# Microbial Metabolism
## Production and Regulation of Primary and Secondary Metabolites

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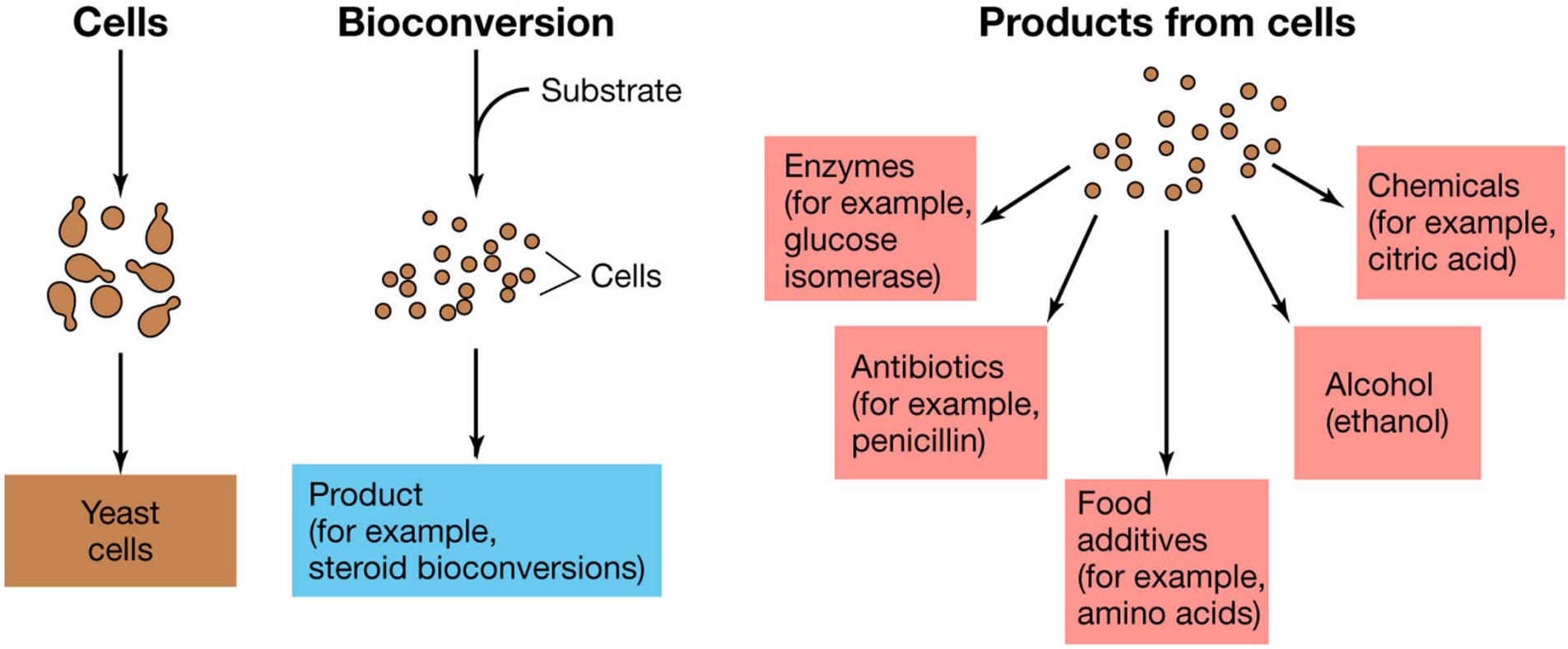
# Products of Microbiology

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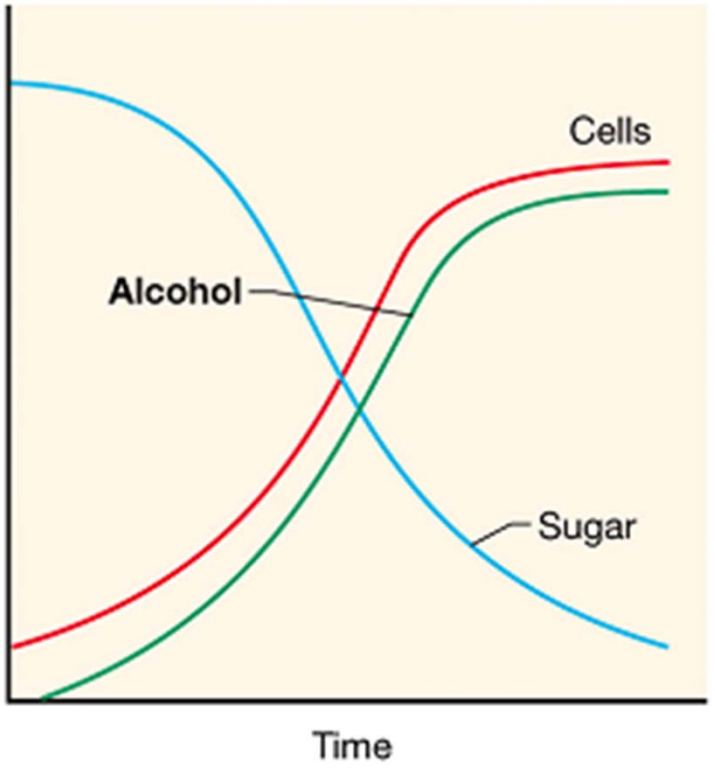
# Primary Metabolites

- Small molecules of living cells
- Intermediates or end products of the pathway
- Related to synthesis of microbial cells in the growth phase
- Include alcohols, amino acids, nucleotides, organic acids, polyols, vitamins, and enzymes

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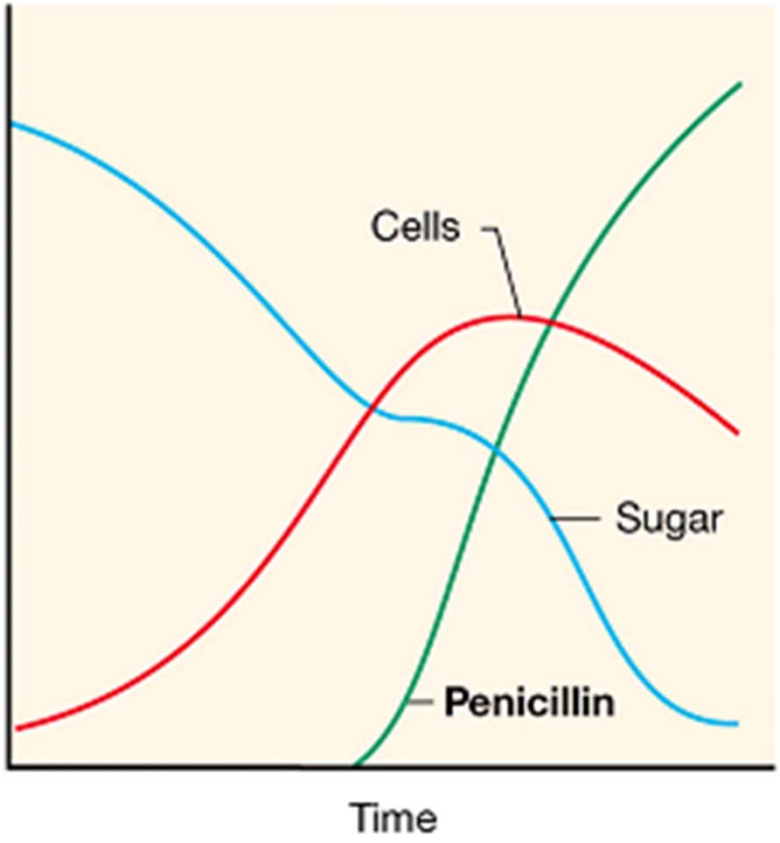
# Secondary Metabolites

- Accumulate following active growth
- Have no direct relationship to synthesis of cell material and natural growth
- Include antibiotics and toxins

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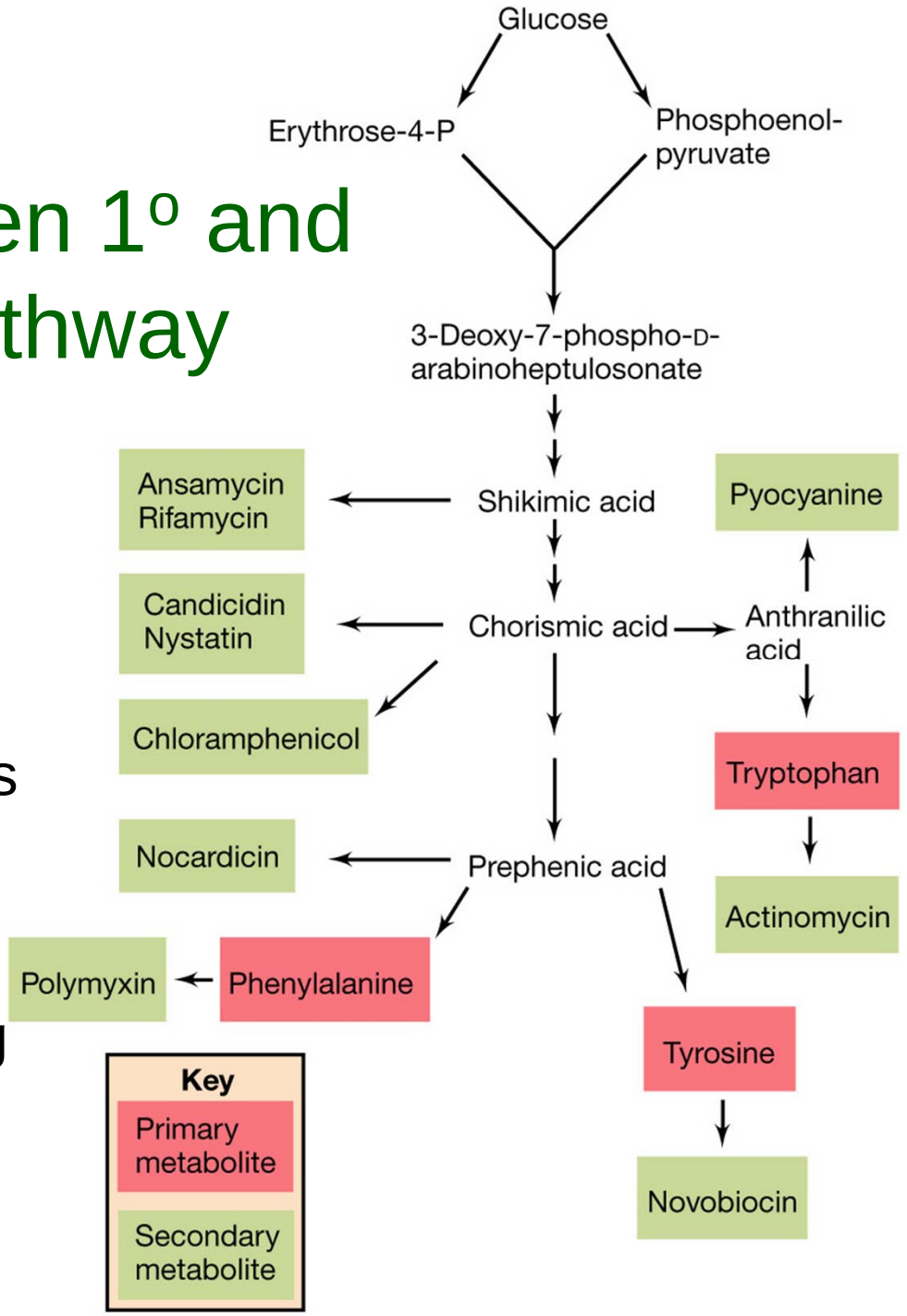
# Relation between 1º and 2º metabolic pathway

## Primary metabolic pathway

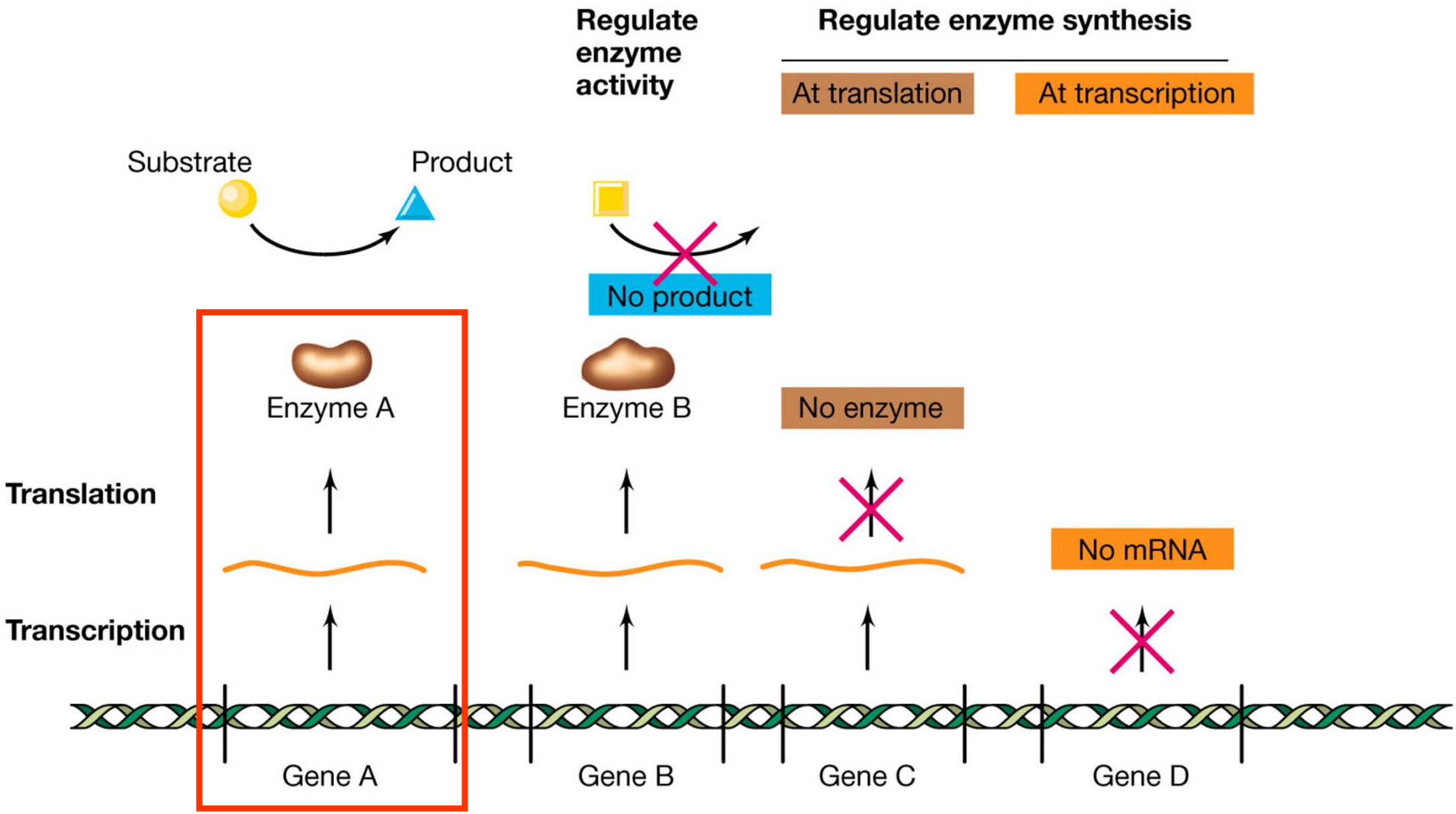
- for the synthesis of aromatic amino acids

## The secondary metabolite

- antibiotics containing aromatic rings.



# Regulation Mechanisms




Central Dogma

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# Modification of Gene Expression

- allows for overproduction of a product, production of more than one product by the same organism, or synthesis of modified products

## Pathway architecture

- analysis, design, and modification of biochemical pathways to increase process efficiency

## Metabolic pathway engineering

- intentional alteration of metabolic pathway by inactivation of specific genes

## Metabolic control engineering

- alteration of control mechanisms of specific genes

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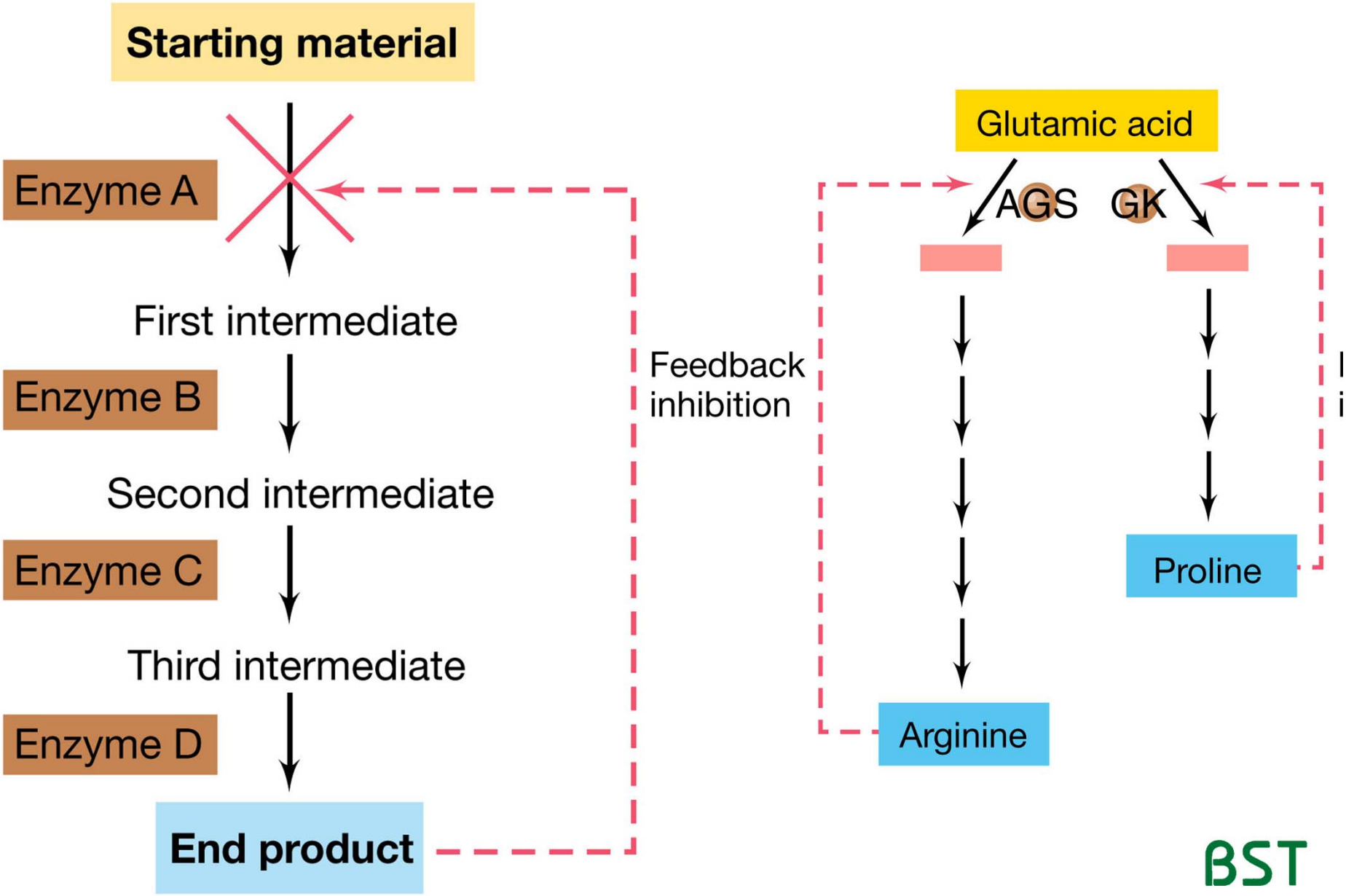
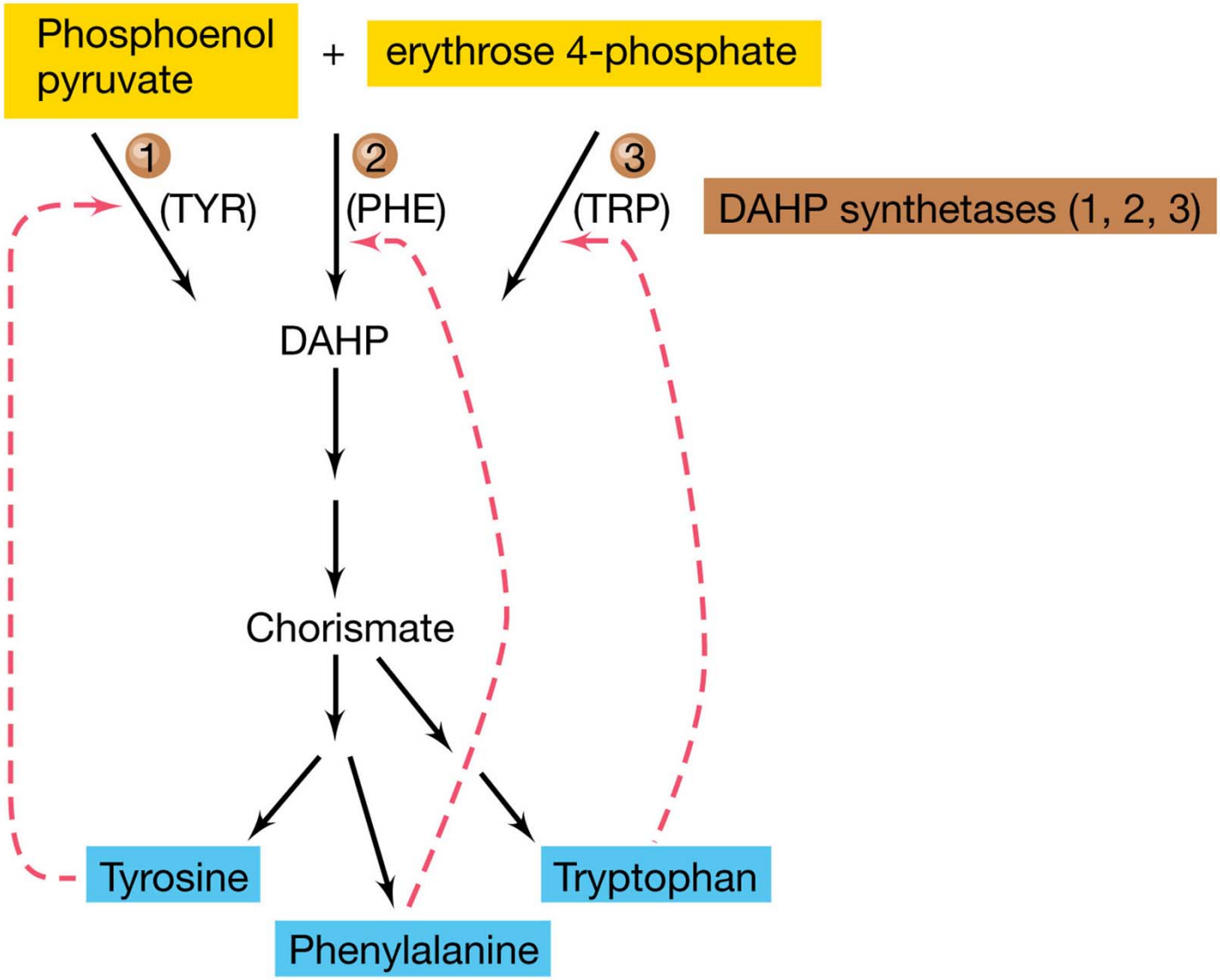
# Feedback inhibition of enzyme activity



# Specific Feedback Inhibition

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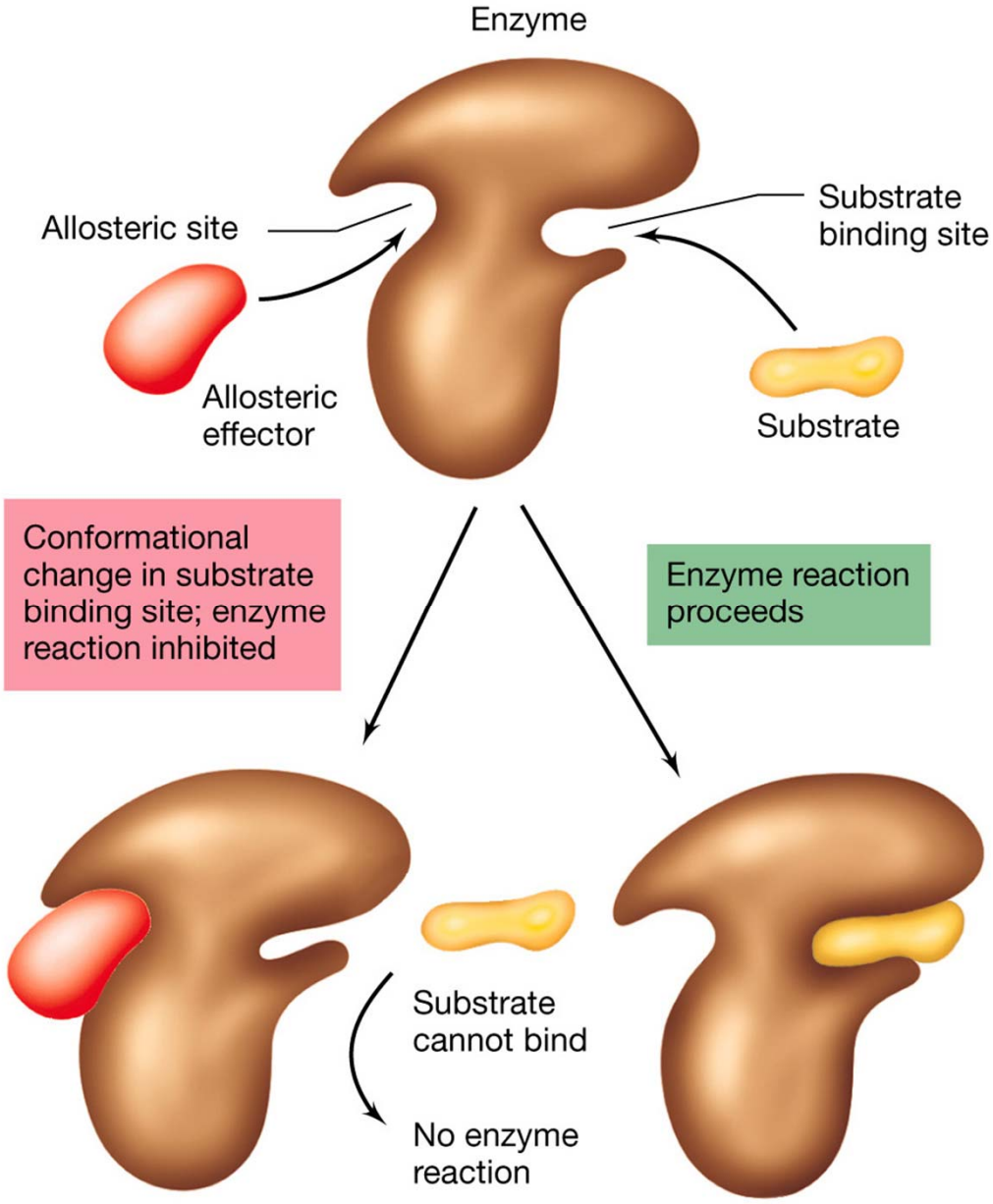
# Enzyme Inhibition by Allosteric Effector

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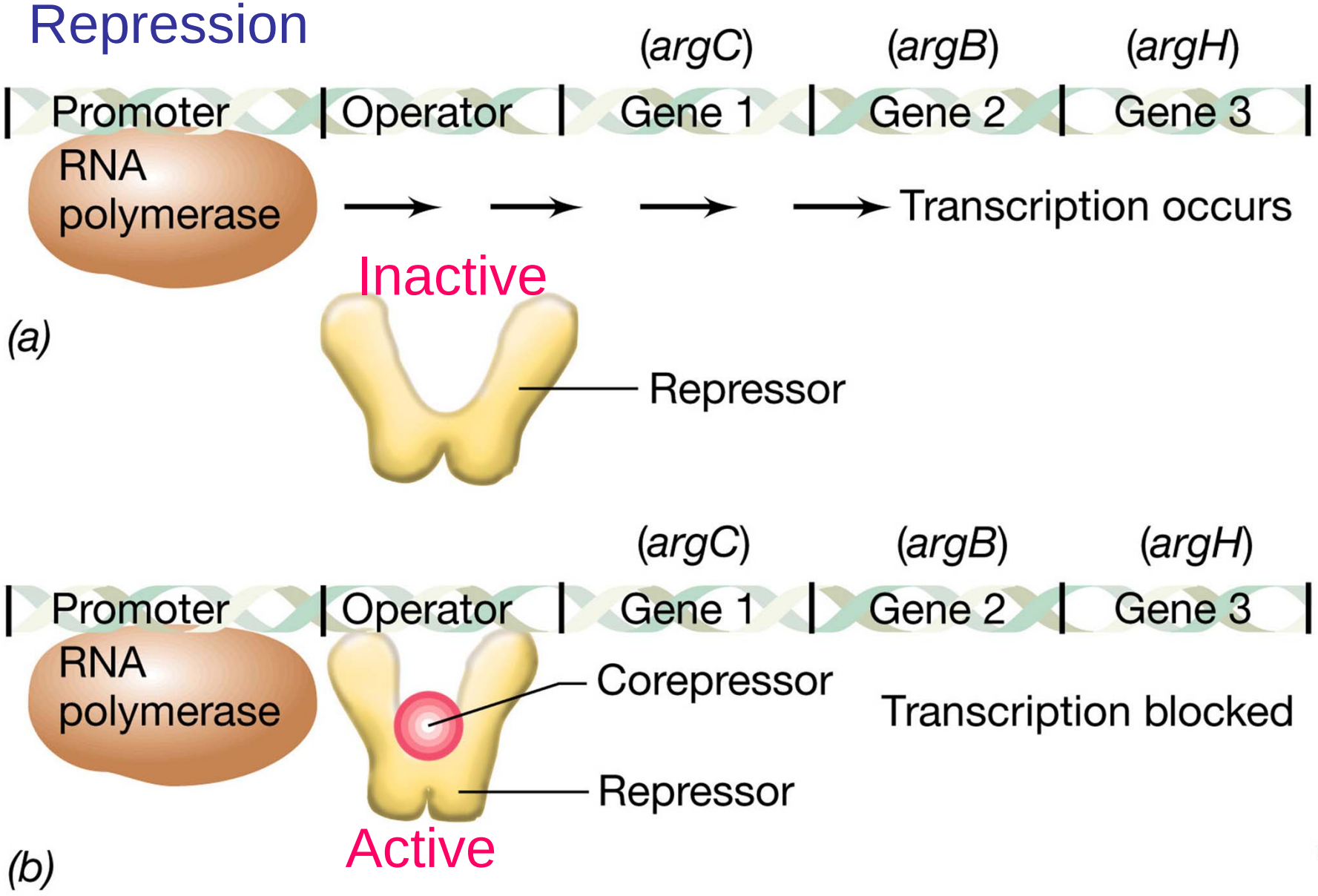
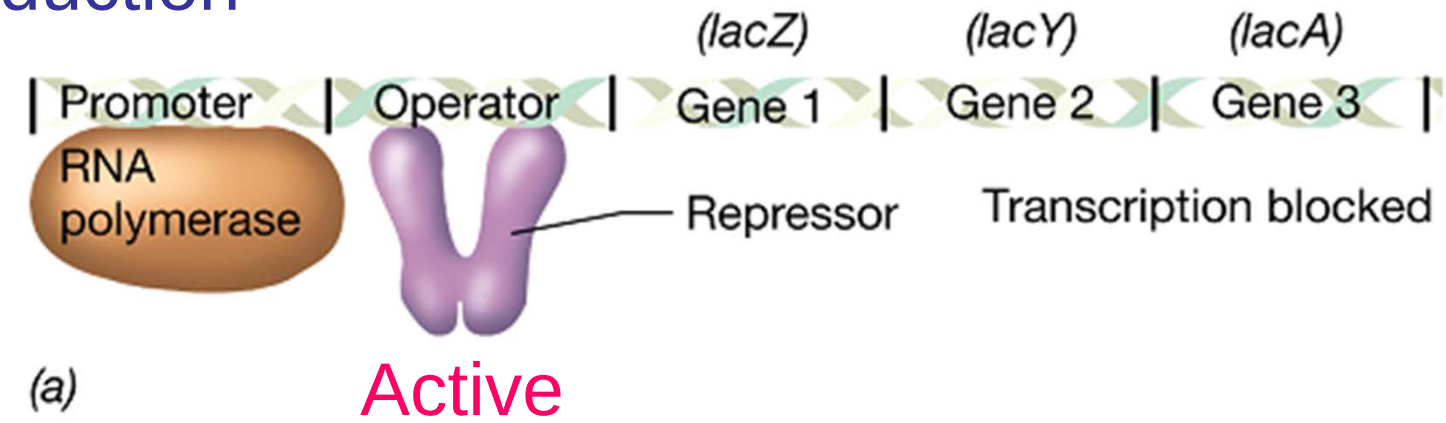
# Negative Control of Transcription

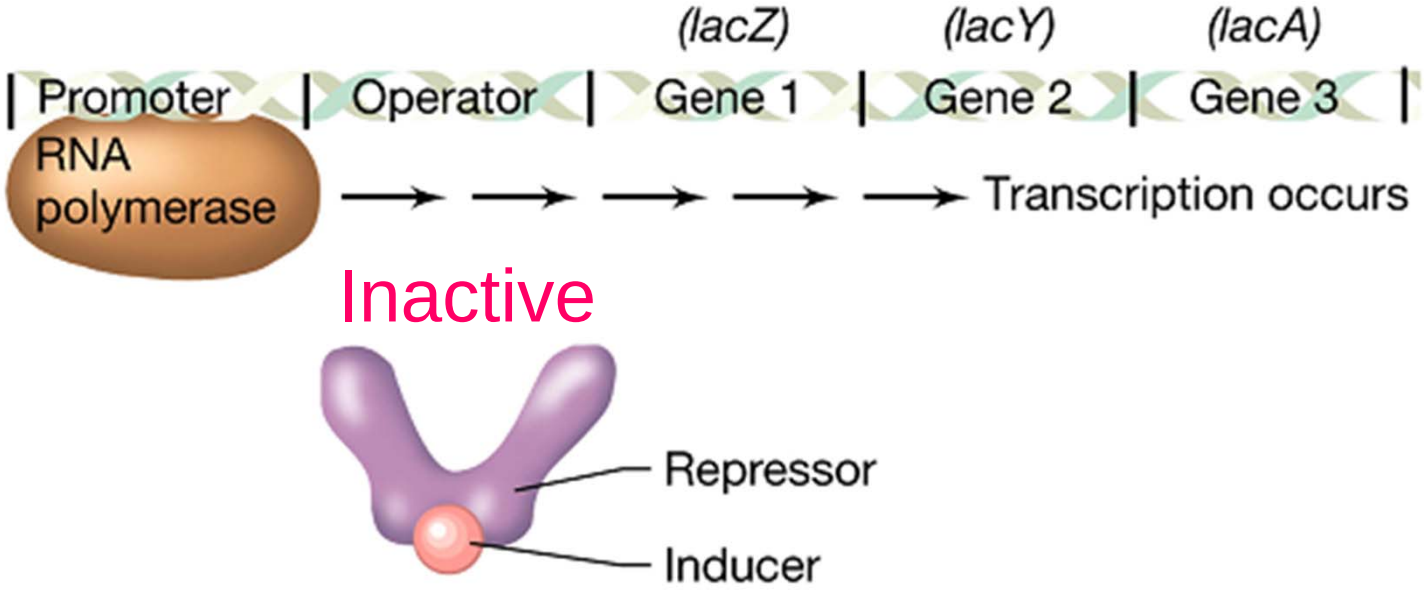


# Negative Control of Transcription

## Induction




Active




Inactive

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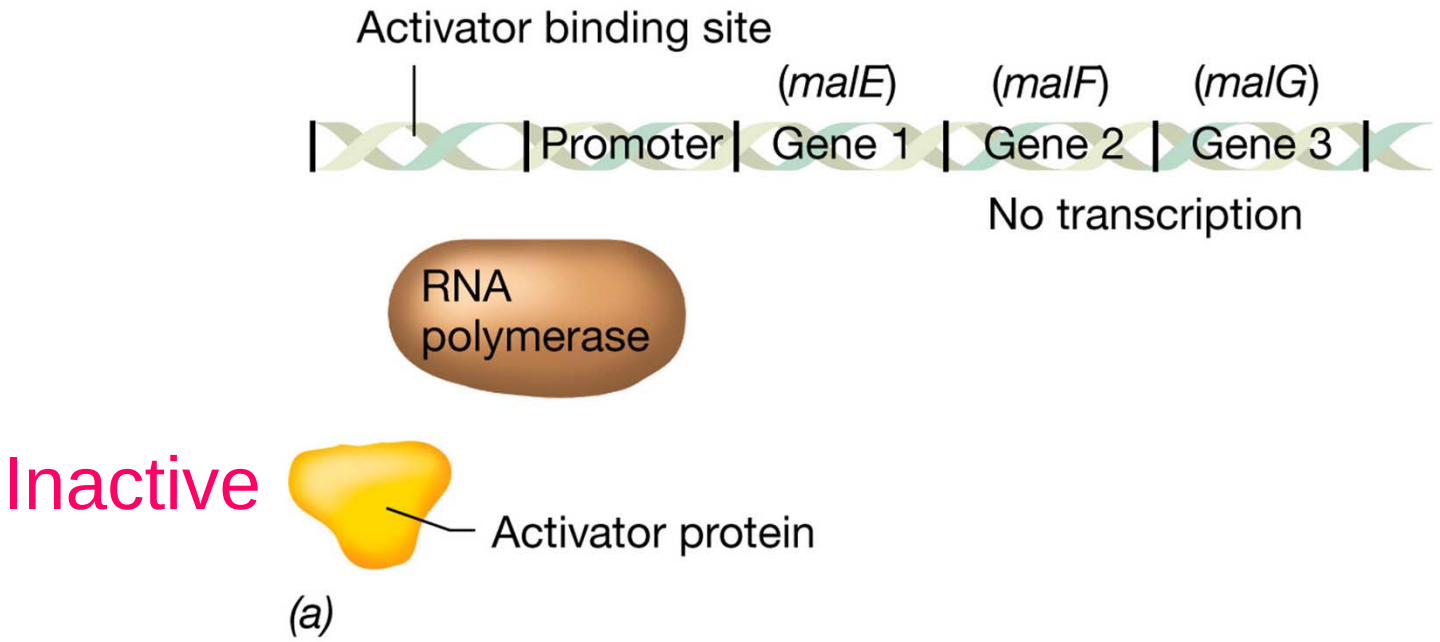
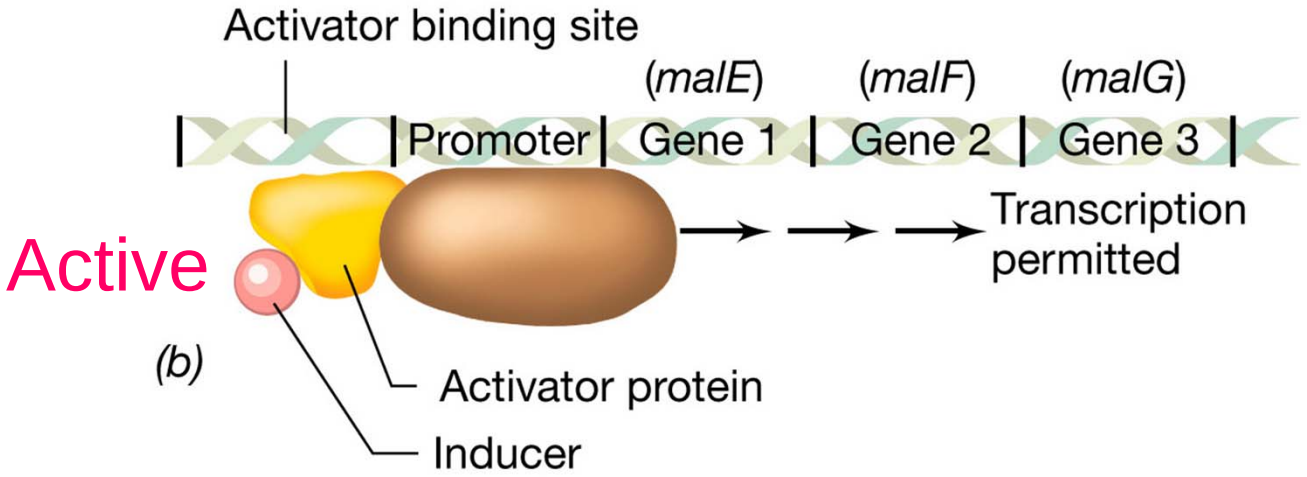
# Positive Control of Enzyme Induction

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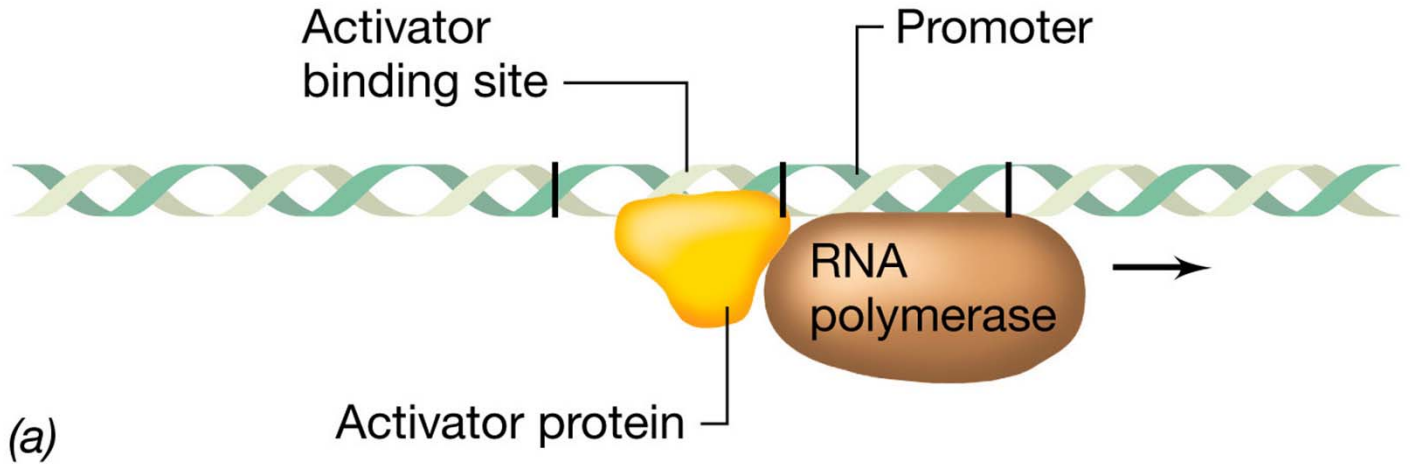


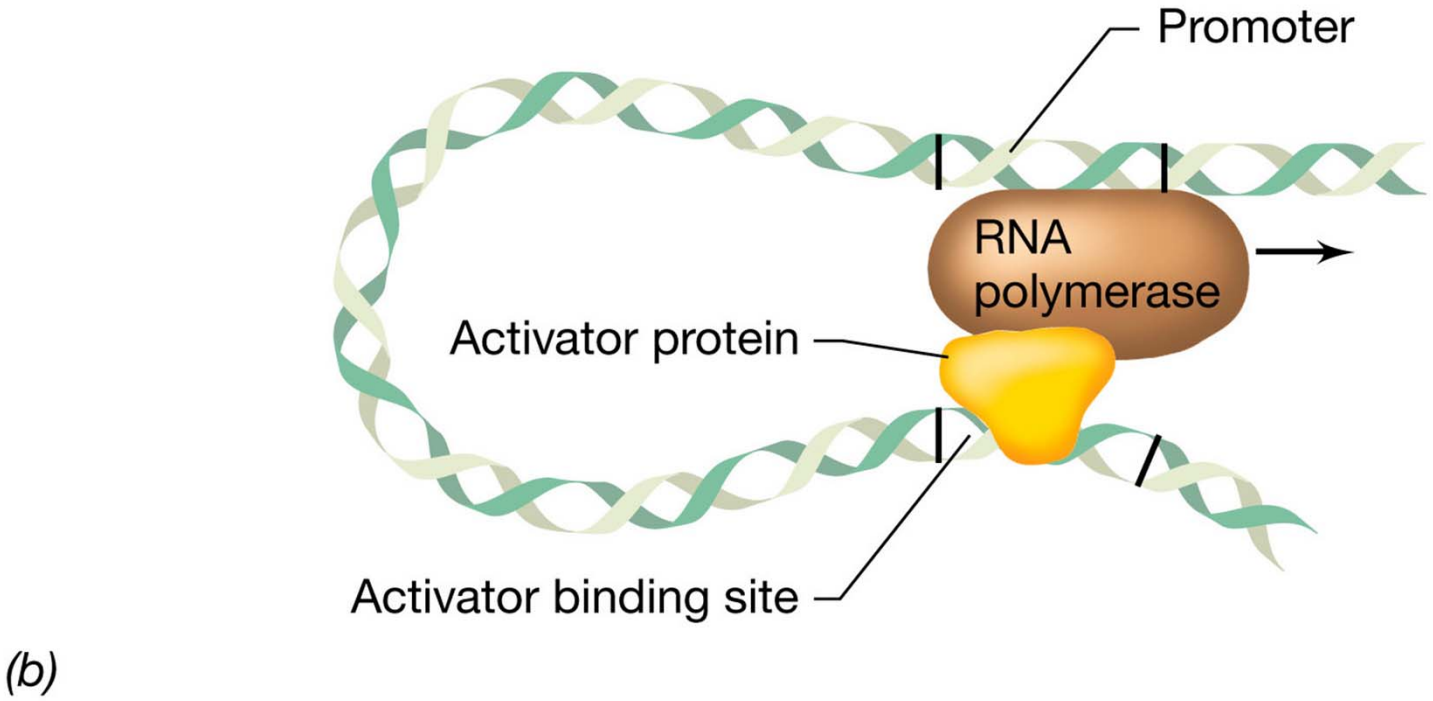


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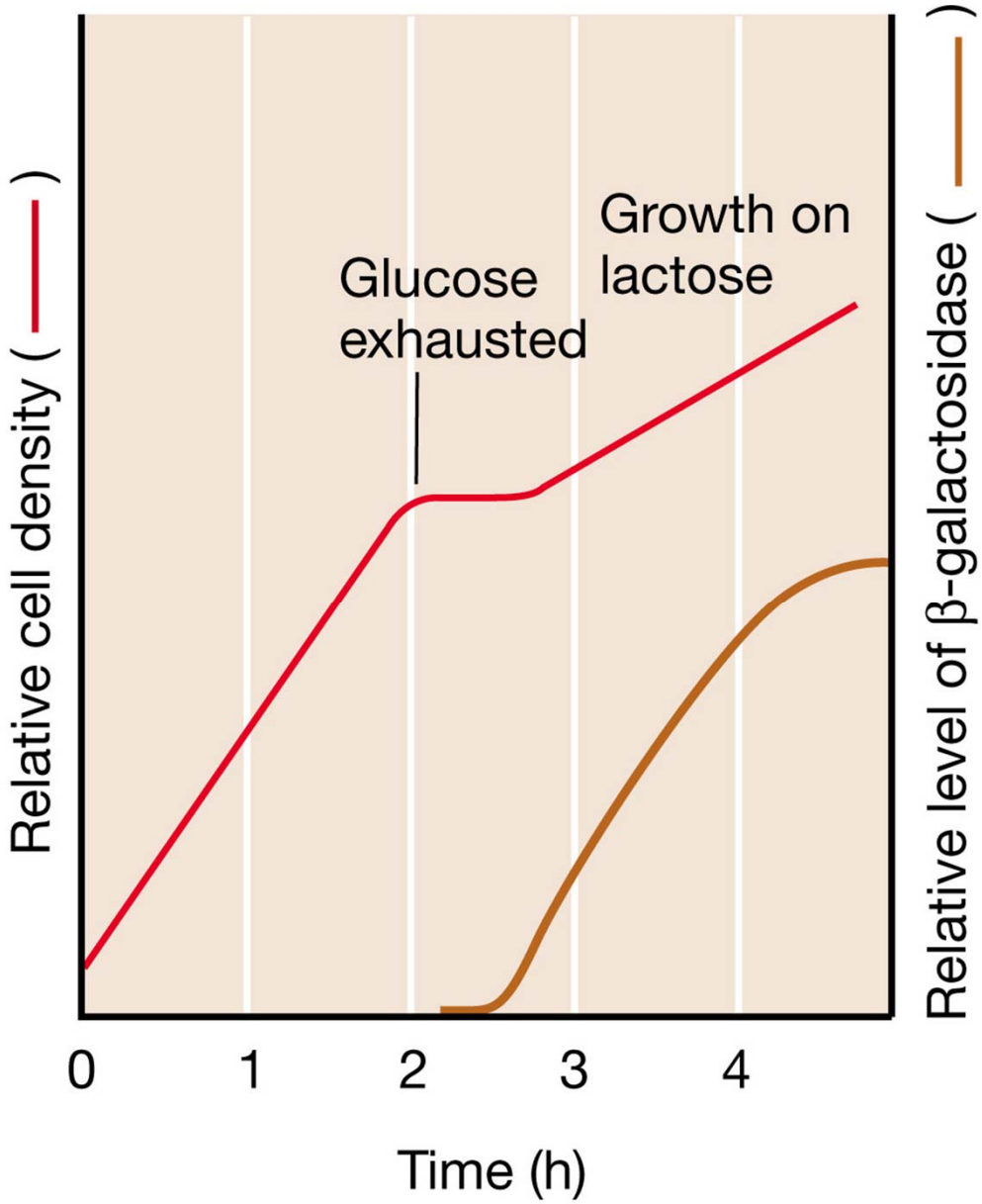
# Catabolite Repression

- Occurs when operon is under control of catabolite other than initial substrate
- Allows preferential use of one carbon source over another

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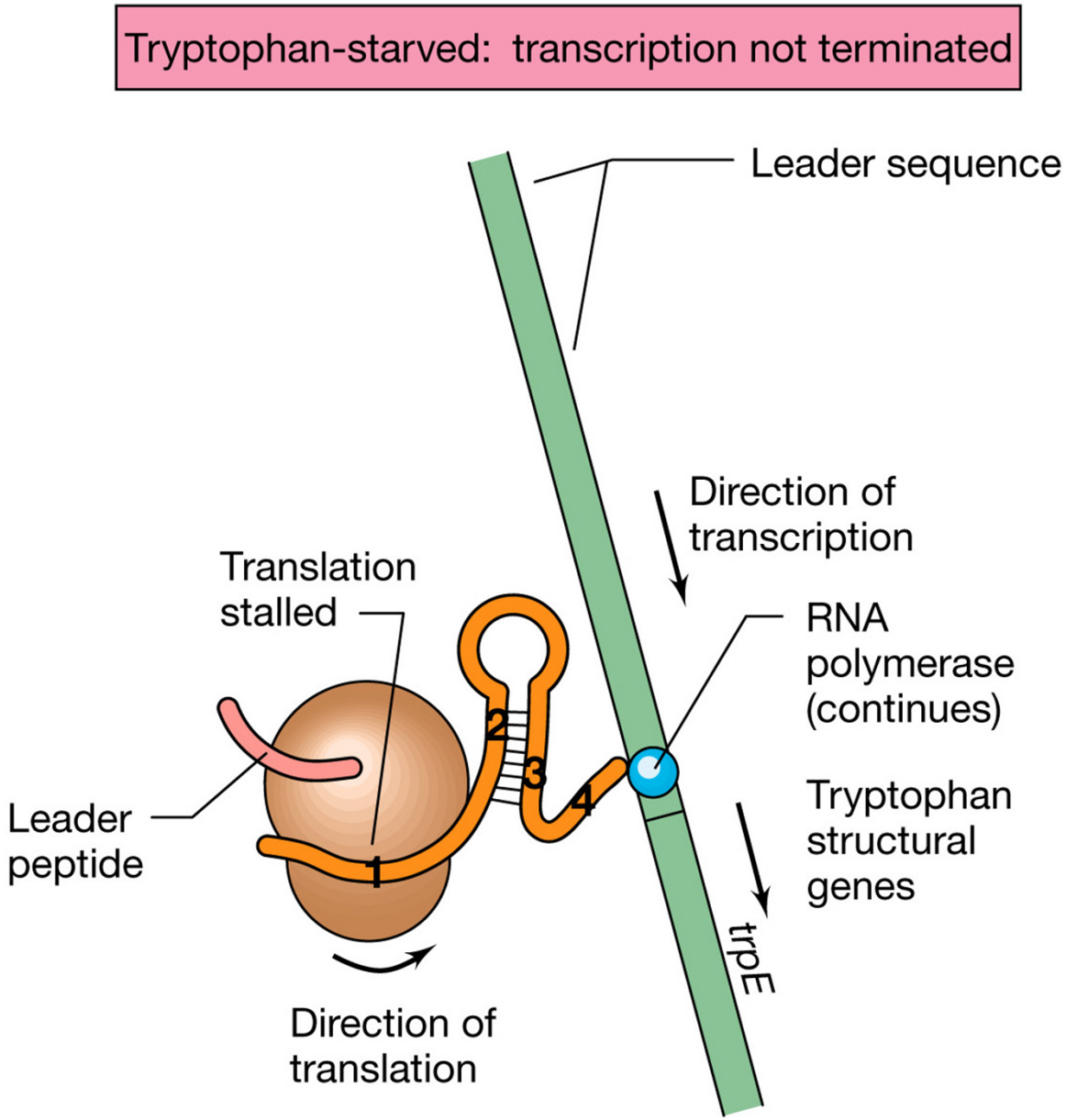
# Transcription of *trp* operon by attenuation



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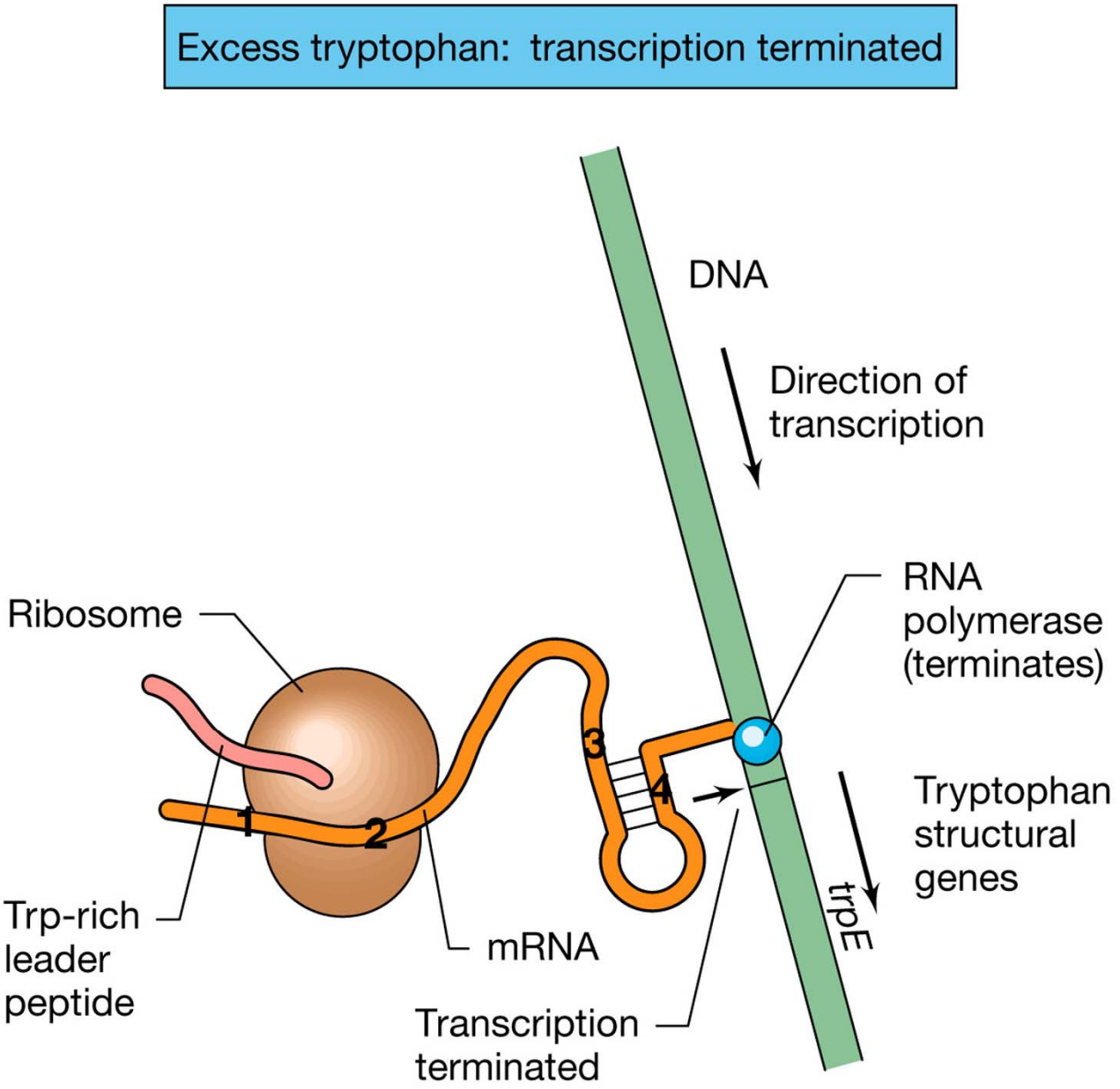
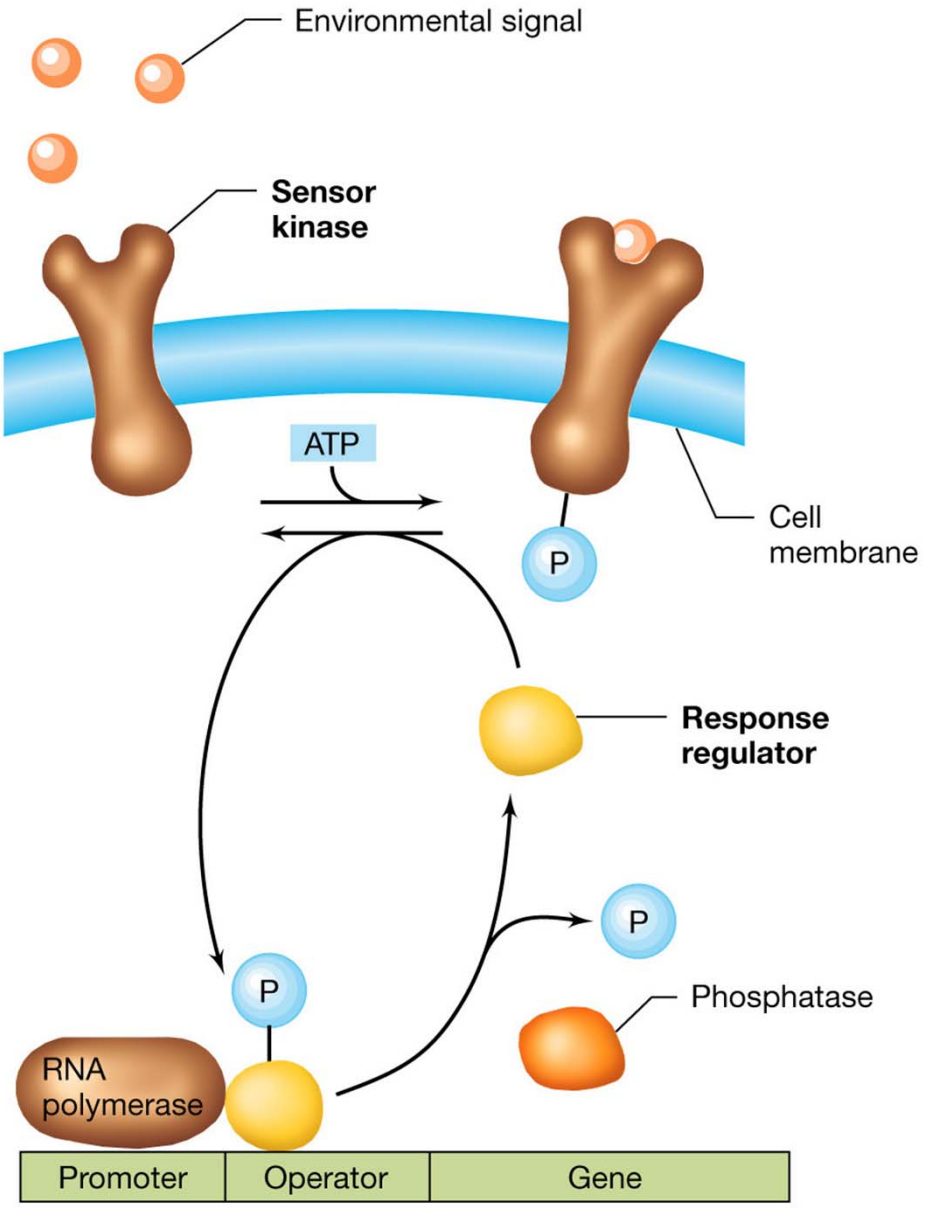
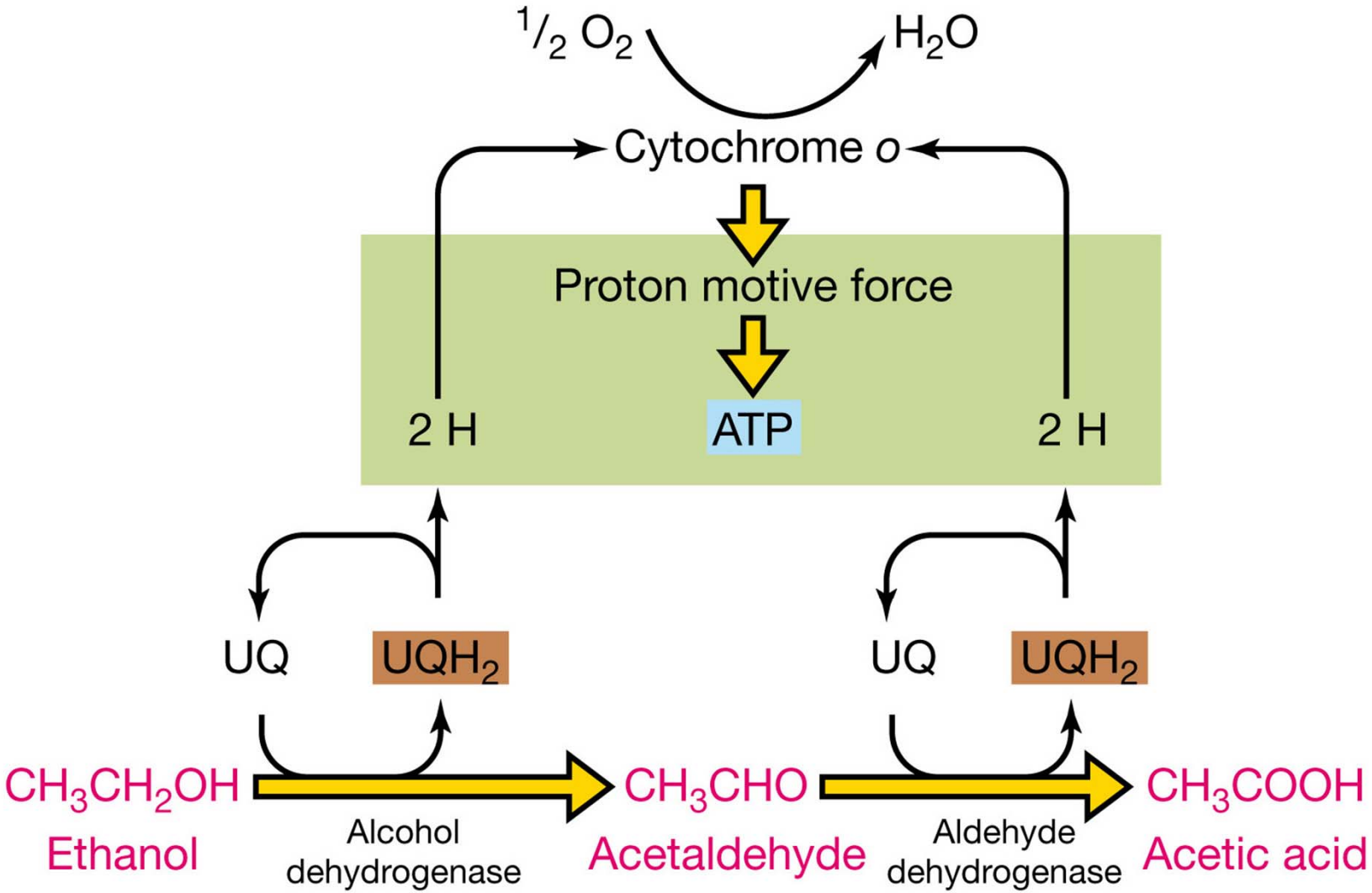


# Two-Component System



# Production of Vinegar

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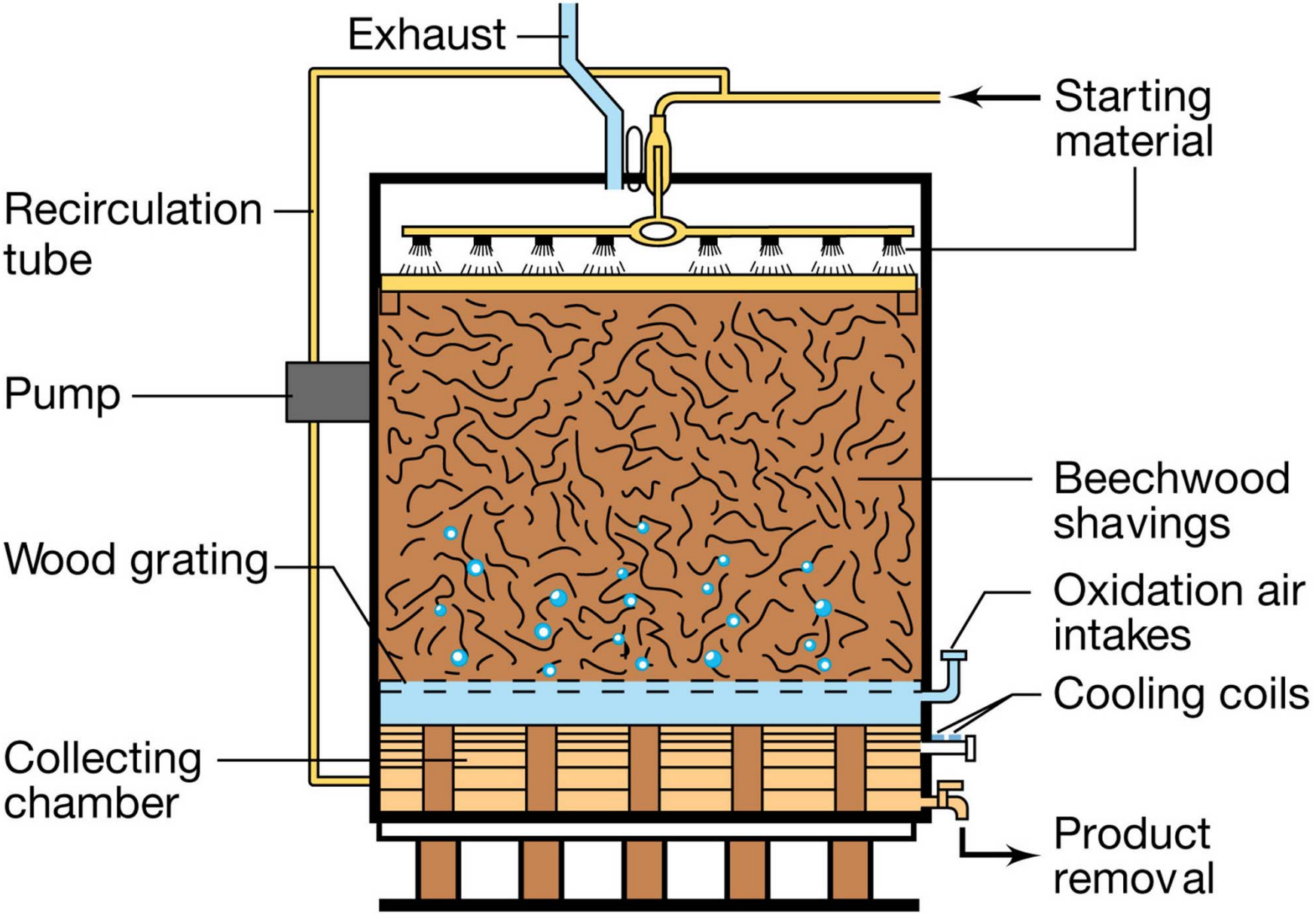
Exhaust
Starting material
Recirculation tube
Pump
Beechwood shavings
Wood grating
Oxidation air intakes
Cooling coils
Collecting chamber
Product removal

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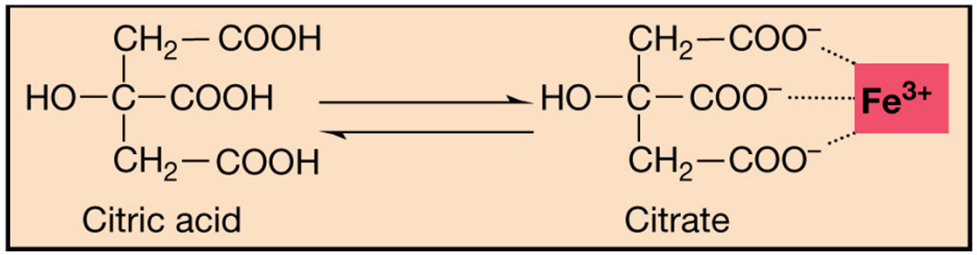
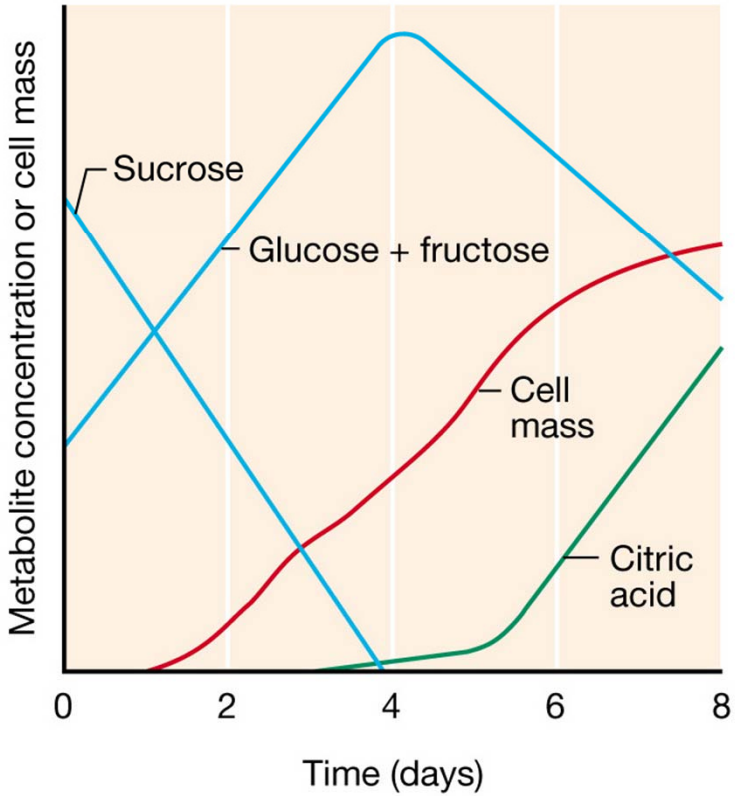
# Citric Acid Fermentation



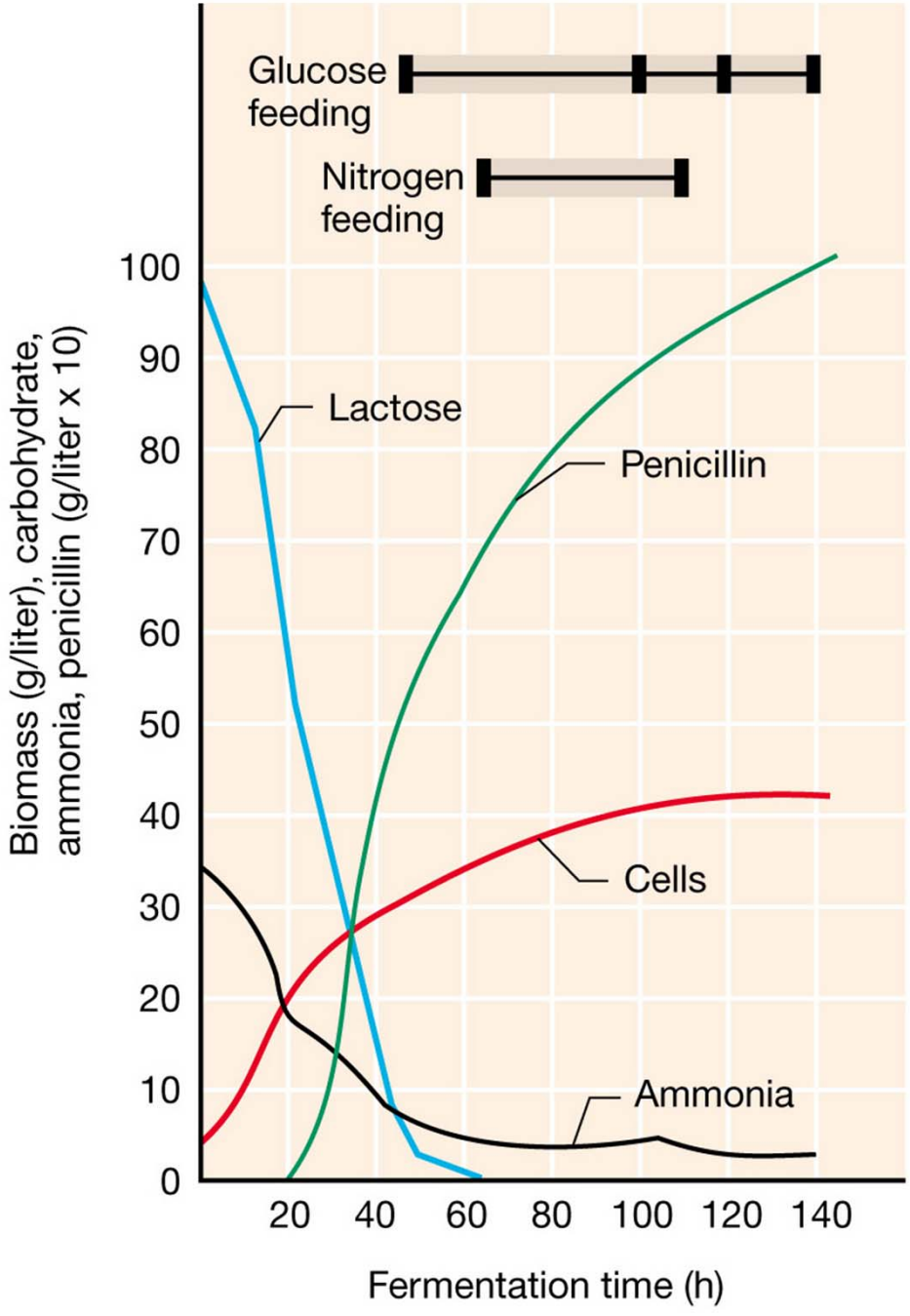

(a)



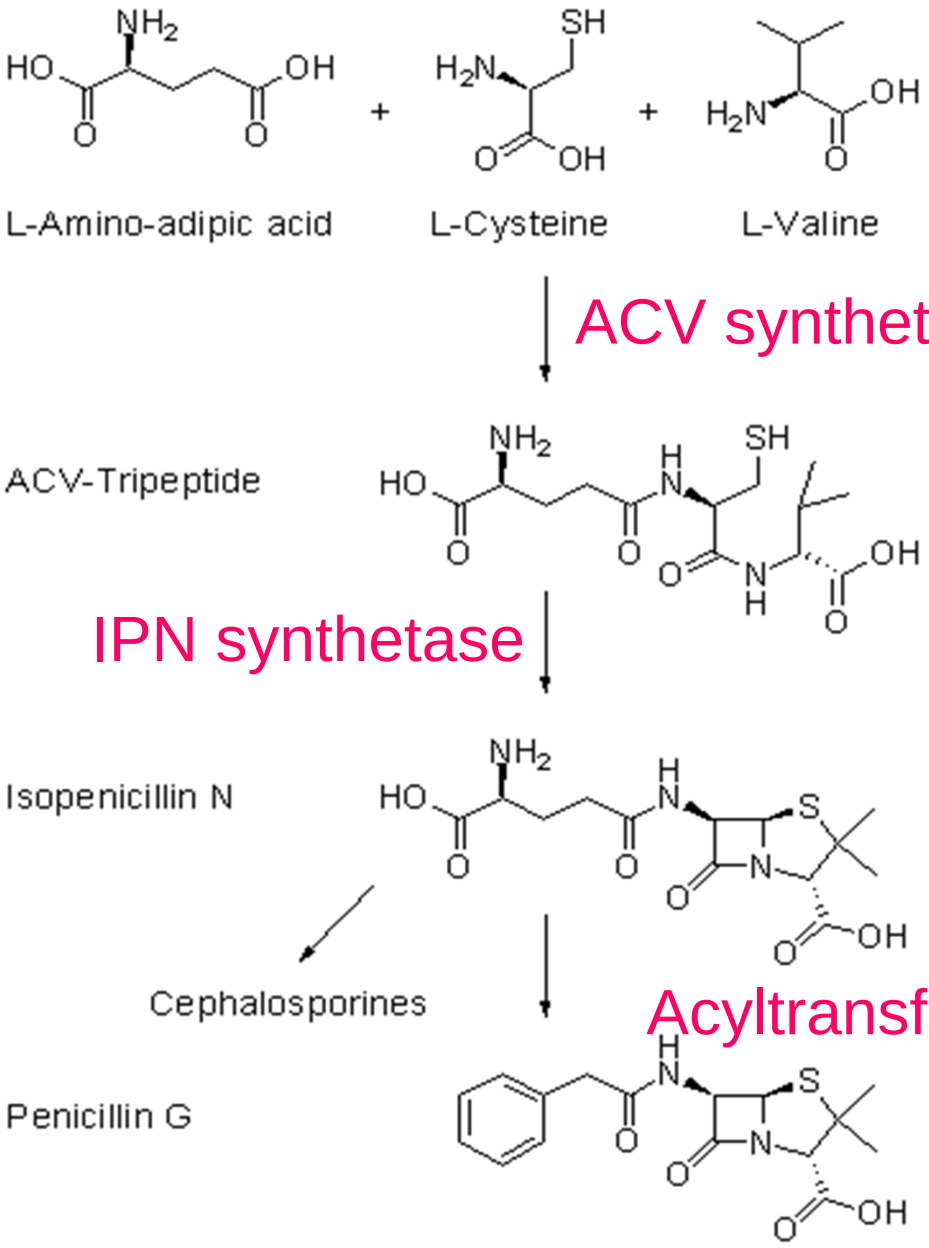

(b)

# Antibiotics

- Requires precise control of nutrients
- Final product can be modified to yield a variety of semisynthetic penicillins



# Biosynthetic Pathway of Penicillin



# Industrial Production of Penicillins