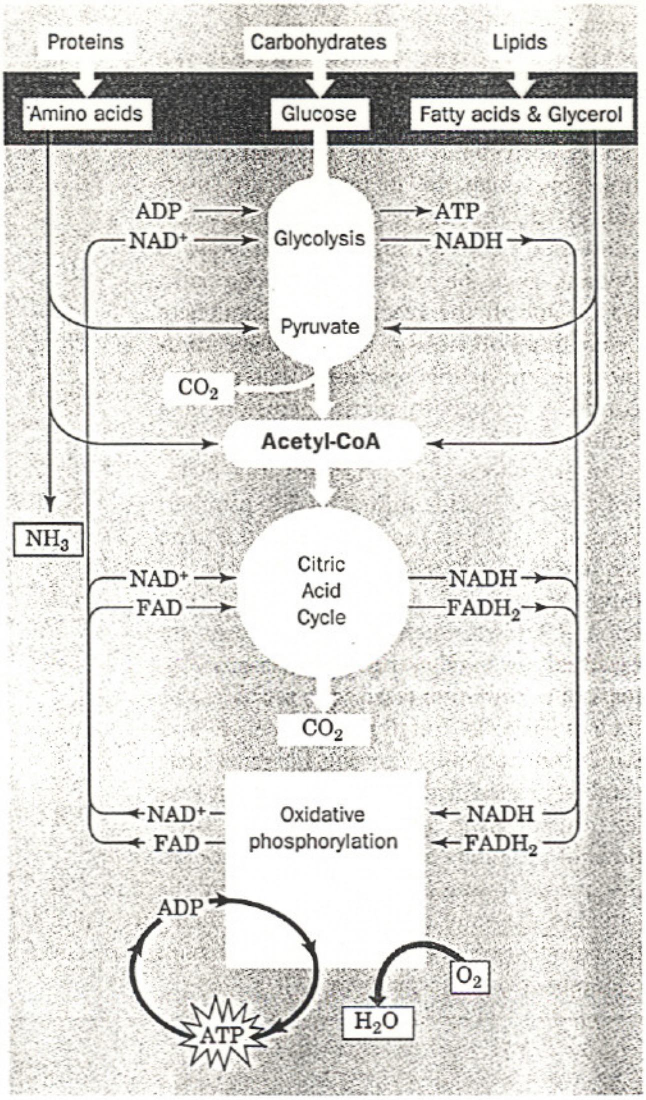
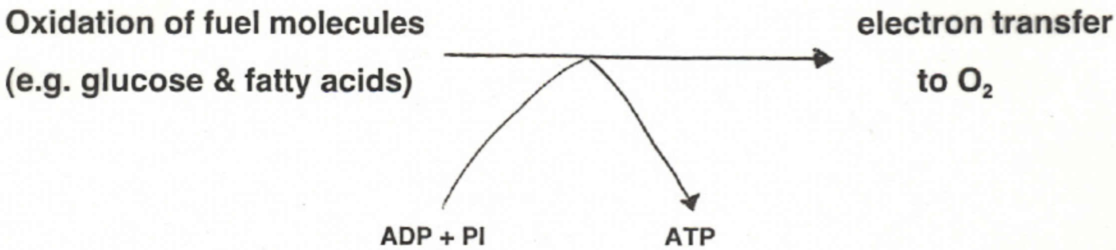


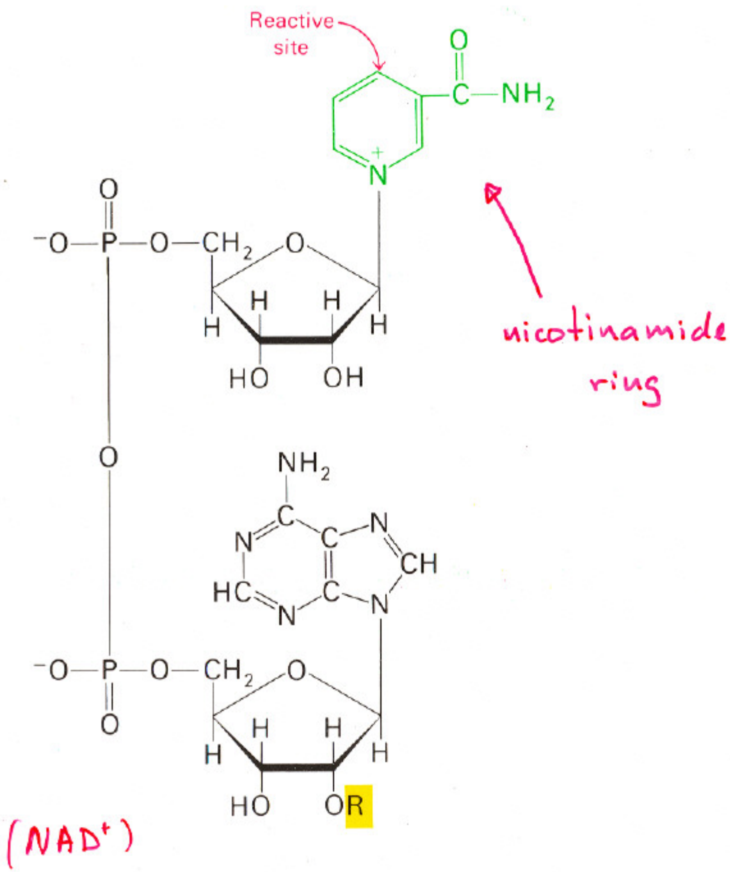
Figure 13-2. *Key to Metabolism.* **Overview of catabolism.** Complex metabolites such as carbohydrates, proteins, and lipids are degraded first to their monomeric units, chiefly glucose, amino acids, fatty acids, and glycerol, and then to the common intermediate, acetyl-CoA. The acetyl group is oxidized to CO_2 via the citric acid cycle with the concomitant reduction of NAD^+ and FAD. Reoxidation of NADH and $FADH_2$ by O_2 during oxidative phosphorylation yields H_2O and ATP.

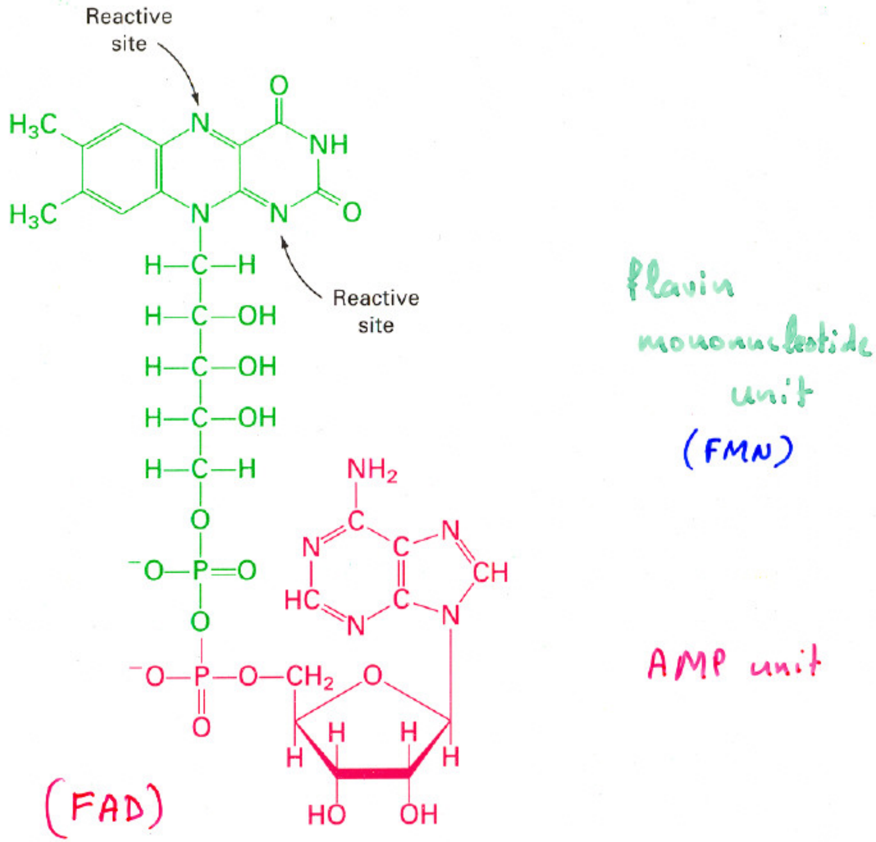
NADH & $FADH_2$

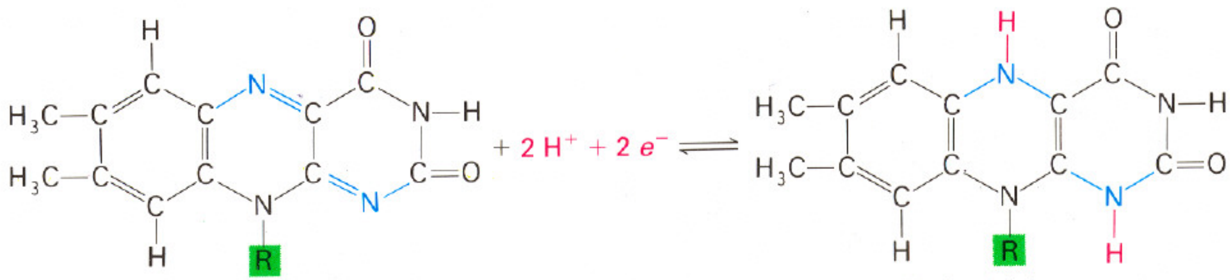
In heterotroph organisms: oxidative phosporylation



NAD^+ (Nicotinamide Adenine Dinucleotide) and FAD (Flavin Adenine Dinucleotide) are the intermediate electron acceptors.







Oxidized form (FAD)

Reduced form ($FADH_2$)

Figure 17-7, page 449; Figures 17-8 and 17-9, page 450

T-49

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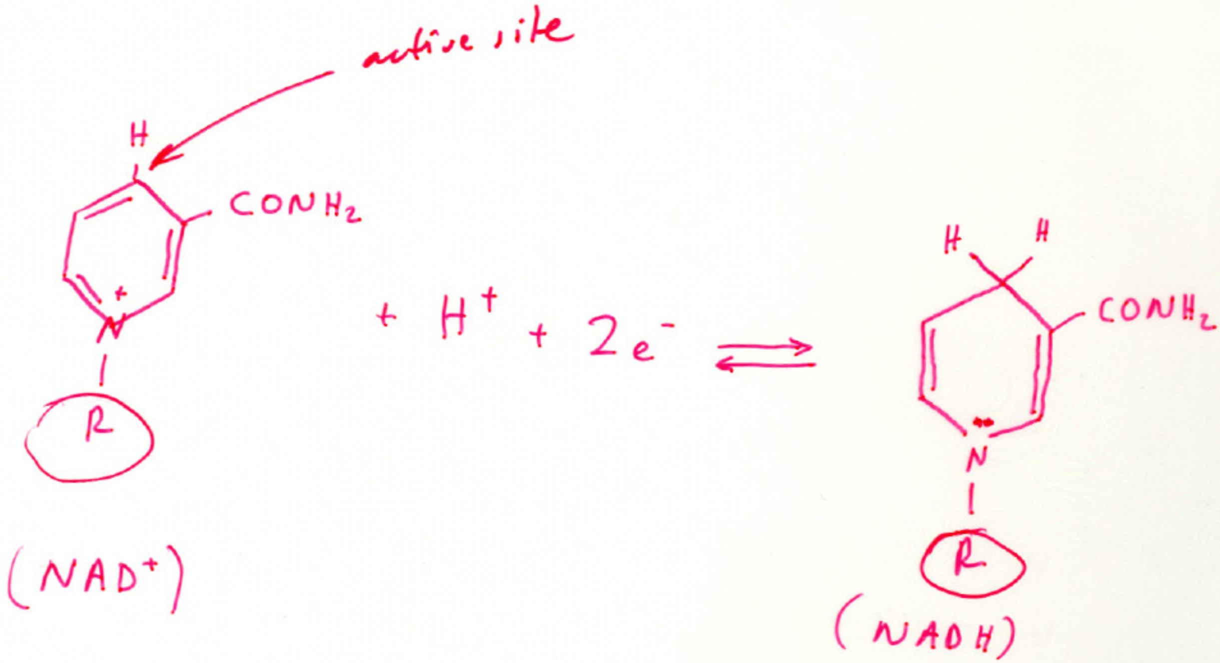

$$NAD^+ + R-\underset{\displaystyle OH}{\overset{\displaystyle H}{C}}-R' \rightleftharpoons NADH + R-\underset{\displaystyle O}{\overset{}{\underset{\|}{C}}}-R' + H^+$$

dehydrogenation reaction

Stereospecificity of Dehydrogenases That Employ NAD^+ or $NADP^+$ as Coenzymes

Enzyme	Coenzyme	Stereochemical specificity for nicotinamide ring (A or B)
Isocitrate dehydrogenase	NAD^+	A
α-Ketoglutarate dehydrogenase	NAD^+	B
Glucose 6-phosphate dehydrogenase	$NADP^+$	B
Malate dehydrogenase	NAD^+	A
Glutamate dehydrogenase	NAD^+ or $NADP^+$	B
Glyceraldehyde 3-phosphate dehydrogenase	NAD^+	B
Lactate dehydrogenase	NAD^+	A
Alcohol dehydrogenase	NAD^+	A

Some Enzymes (Flavoproteins) That Employ Flavin Nucleotide Coenzymes

Enzyme	Flavin nucleotide
Fatty acyl–CoA dehydrogenase	FAD
Dihydrolipoyl dehydrogenase	FAD
Succinate dehydrogenase	FAD
Glycerol 3-phosphate dehydrogenase	FAD
Thioredoxin reductase	FAD
NADH dehydrogenase (Complex I)	FMN
Glycolate dehydrogenase	FMN

ORIGIN OF RIBONUCLEOTIDES

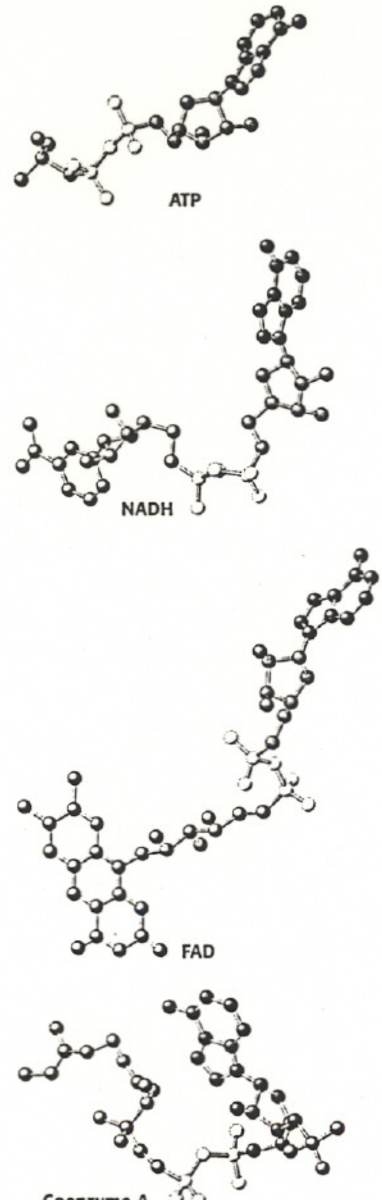

FIGURE 14.19 Adenosine diphosphate (ADP) is an ancient module in metabolism. This fundamental building block is present in key molecules such as ATP, NADH, FAD, and coenzyme A. The adenine unit is shown in blue, the ribose unit in red, and the diphosphate unit in yellow.

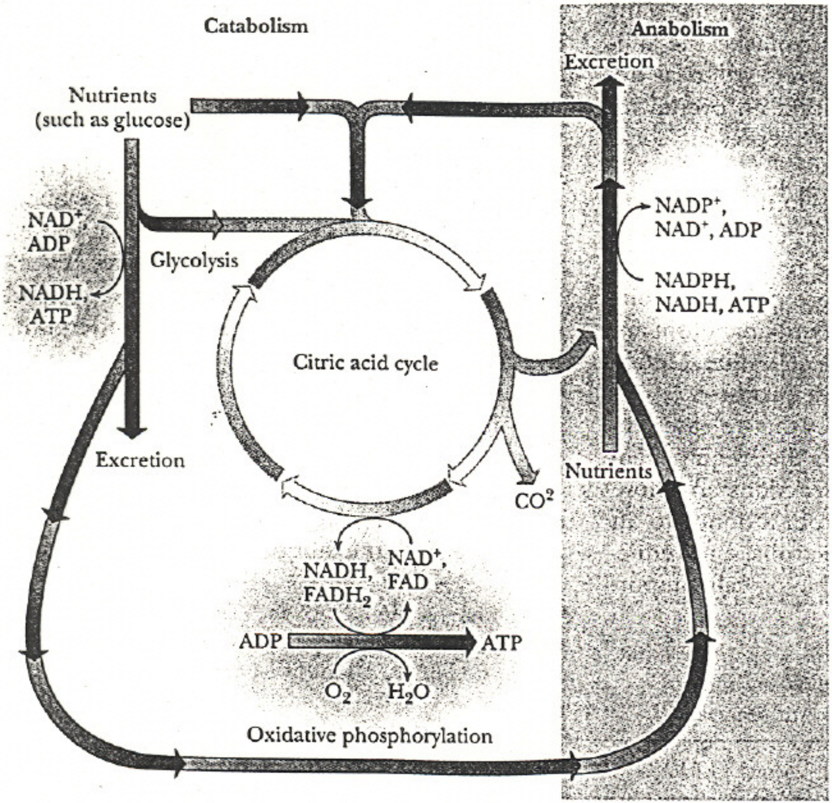

FIGURE 12.14
The role of electron transfer and ATP production in metabolism. NAD^-, FAD^-, and ATP are constantly recycled.

COENZYME A (CoA)

Coenzyme A: A heat- stable enzyme cofactor that is required in many enzyme- catalyzed acetylation reactions

H—S— CoA **CoA**

O

||

R—C— S— CoA **AcylCoA**

O

||

H_3C—C— S —CoA **Acetyl CoA**

Acetyl CoA + H_2O ⇔ Acetate + CoA + H^+ $\Delta G^{\circ\prime} = -7.5$ kcal/ mol

Acetyl CoA has a high acetyl potential

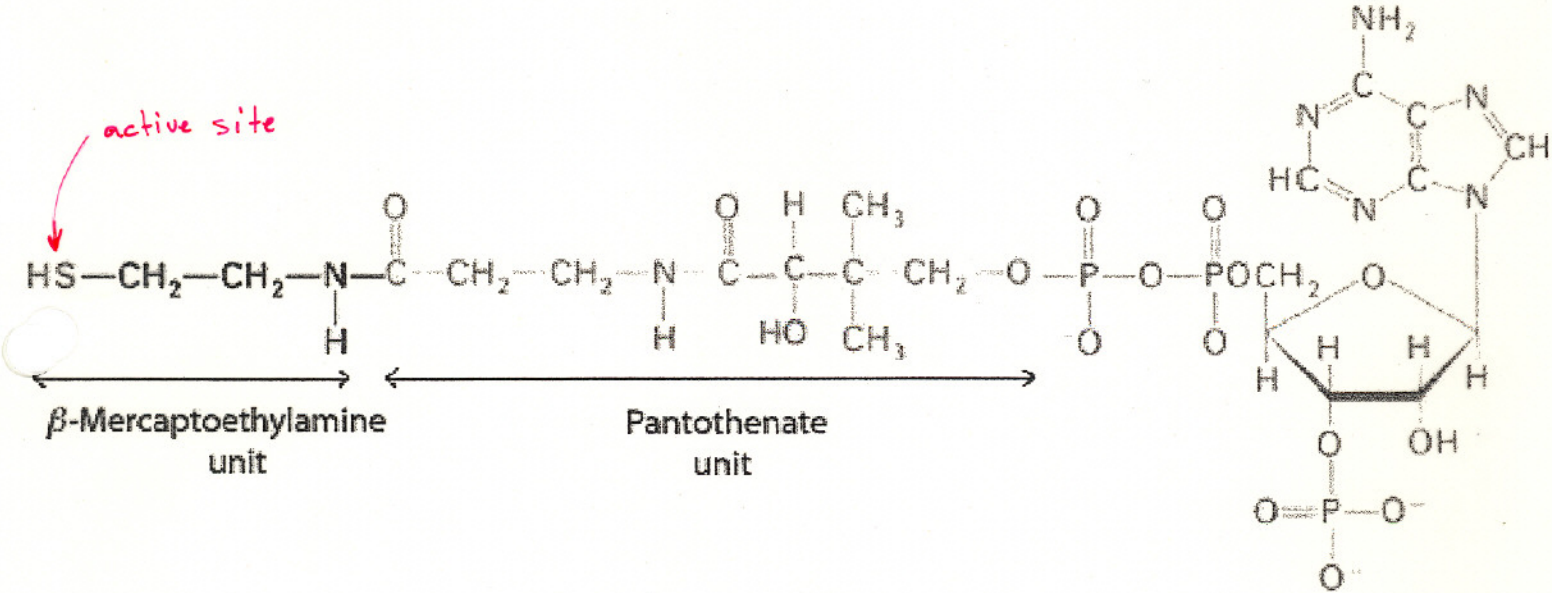

Fig 17- 10

Minerals:

(i) **majors: present in more than 5 g quantities in the human body**

(ii) **minors: present at lower quantities**

- **<u>calcium</u> and <u>phosphorus</u> are the principal minerals in the skeleton, but both also play important roles in metabolism**

- **<u>calcium</u> is a prominent intracellular signaling agent**

- **<u>phosphate</u> is part of DNA and RNA and organic phosphates are key intermediates in energy metabolism**

- **<u>potassium</u>, <u>sodium</u>, and <u>chloride</u> are crucial in maintaining fluid and electrolyte balance**

- **<u>potassium</u> is also an essential activator for some enzyme**

- **most of the remaining minerals serve as cofactors for enzymes**

Table 14.7 Principal Minerals in the Human Body

Mineral	Amount*
Major	
Calcium	1150
Phosphorus	600
Potassium	210
Sulfur	150
Sodium	90
Chloride	90
Magnesium	30
Trace	
Iron	2.4
Zinc	2.0
Copper	0.09
Manganese	0.02
Iodine	0.02
Selenium	0.02

Fluoride, molybdenum, and chromium are essential trace elements present in even lower amounts in the body. Evidence for silicon, tin, vanadium, boron, aluminum, and even arsenic as essential trace elements for humans has been reported.

*Amounts given are grams present in a typical 60-kg human.