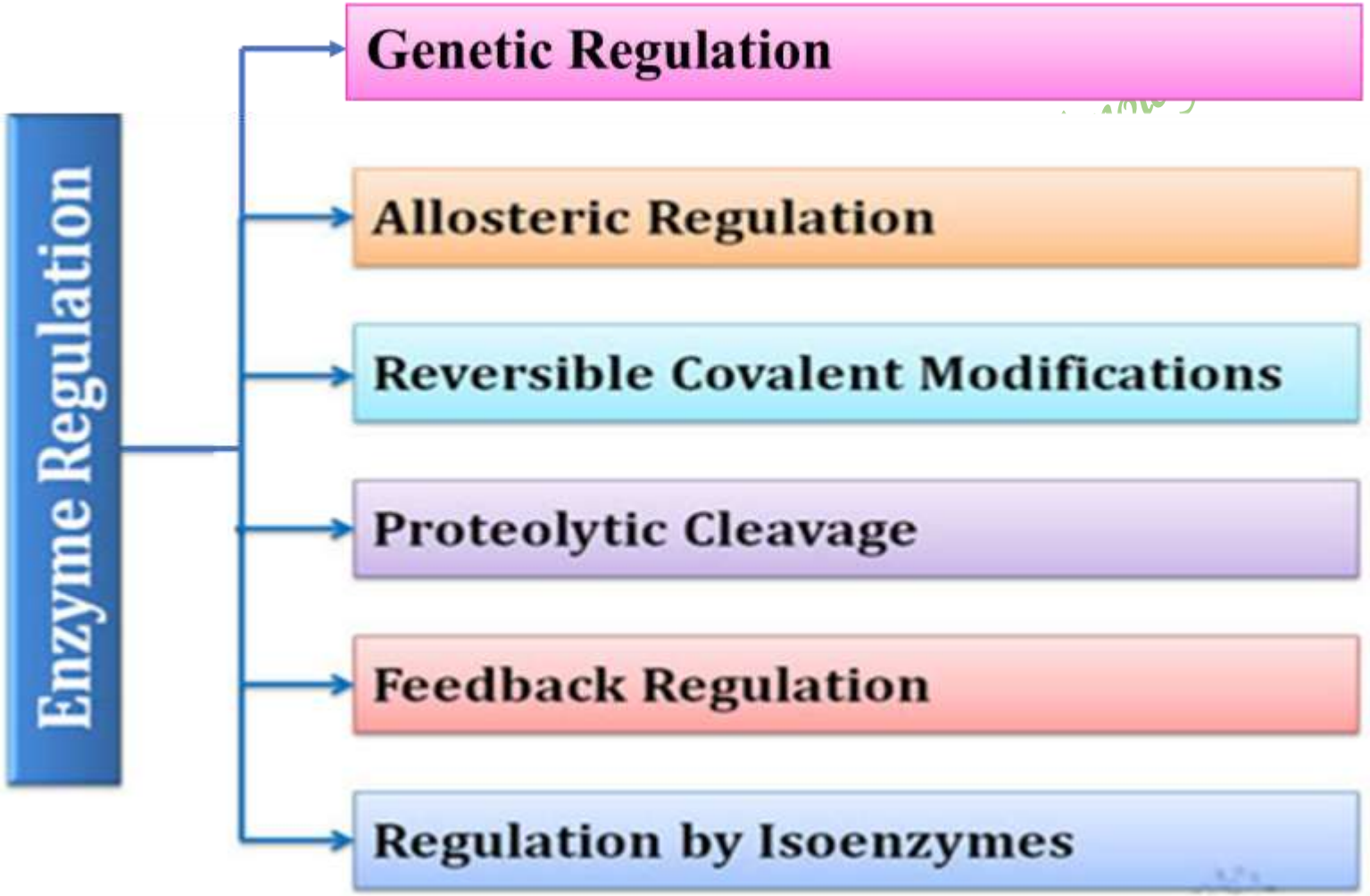
An organism must be able to control the catalytic activities of its component enzymes so that it can coordinate its numerous metabolic processes, respond to changes in its environment, and grow and differentiate, all in an orderly manner.

There are two ways that this may occur:

1. ***Control of enzyme availability:*** *The amount of a given enzyme in a cell depends on both its rate of synthesis and its rate of degradation.*

2. ***Control of enzyme activity:*** *An enzyme's catalytic activity may be directly controlled through conformational or structural alterations.*

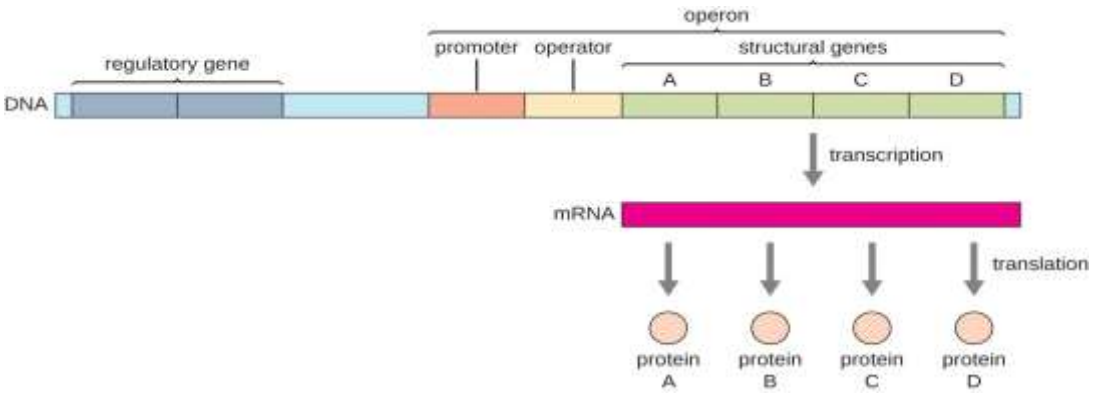
# ENZYME REGULATION



# ENZYME REGULATION

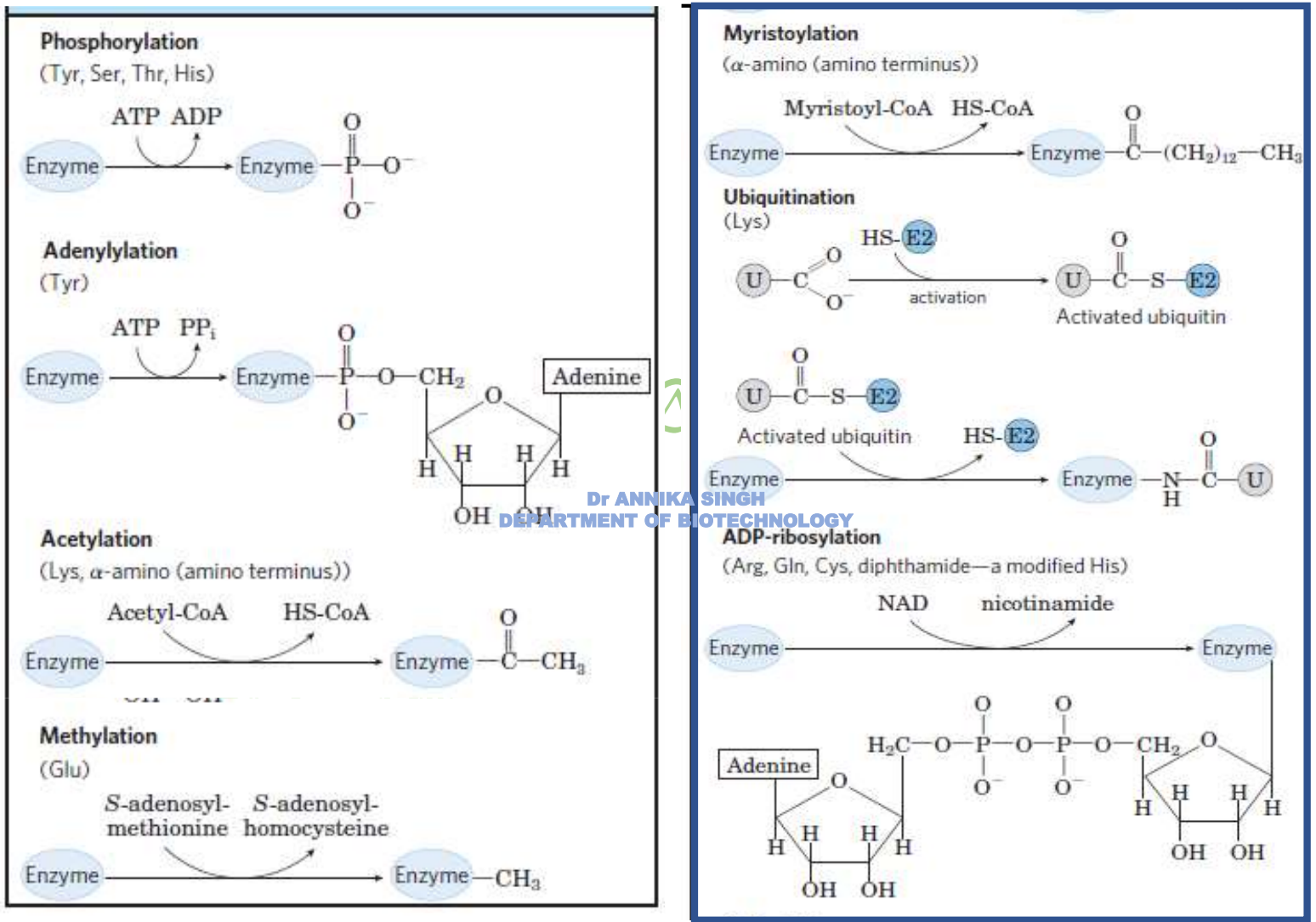
- **Genetic control**
- Genetic control of enzyme activity refers to controlling transcription of the mRNA needed for an enzyme's synthesis.
- In prokaryotic cells, this involves the induction, repression, or enhancement of enzyme synthesis by regulatory proteins (part of either an operon or a regulon) that can bind to DNA and either induce, block, or enhance the function of RNA polymerase , the enzyme required for transcription.
- An operon is a set of genes transcribed as a polycistronic message that is collectively controlled by a regulatory protein.
- A regulon is a set of related genes controlled by the same regulatory protein but transcribed as monocistronic units.





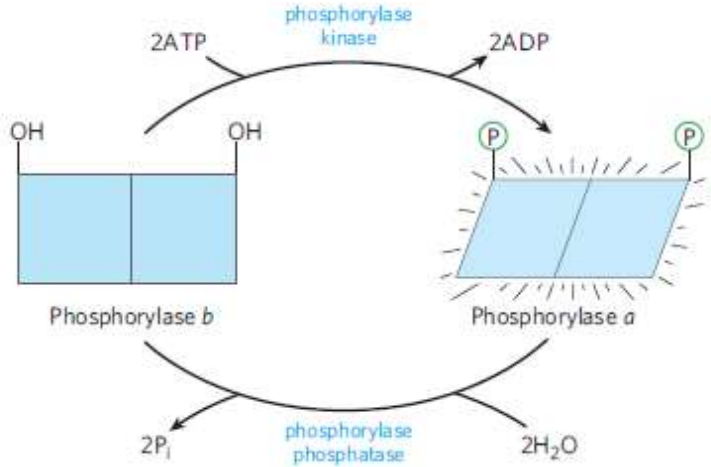
# ENZYME REGULATION

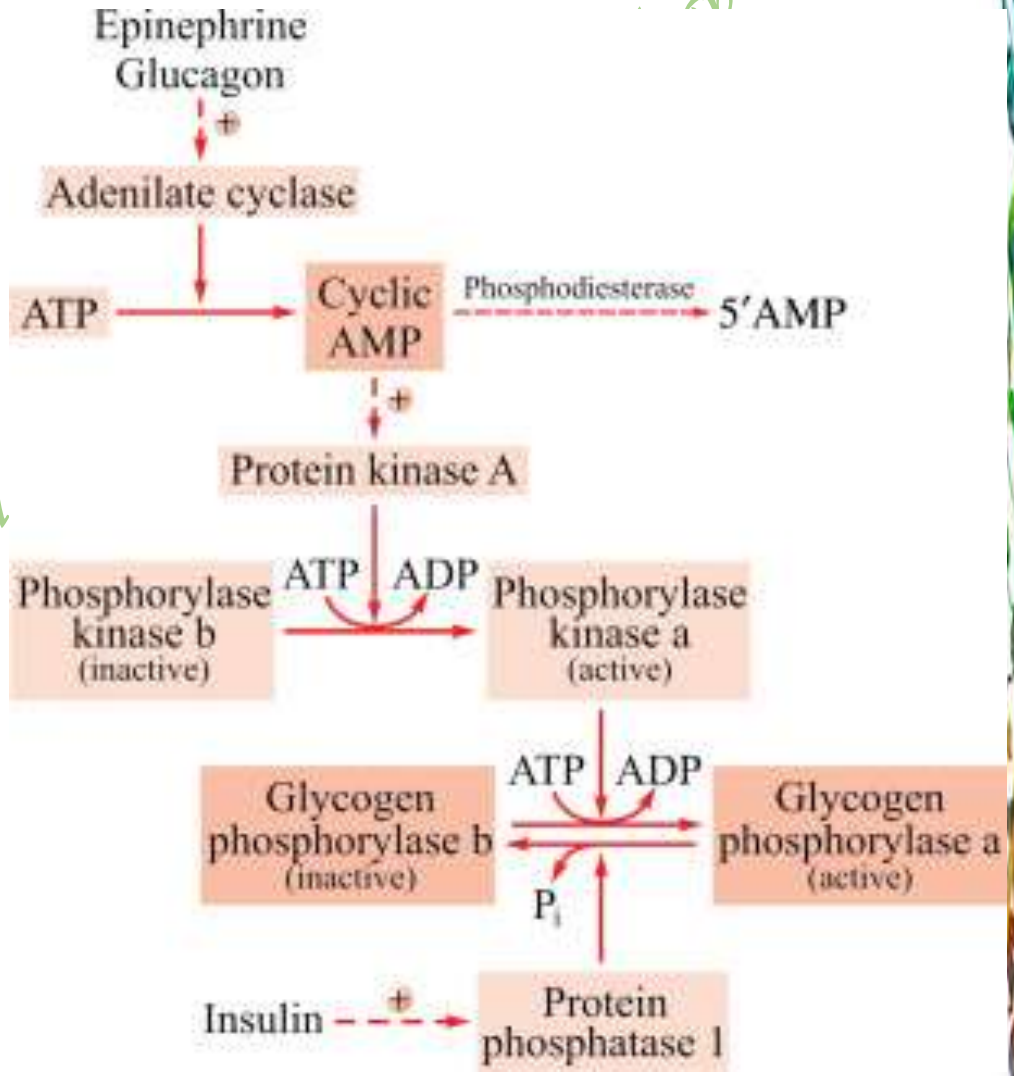
**Reversible covalent modification** The catalytic properties of many enzymes are markedly altered by the covalent attachment of a modifying group



# ENZYME REGULATION

## Cascade mechanism for the activation of glycogen phosphorylase



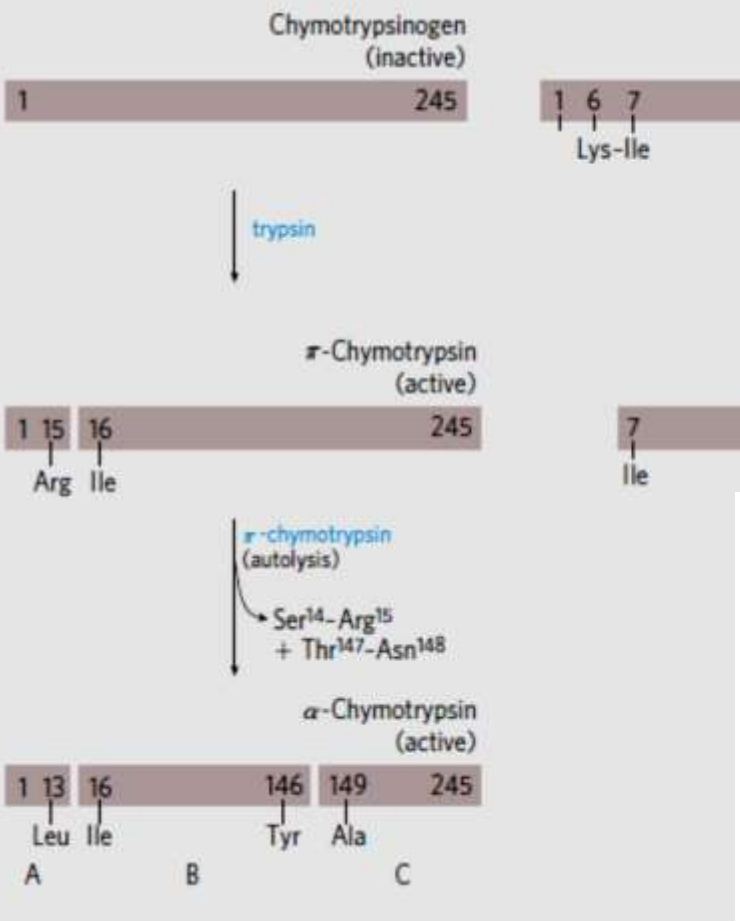



# ENZYME REGULATION

## 3. *Proteolytic activation*

- For some enzymes, an inactive precursor called a **zymogen** is cleaved to form the active enzyme. Specific cleavage causes conformational changes that expose the enzyme active site.
- This regulatory mechanism generates digestive enzymes such as chymotrypsin, trypsin, and pepsin.
- Caspases, which are proteolytic enzymes that are the executioners in *programmed cell death,* or *apoptosis* are proteolytically activated from the procaspase form.
- Blood clotting is due to a remarkable cascade of zymogen activations.
- Many proteolytic enzymes (proteases) of the stomach and pancreas are regulated in this way. Chymotrypsin and trypsin are initially synthesized as chymotrypsinogen and trypsinogen.

# ENZYME REGULATION

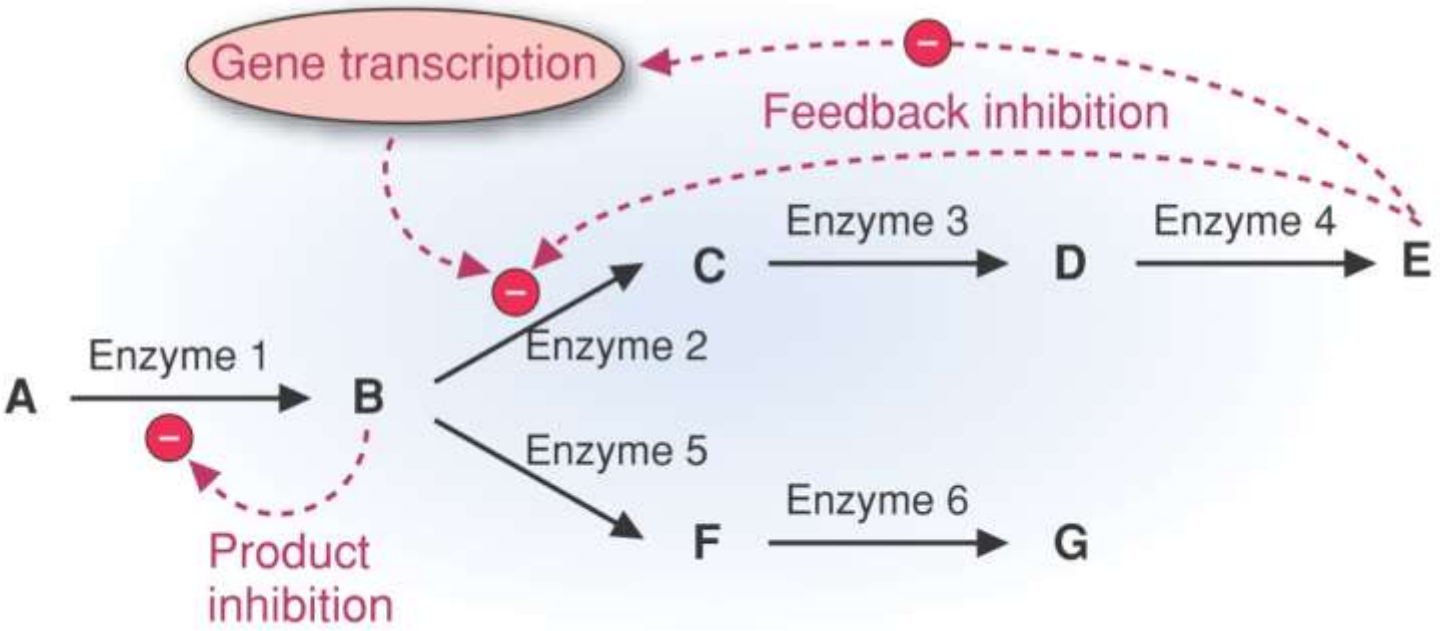



Activation of zymogens by proteolytic cleavage. formation of chymotrypsin and trypsin from their zymogens, chymotrypsinogen and trypsinogen. The bars represent the amino acid sequences of the polypeptide chains, with numbers indicating the positions of the residues

The three polypeptide chains (A, B, and C) of chymotrypsin are linked by disulfide bonds

# ENZYME REGULATION

## Feed back regulation

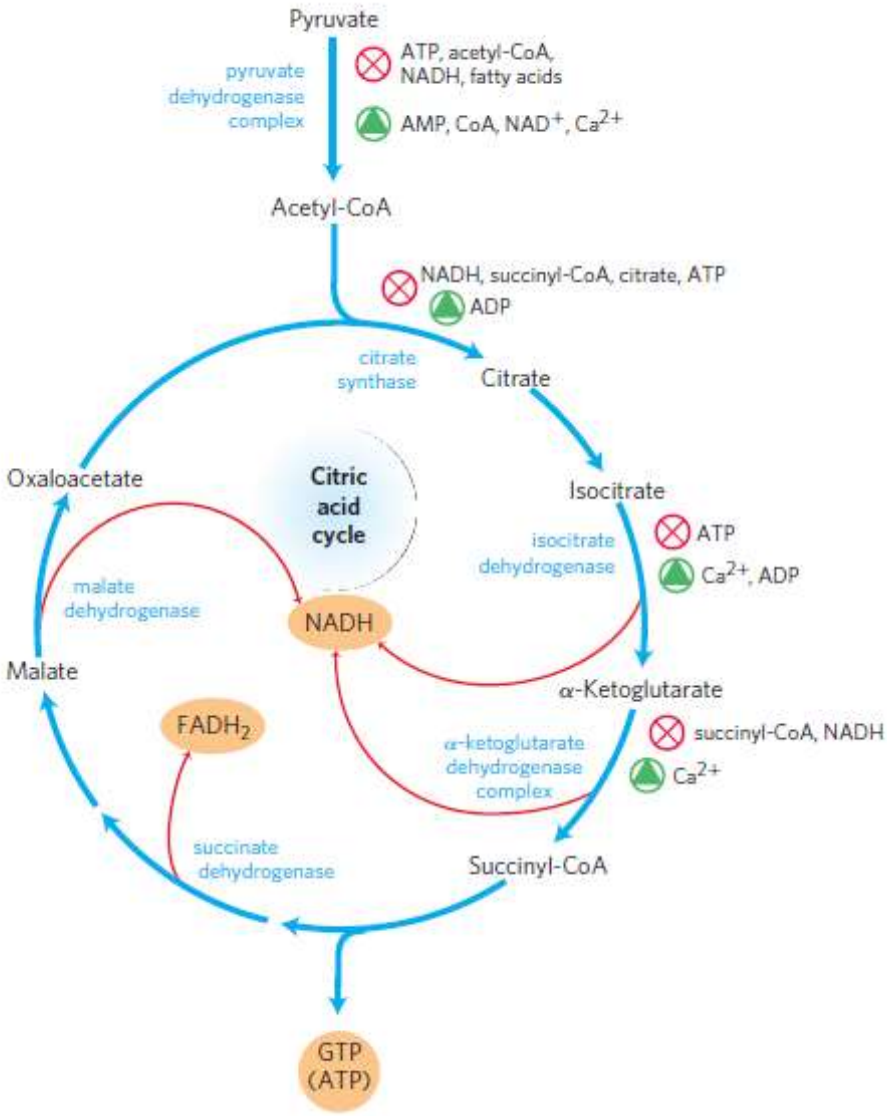


# ENZYME REGULATION

Regulation of metabolite flow from the PDH complex through the citric acid cycle in mammals.

The PDH complex is allosterically inhibited when [ATP]/ [ADP], [NADH]/[NAD1], and [acetyl-CoA]/[CoA] ratios are high, indicating an energy-sufficient metabolic state. When these ratios decrease, allosteric activation of pyruvate oxidation results. The rate of flow through the citric acid cycle can be limited by the availability of the citrate synthase substrates, oxaloacetate and acetyl-CoA, or of NAD1, which is depleted by its conversion to NADH, slowing the three NAD-dependent oxidation steps.

**Feedback inhibition by succinyl-CoA, citrate, and ATP also slows the cycle by inhibiting early steps.**



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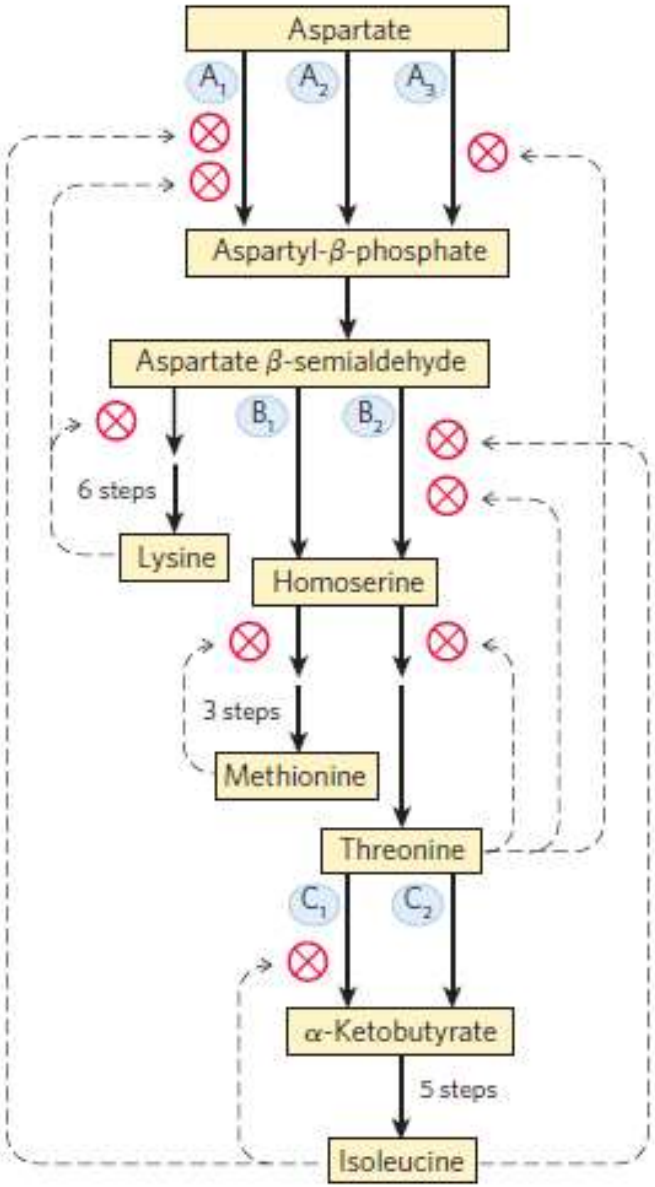

# ENZYME REGULATION

Subcellular localization and organisation of enzymes in the cell. compartmentation of metabolic pathways, enzymes in membranes, concentrations. Mechanisms of enzyme degradation, lysosomal and nonlysosomal pathways, examples.

# ENZYME REGULATION

| Component | Marker |
|---|---|
| **Nuclei** | DNA polymerase<br>RNA polymerase<br>NAD pyrophosphorylase |
| **Plasma membranes** | 5'-Nucleotidase Leucine aminopeptidase<br>Aminopeptidase<br>Alkaline phosphodiesterase<br>Mg2-Stimulated ATPase<br>Leucyl-naphthylamidase<br>Nucleotide triphosphatase<br>Adenylate cyclase |
| **Mitochondria** | Succinate dehydrogenase<br>Cytochrome oxidase<br>Glutamate dehydrogenase<br>Monoamine oxidase<br>Cytochrome c oxidoreductase |
| **Lysosomes** | Acid phosphatase<br>Aryl sulfatase-c<br>Phosphodiesterase-11<br>B-glucuronidase<br>Acridine orange |

# ENZYME REGULATION

| | |
|---|---|
| Peroxisomes | Catalase<br>Uric acid oxidase<br>Peroxidase |
| Glyoxysomes | Glycollate oxidase<br>Glyoxylate reductase |
| Golgi bodies | UDP galactose:N-acetyl glucosamine galactosyl transferase<br>Sialyl transferase |
| Chloroplasts | Chlorophyll<br>Ribulose diphosphate carboxylase |
| Endoplasmic reticulum | Glucose-6-phosphatase<br>NADPH-cytochrome c reductase |
| Cytosol | Aldolase<br>Phosphoglucomutase<br>Hexokinase |