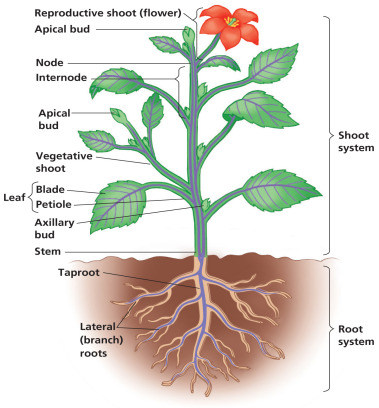
Key Features of Plants and Plant Function

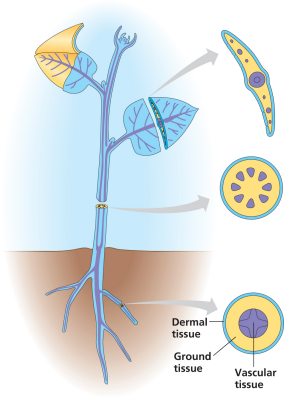
Plants have indeterminate growth
- no set body plan
- parts of different physiological ages

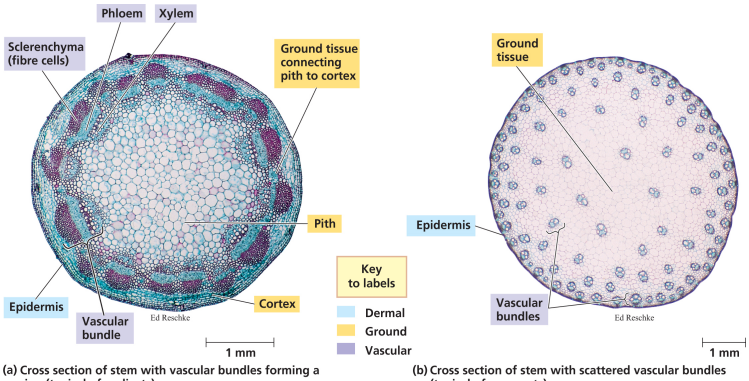
Plants are immobile
- mine the soil to get mineral nutrients
(are any animals photosynthetic?)
- must adapt to stress via <u>biochemical</u> means

Plants are decentralized
- control of metabolic processes is decentralized, for example driven by demand (starch vs. sucrose synthesis)

Plants have a vascular system to transport molecules
Xylem: water, minerals, also some organic compounds (amino acids, proteins)
Phloem: nutrients (sugars), amino acids, also RNAs and proteins







(a) Cross section of stem with vascular bundles forming a ring (typical of eudicots).

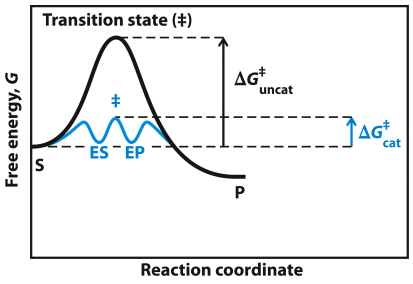
(b) Cross section of stem with scattered vascular bundles (typical of monocots).

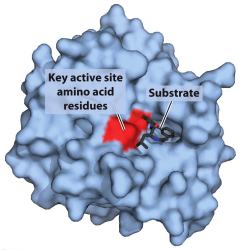
Review of Enzymes and Enzyme Regulation

Metabolism and its control requires the coordinated activities of many enzymes.

Enzymes*: *proteins that catalyze specific chemical reactions

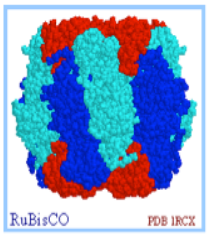
- speed up reaction rates by lowering activation energy
- contain active (catalytic) site (= pocket),
- highly specific, via specificity of binding site for substrate

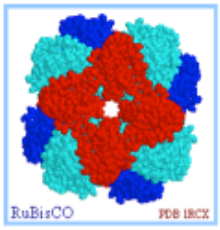




Enzyme structure

- can be **multi-subunit** (i.e. ribulose bisphosphate carboxylase/oxygenase, alcohol dehydrogenase)
- there can be multiple forms of very similar enzymes called **<u>isoenzymes</u>** (isozymes). These are encoded by separate genes (in gene families).
- often have **multi-enzyme complexe**s (sequential reactions)
- many enzymes require **cofactors.**





[enzyme cofactors: = small molecules or metal ions which are required for the action of certain enzymes] *= organic or inorganic, low-MW, heat-stable i.e.: Mg^{++}, heme, NADP*

- are often vitamin-derived (i.e., biotin)

- can be covalently linked, but not necessarily

TABLE 6–2 Some Coenzymes That Serve as Transient Carriers of Specific Atoms or Functional Groups

Coenzyme	Examples of chemical groups transferred	Dietary precursor in mammals
Biocytin	CO_2	Biotin
Coenzyme A	Acyl groups	Pantothenic acid and other compounds
5′-Deoxyadenosylcobalamin (coenzyme B_{12})	H atoms and alkyl groups	Vitamin B_{12}
Flavin adenine dinucleotide	Electrons	Riboflavin (vitamin B_2)
Lipoate	Electrons and acyl groups	Not required in diet
Nicotinamide adenine dinucleotide	Hydride ion ($:H^-$)	Nicotinic acid (niacin)
Pyridoxal phosphate	Amino groups	Pyridoxine (vitamin B_6)
Tetrahydrofolate	One-carbon groups	Folate
Thiamine pyrophosphate	Aldehydes	Thiamine (vitamin B_1)

Note: The structures and modes of action of these coenzymes are described in Part II.

Table 6-2
Lehninger Principles of Biochemistry, Sixth Edition
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TABLE 6–1 Some Inorganic Ions That Serve as Cofactors for Enzymes

Ions	Enzymes
Cu^{2+}	Cytochrome oxidase
Fe^{2+} or Fe^{3+}	Cytochrome oxidase, catalase, peroxidase
K^+	Pyruvate kinase
Mg^{2+}	Hexokinase, glucose 6-phosphatase, pyruvate kinase
Mn^{2+}	Arginase, ribonucleotide reductase
Mo	Dinitrogenase
Ni^{2+}	Urease
Zn^{2+}	Carbonic anhydrase, alcohol dehydrogenase, carboxypeptidases A and B

Table 6-1
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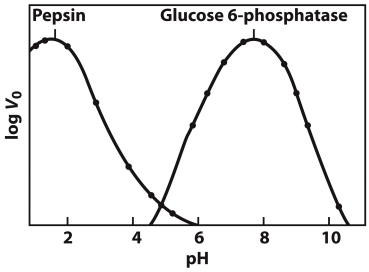
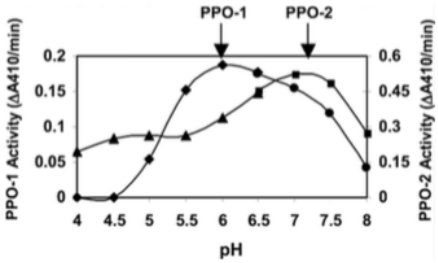
Common Mechanisms to Regulate Enzyme Activity

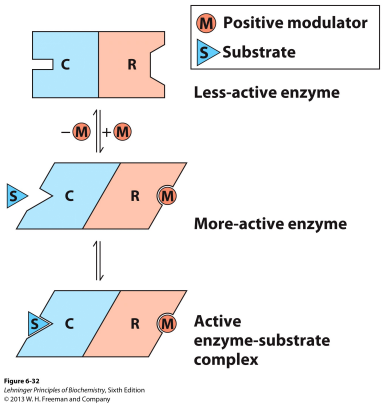
1. Modifications of the chemical environment

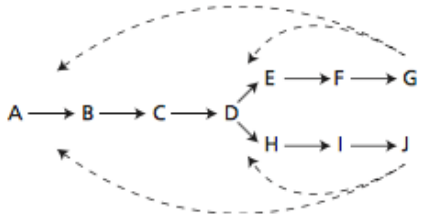
- substrate or cofactor concentrations
- altered pH (enzymes have distinct pH optima)





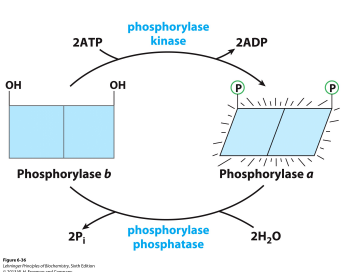
2. Allosteric regulation: = *regulation of enzyme activity by the non-covalent binding of a specific metabolite at a site other than the catalytic site.*

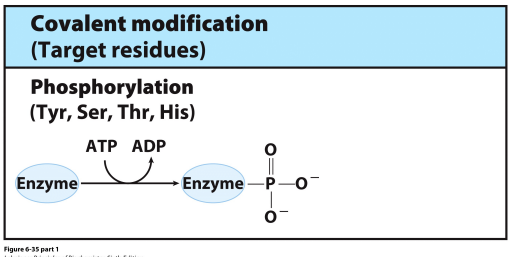




3. Covalent modifications of enzyme

- reduce S to SH (ribulose-5-P kinase)
- protein phosphorylation (kinases add phosphate to specific a.a. residues)
- proteolytic cleavage to activate (e.g. trypsin)
- other: ribosylation, prenylation





4. Alter localisation / substrate proximity; i.e. move to membrane (prenylation)

5. Degradation or synthesis of enzyme (gene expression) - generally considered as "coarse" control