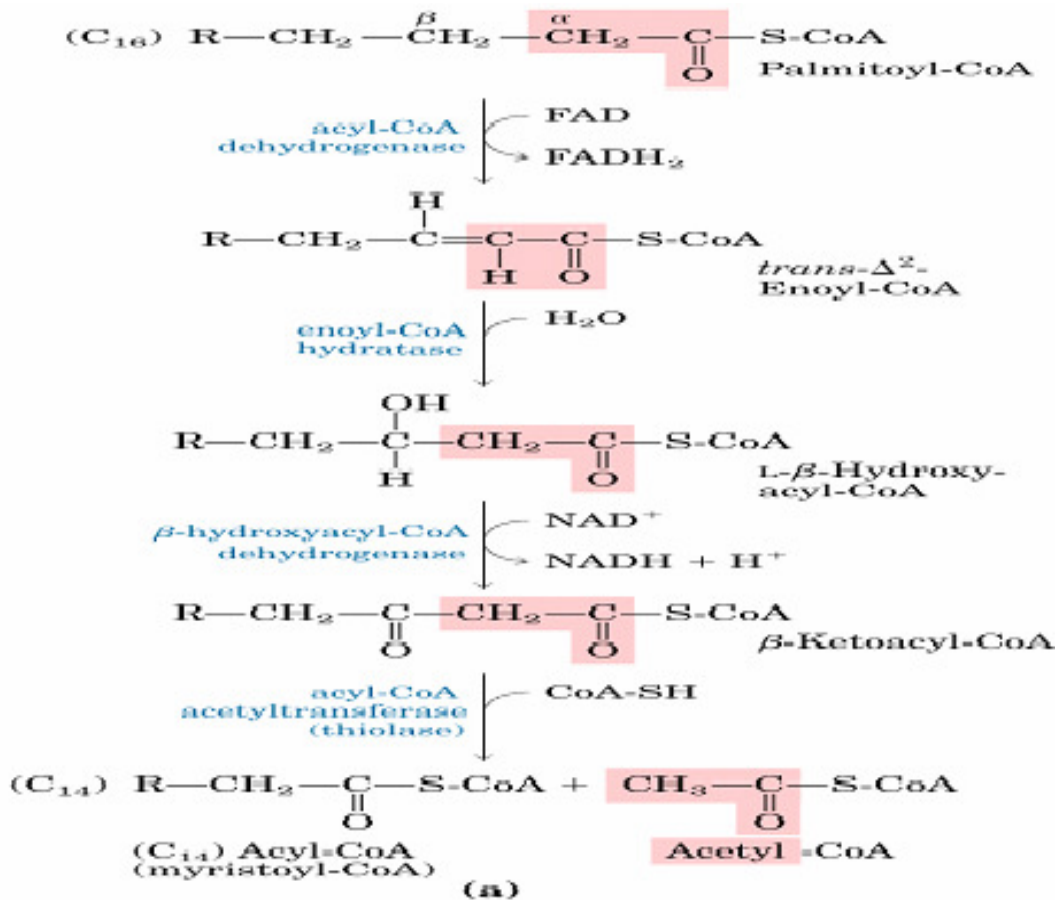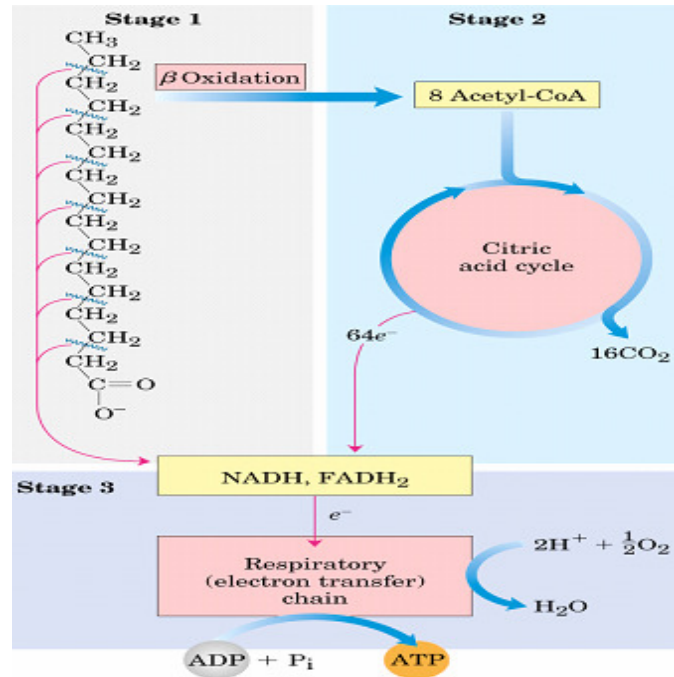## Oxidation of Fatty Acids

β-oxidation

(C_{16}) $R-CH_2-\overset{\beta}{C}H_2-\overset{\alpha}{C}H_2-\overset{O}{\underset{\|}{C}}-S\text{-}CoA$ Palmitoyl-CoA

acyl-CoA dehydrogenase — FAD → FADH$_2$

$R-CH_2-\overset{H}{\underset{H}{C}}=\overset{O}{\underset{\|}{C}}-S\text{-}CoA$ *trans*-Δ^2- Enoyl-CoA

enoyl-CoA hydratase — H$_2$O

$R-CH_2-\overset{OH}{\underset{H}{C}}-CH_2-\overset{O}{\underset{\|}{C}}-S\text{-}CoA$ L-β-Hydroxy-acyl-CoA

β-hydroxyacyl-CoA dehydrogenase — NAD$^+$ → NADH + H$^+$

$R-CH_2-\overset{O}{\underset{\|}{C}}-CH_2-\overset{O}{\underset{\|}{C}}-S\text{-}CoA$ β-Ketoacyl-CoA

acyl-CoA acetyltransferase (thiolase) — CoA-SH

(C_{14}) $R-CH_2-\overset{O}{\underset{\|}{C}}-S\text{-}CoA$ + $CH_3-\overset{O}{\underset{\|}{C}}-S\text{-}CoA$

(C_{14}) Acyl-CoA (myristoyl-CoA)   Acetyl-CoA

(a)

C14 → Acetyl -CoA
C12 → Acetyl -CoA
C10 → Acetyl -CoA
C8   → Acetyl -CoA
C6   → Acetyl -CoA
C4   → Acetyl -CoA

Acetyl -CoA

(b)

Oxidation of monounsaturated fatty acid

18 ⋯⋯ 9 ⋯⋯ 1 C
O
S-CoA

Oleoyl-CoA

β oxidation
(three cycles) → 3 Acetyl-CoA

12 ⋯ H H C
O
S-CoA

cis-Δ^3-
Dodecenoyl-CoA

enoyl-CoA isomerase

12 ⋯ H C
O
S-CoA
H

trans-Δ^2-
Dodecenoyl-CoA

β oxidation
(five cycles)
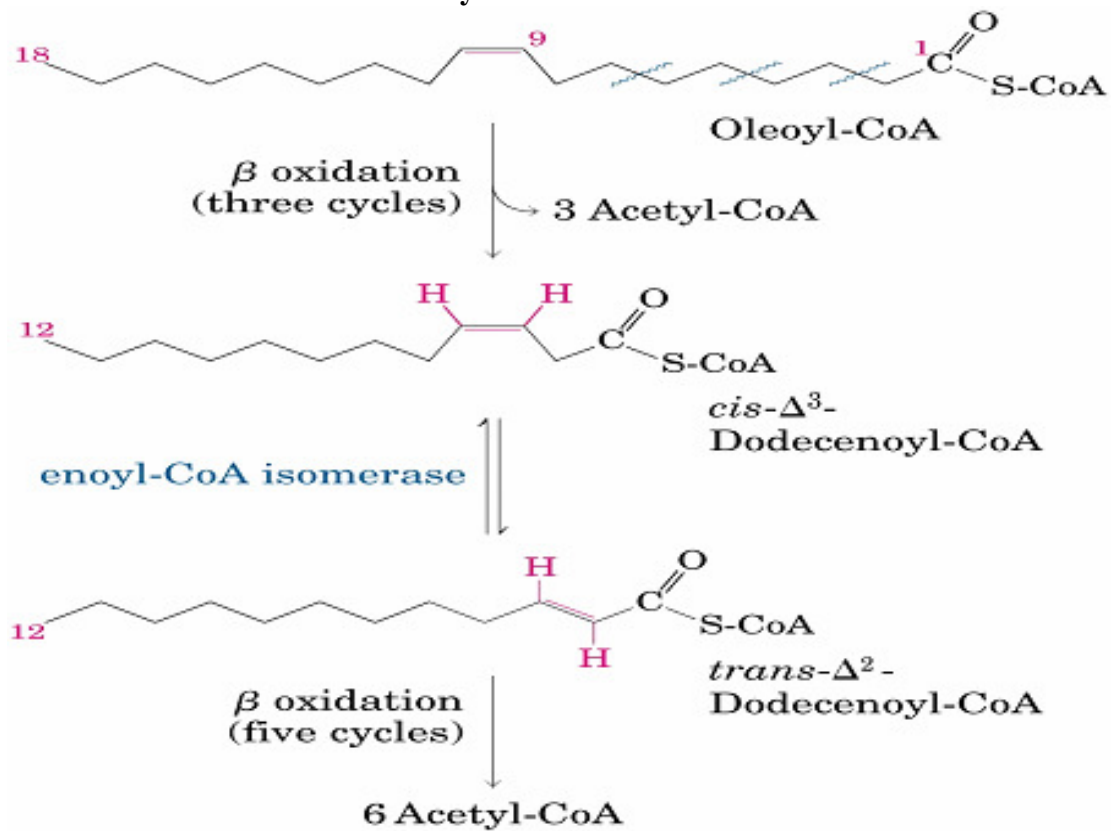
6 Acetyl-CoA

Oxidation of polyunsaturated fatty acid

Linoleoyl-CoA
cis-Δ^9,cis-Δ^{12}

β oxidation
(three cycles) → 3 Acetyl-CoA

cis-Δ^3,cis-Δ^6

enoyl-CoA
isomerase

$trans$-Δ^2,cis-Δ^6

β oxidation
(one cycle, and
first oxidation
of second cycle) → Acetyl-CoA

$trans$-Δ^2,cis-Δ^4

2,4-dienoyl-CoA
reductase
— NADPH + H$^+$
→ NADP$^+$

$trans$-Δ^3

enoyl-CoA
isomerase

$trans$-Δ^2

β oxidation
(four cycles)
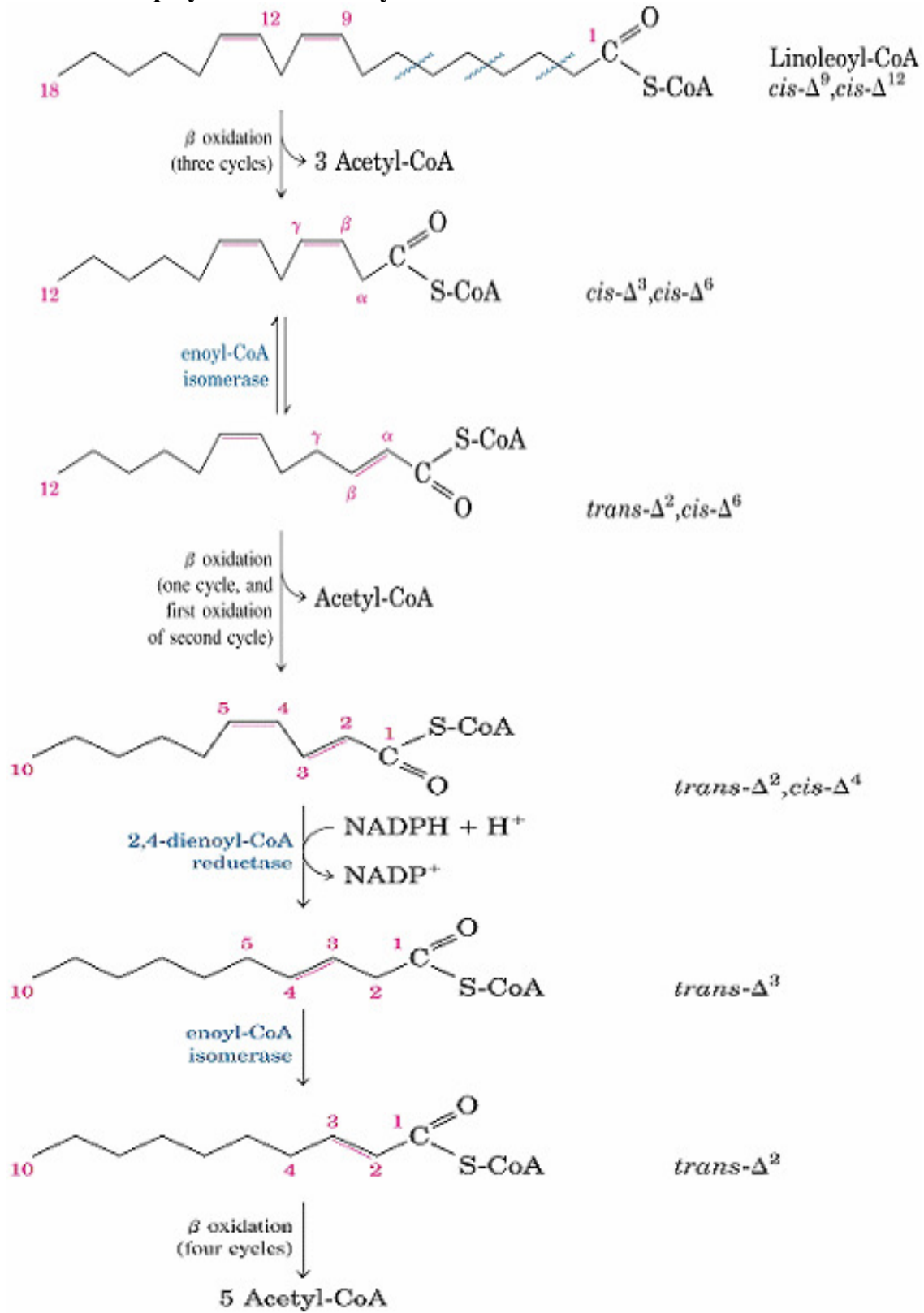
5 Acetyl-CoA

Oxidation of odd number fatty acid

Propionyl-CoA

propionyl-CoA
carboxylase | biotin

HCO_3^-
ATP

ADP + P_i

D-Methylmalonyl-CoA

methylmalonyl-CoA
epimerase

coenzyme
B_{12}

methyl-
malonyl-CoA
mutase

L-Methylmalonyl-CoA

Succinyl-CoA
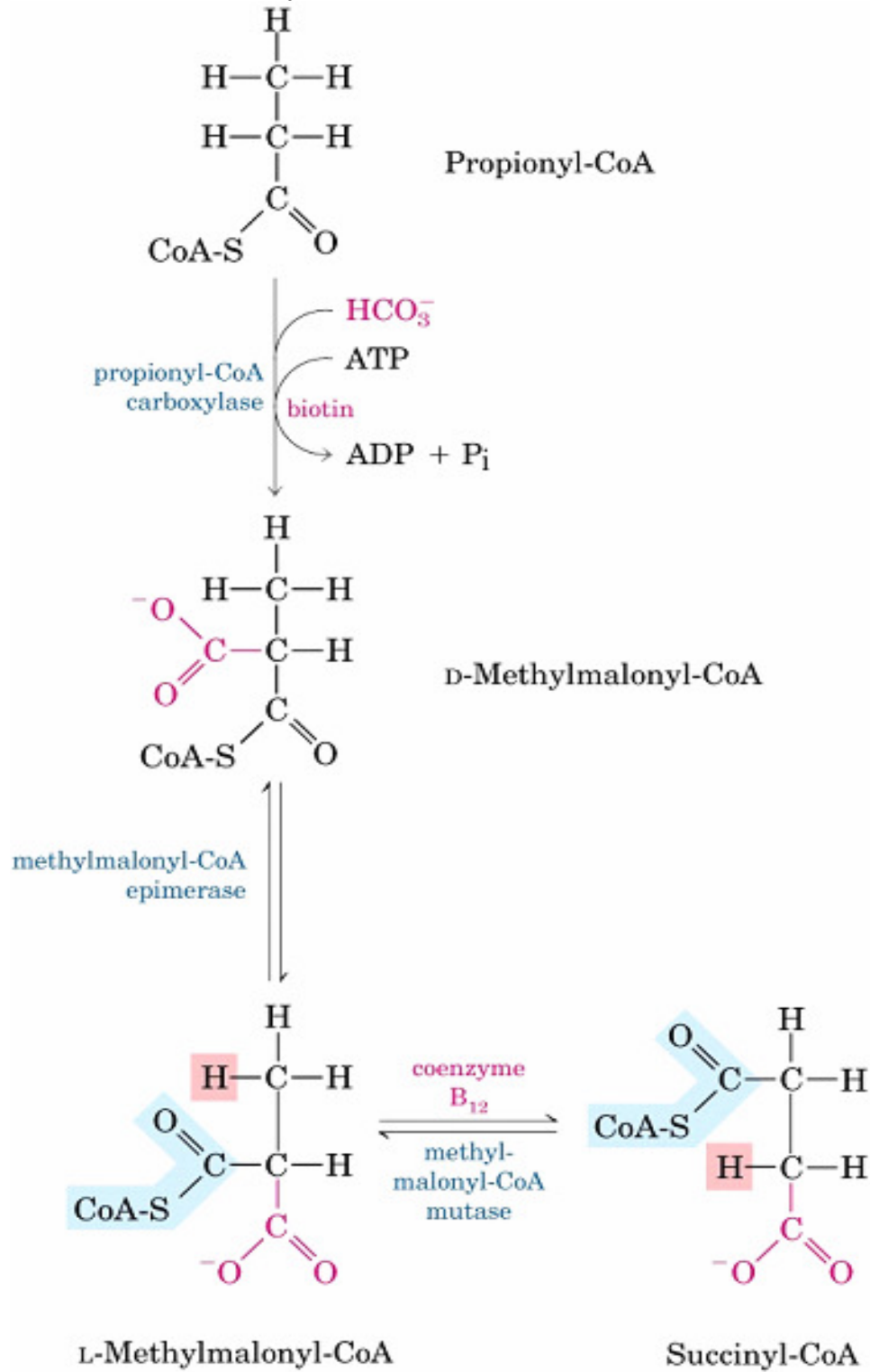
Mitochondrion   **Peroxisome/glyoxysome**

$$R-CH_2-CH_2-C\overset{\displaystyle O}{\underset{\displaystyle S\text{-}CoA}{\Big\|}}$$

O_2 — **Respiratory chain** — FAD ⇌ FAD ⇌ H_2O_2

H_2O — FADH$_2$ ⇌ FADH$_2$ ⇌ O_2

ATP $H_2O + \tfrac{1}{2}O_2$

$$R-\overset{\displaystyle H}{\underset{\displaystyle H}{C}}=C-C\overset{\displaystyle O}{\underset{\displaystyle S\text{-}CoA}{\Big\|}}$$

H_2O — | — H_2O

$$R-\overset{\displaystyle OH}{\underset{\displaystyle H}{C}}-CH_2-C\overset{\displaystyle O}{\underset{\displaystyle S\text{-}CoA}{\Big\|}}$$

O_2 — **Respiratory chain** — NAD^+ ⇌ NAD^+ ⤙⤙ NADH exported for reoxidation

H_2O — NADH ⇌ NADH ⤙⤙

ATP

$$R-\overset{\displaystyle O}{C}-CH_2-C\overset{\displaystyle O}{\underset{\displaystyle S\text{-}CoA}{\Big\|}}$$

CoASH — | — CoASH

$$R-C\overset{\displaystyle O}{\underset{\displaystyle S\text{-}CoA}{\Big\|}}$$

$+$

Citric acid cycle ⬅--- $CH_3-C\overset{\displaystyle O}{\underset{\displaystyle S\text{-}CoA}{\Big\|}}$ ---➤ Acetyl-CoA exported

Seed triacylglycerols

↓ lipases

Fatty acids

↓ β oxidation

Acetyl-CoA

↓ glyoxylate cycle
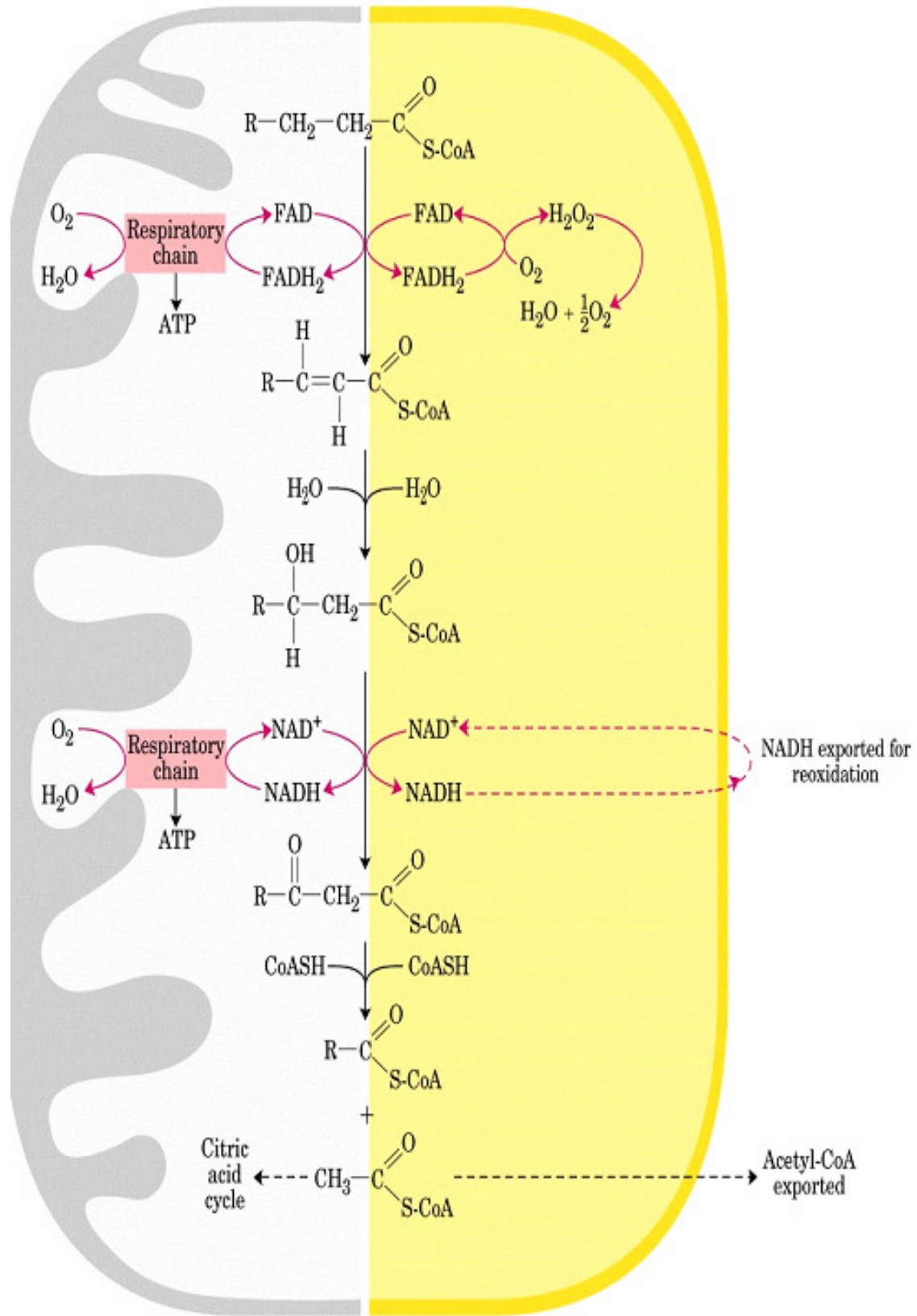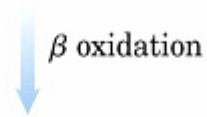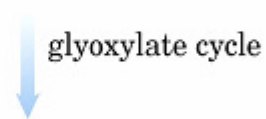
Oxaloacetate

↓ gluconeogenesis
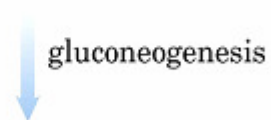
Glucose

Sucrose, polysaccharides ← Glucose → Metabolic intermediates

Amino acids ← Glucose → Nucleotides

↓

Energy