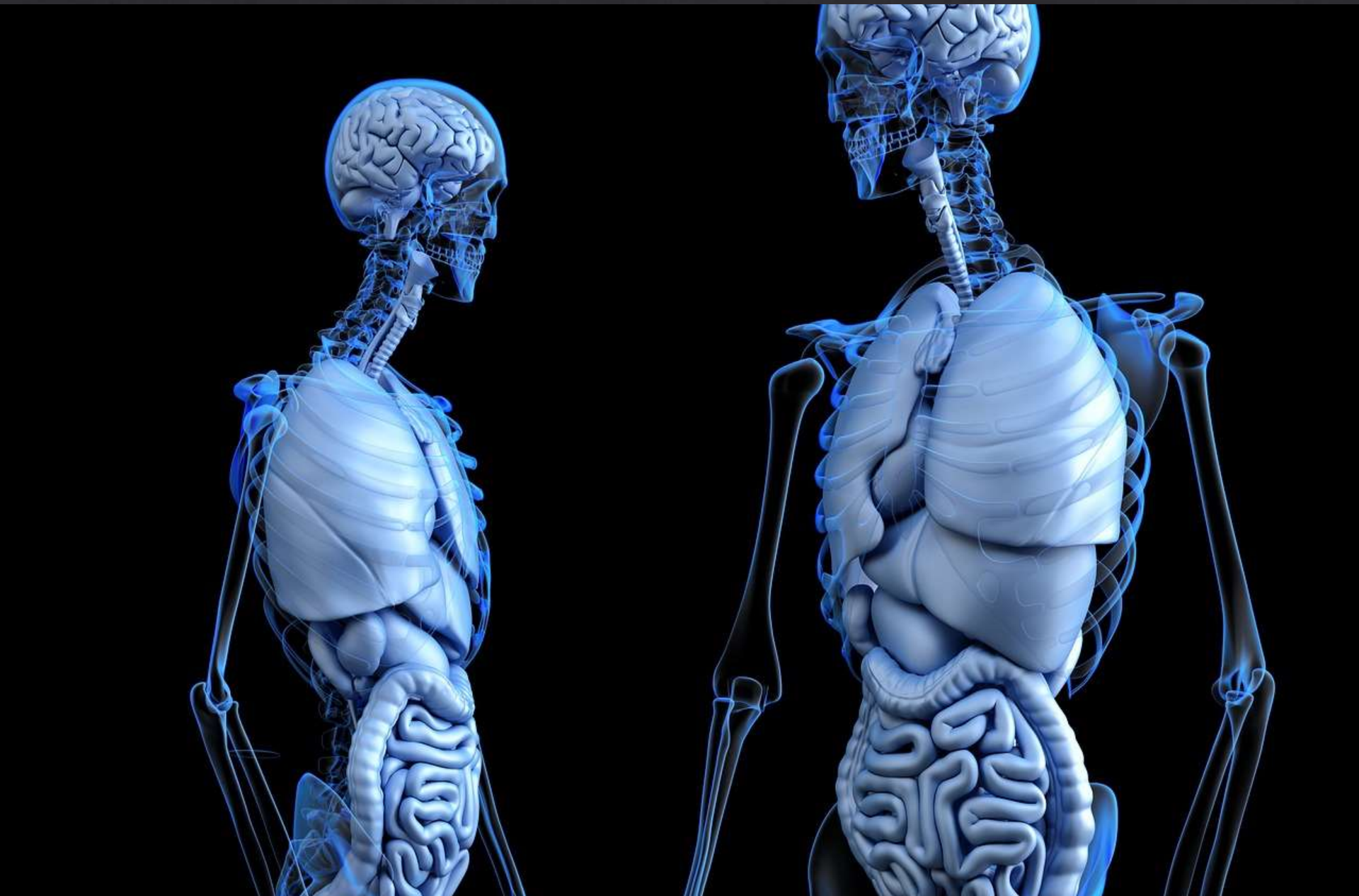
Urea cycle and organs



Urea cycle

- Amino nitrogen – ammonia (aquatic spp)/ urea (terrestrial animals)/ uric acid (birds)
- Liver mitochondria and cytosol
- ATP dependent, 4 enzymatic steps (regulation on the first)
- Diet dependent

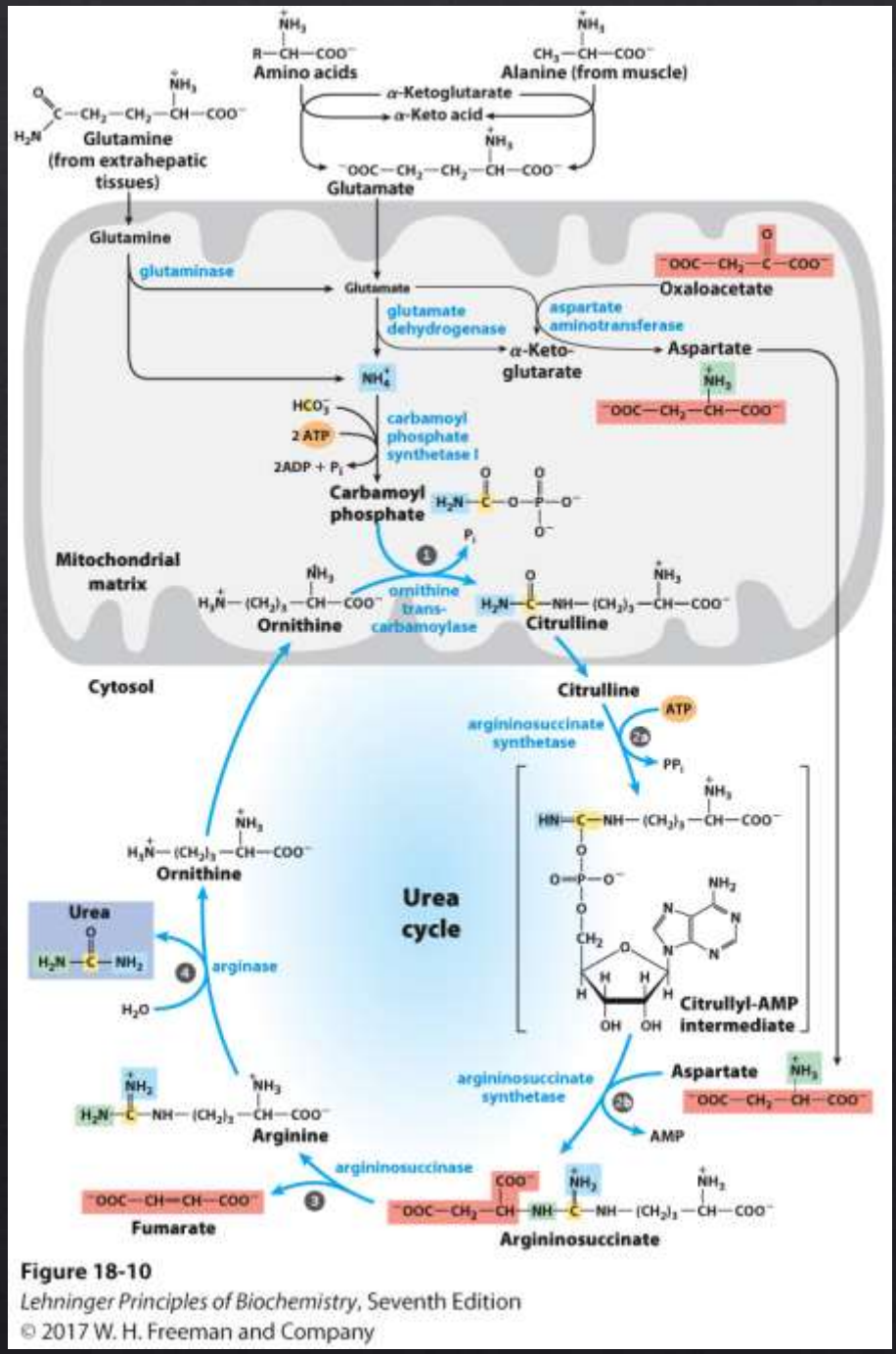


Figure 18-10

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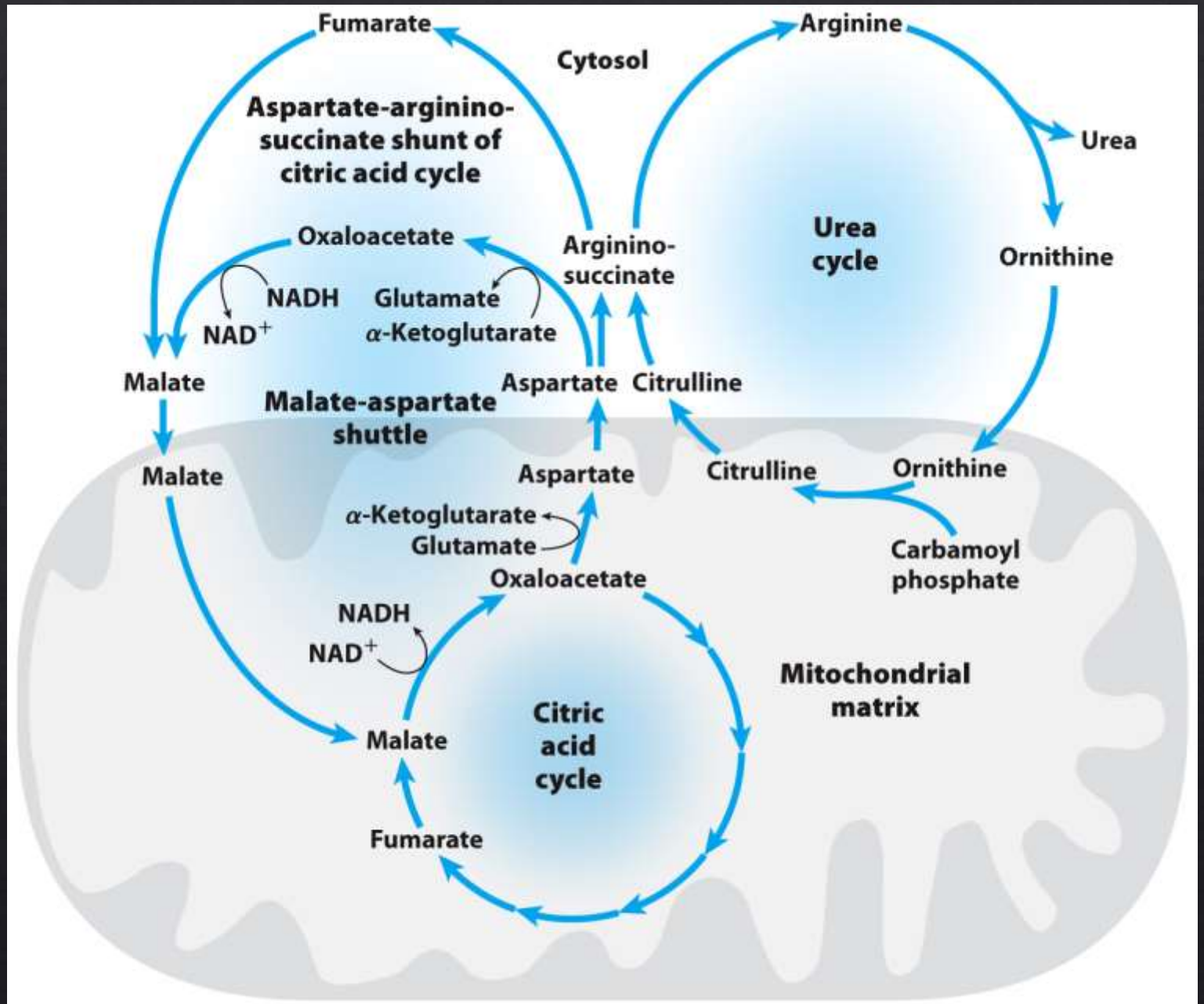

Figure 18-12
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Tissues and organs

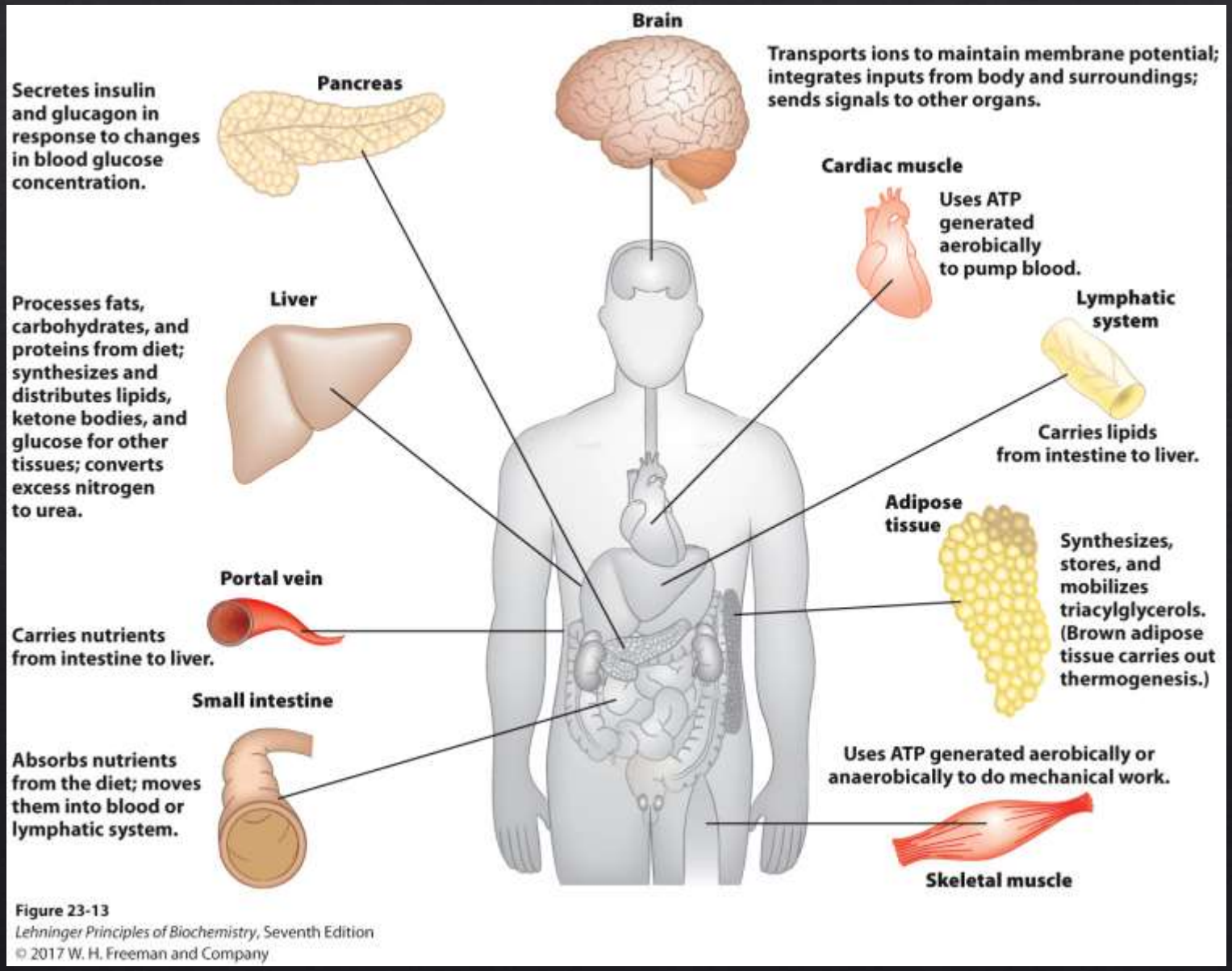


Figure 23-13

Lehninger Principles of Biochemistry, Seventh Edition

The liver

- The portal vein carries nutrients to the liver.
- Hepatocytes turn nutrients into fuel.
- Hepatocyte enzymes turn over quickly.
- Enzymes increase or decrease with changes in diet and the needs of other tissues.

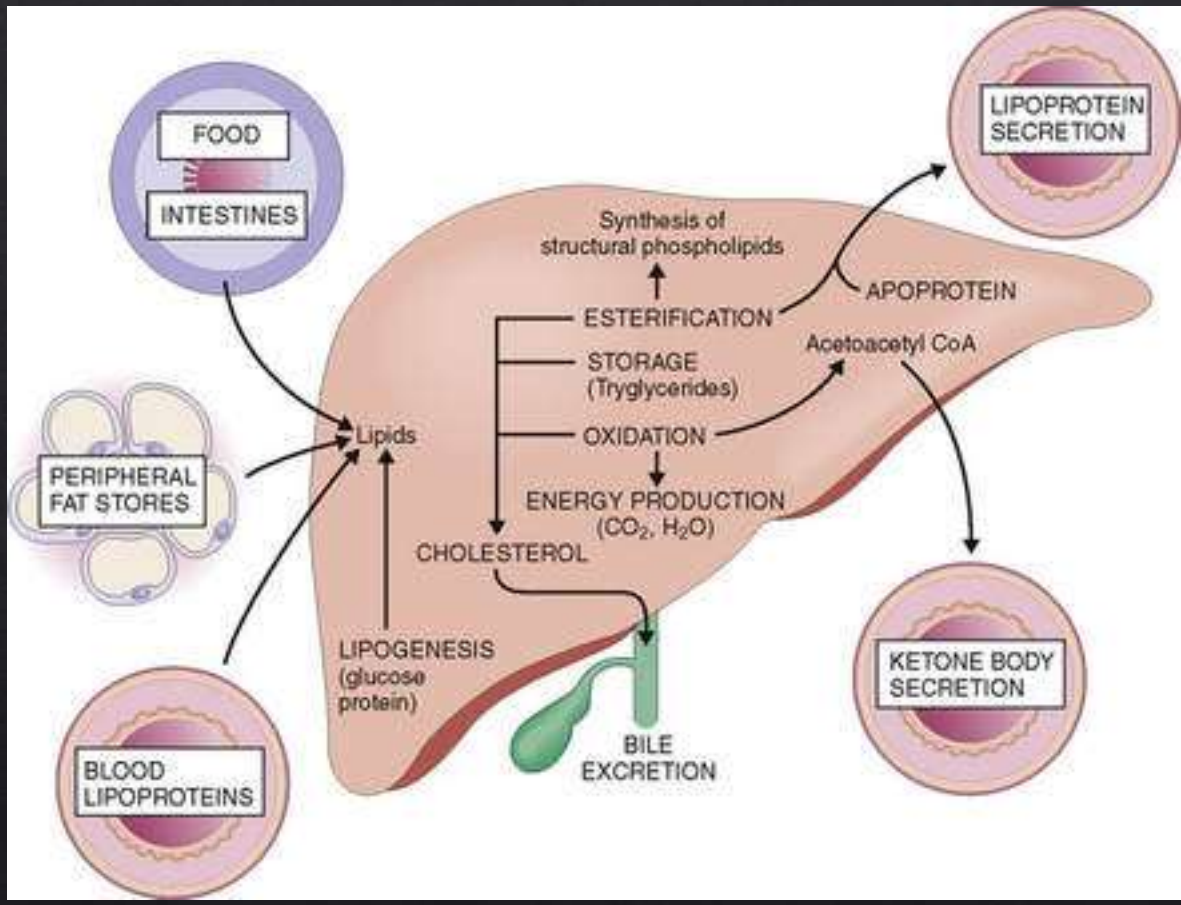


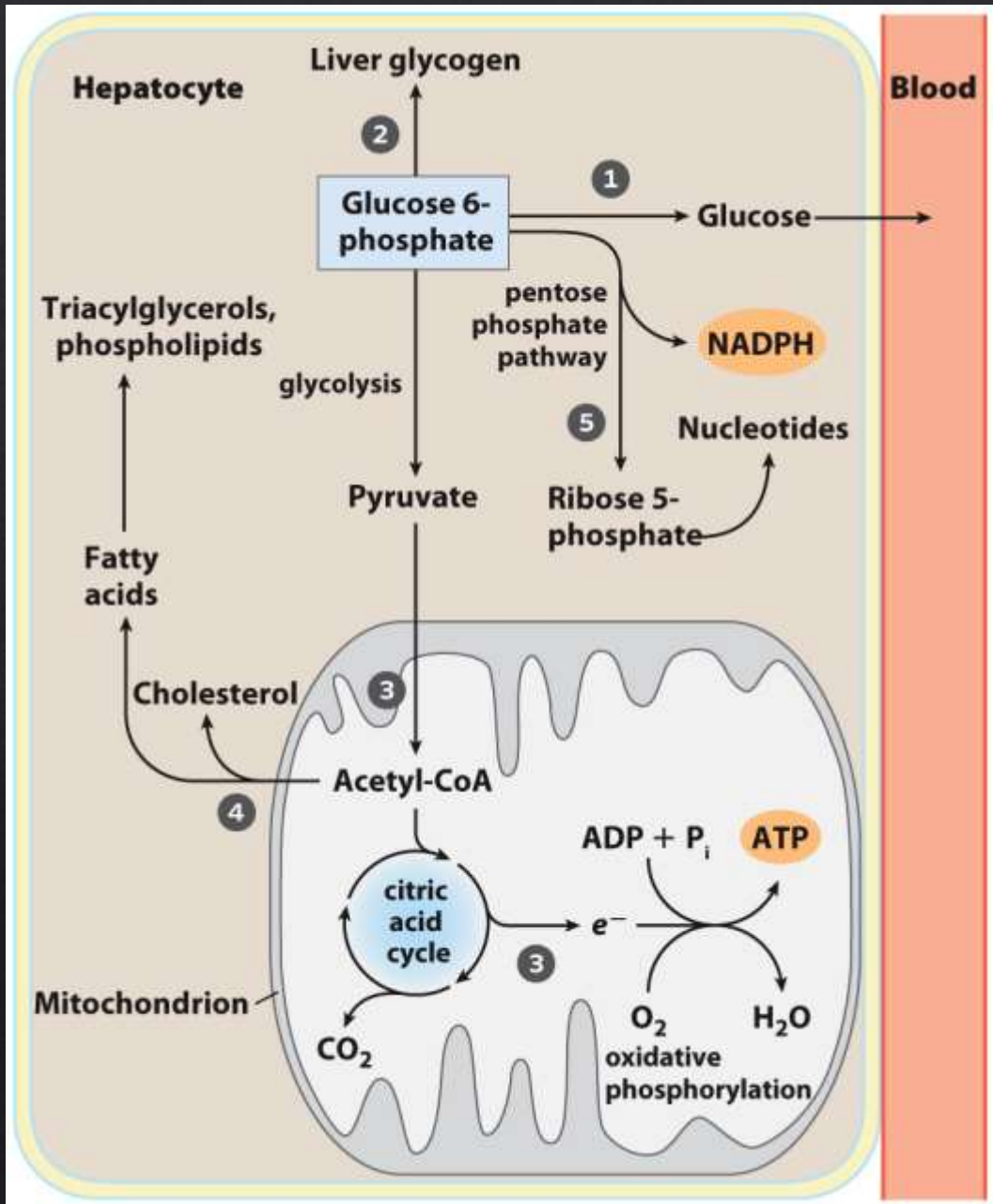
Image from BasicMedical Keys

Sugars in the liver

- Simple sugars convert to glucose-6-phosphate (G6p)
- G6p can be produced by multiple pathways, can be used in multiple processes
- Hepatocytes have GLUT2 transporter
- Hepatocytes have glucokinase (hexokinase IV)
  - Not inhibited by G6p → continuous production
  - Allows higher glucose concentrations
  - No G6p production at low levels of glucose

G6p in the liver

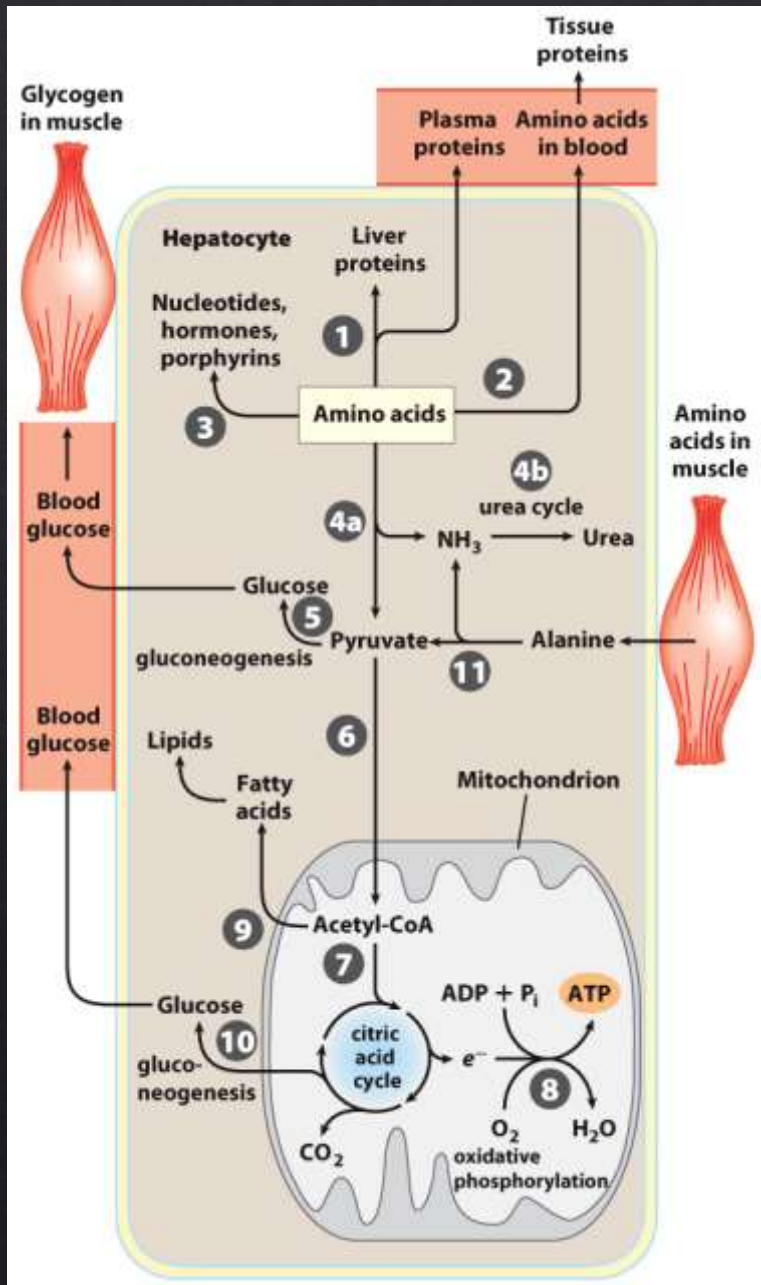
- Dephosphorylate to yield free glucose to send to other tissues
- Make into liver glycogen
- Enter glycolysis, make acetyl CoA and then ATP for hepatocytes themselves
- Enter glycolysis, make acetyl CoA to be made into fatty acids and then TAGs
- Enter pentose phosphate pathway to yield NADPH and ribose-5-phosphate



Picture from Nelson&Cox

Amino acids in the liver

- Make into proteins for liver and other tissues
- Make into hormones, nucleotides
- Make into citric acid cycle intermediates or pyruvate:
  - for gluconeogenesis
  - convert pyruvate to acetyl-CoA for:
    - liver cell energy
    - conversion to lipids



Picture from Nelson&Cox

Fatty acids in the liver

- FA are primary fuel for liver
- Production of:
  - liver lipids
  - Phospholipids
  - TAGs for storage
  - acetyl-CoA and NADH
    - excess acetyl-CoA → ketone bodies for other tissues during carbs restriction, fasting
- Carry FA to heart and muscle for oxidation

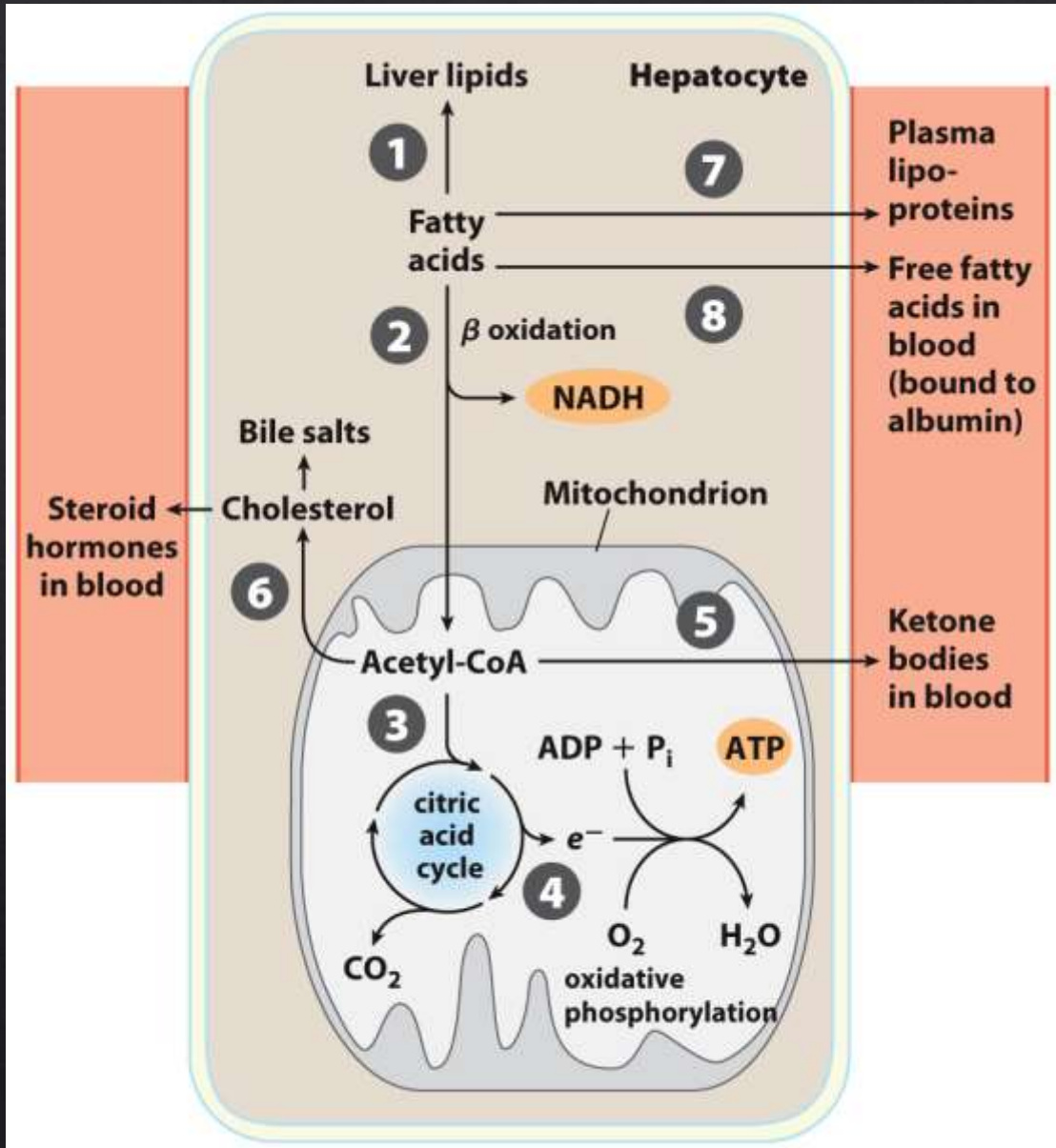


Figure 23-16
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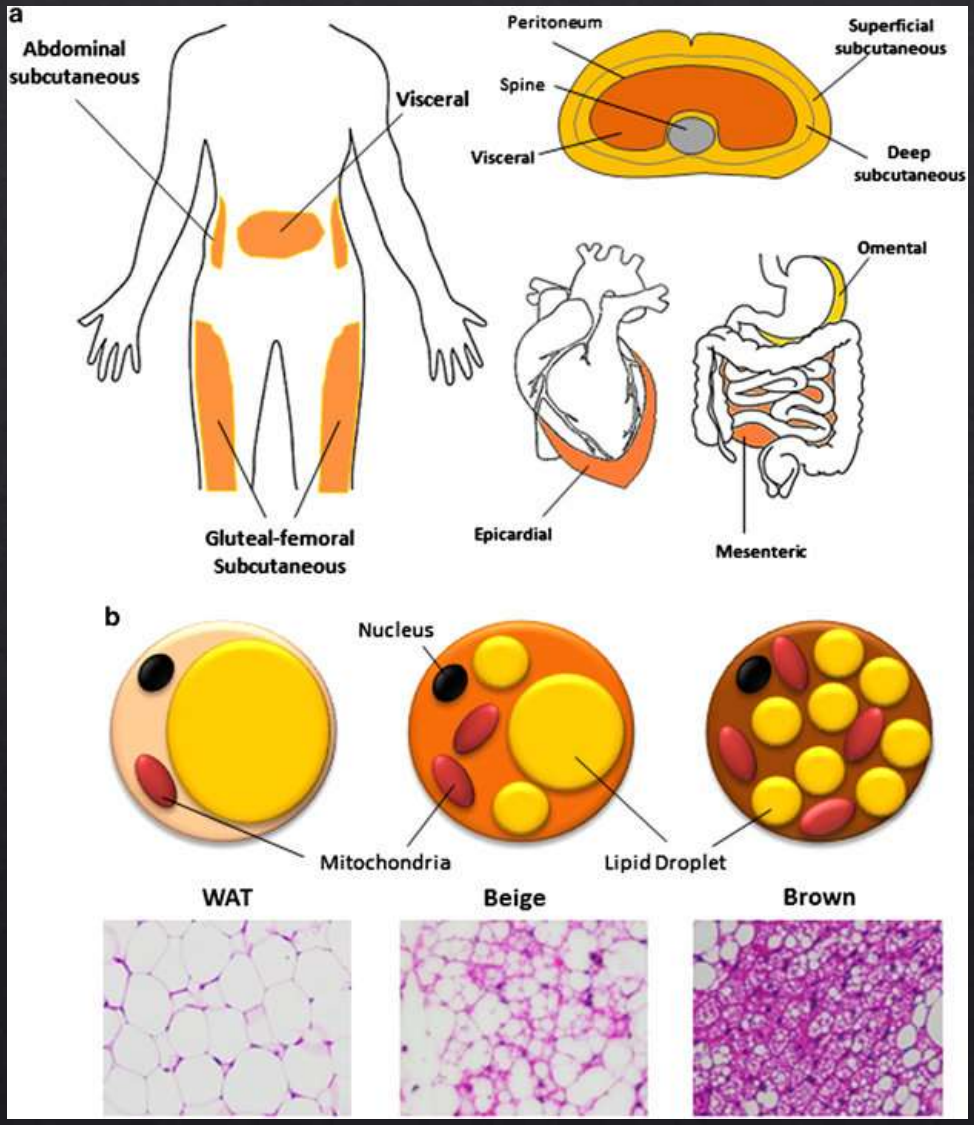
Adipose tissue

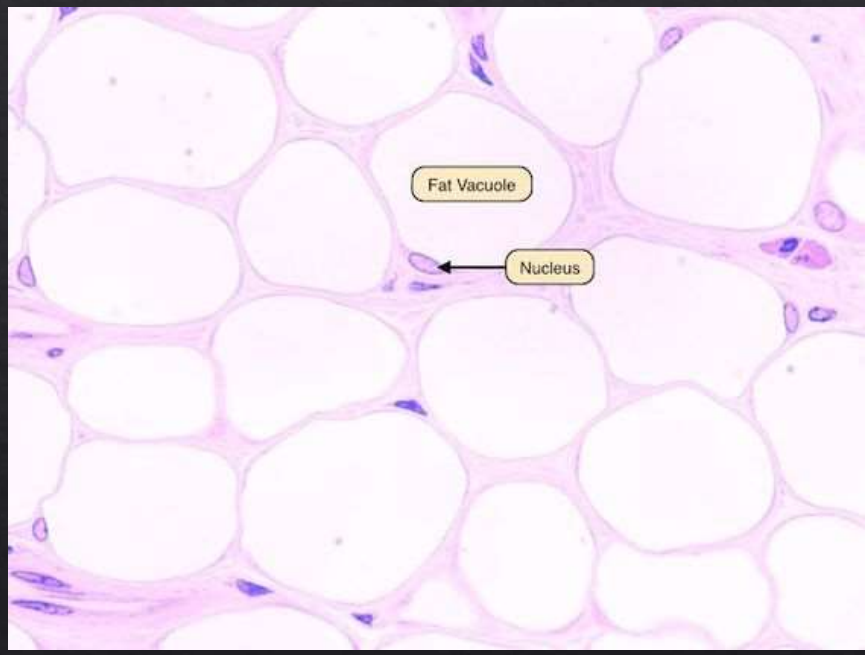
- White adipose tissue (WAT)
  - large spherical cells with one lipid droplet
  - little room left for mitochondria and nucleus
- Brown adipose tissue (BAT)
  - smaller
  - several lipid droplets
  - more mitochondria
  - uncoupling protein 1 (UCP1)



Picture from Kwok at al. (2016)

WAT

- Serves as fuel storage
- Proteins and enzymes for the synthesis and breakdown of TAGs on the surface of the vacuole
- Metabolically active
- Can store or release fatty acids responding to hormone stimulation
- Endocrine organ
  - Produces and releases hormones
  - Regulates metabolism of fats and carbs



Brown and beige adipose tissue

- Better vascularization and innervation than WAT
- Involved in thermoregulation
- UCP1 provides an alternative for electrons produced in the citric acid cycle → heat release
- Oxidase both their own and blood fatty acids and glucose
- Activated by cold and exercise

Photo by Kentish Plumber

Muscle

- Slow-twitch (red muscle)
  - fed by many blood vessels
  - rich in mitochondria
  - energy via slow and steady oxidative phosphorylation
- Fast-twitch (white muscle)
  - fewer mitochondria and lower O_2 delivery
  - uses ATP faster and fatigues faster due to greater demands combined with reduced O_2 delivery
  - Endurance training can increase mitochondria

Muscle

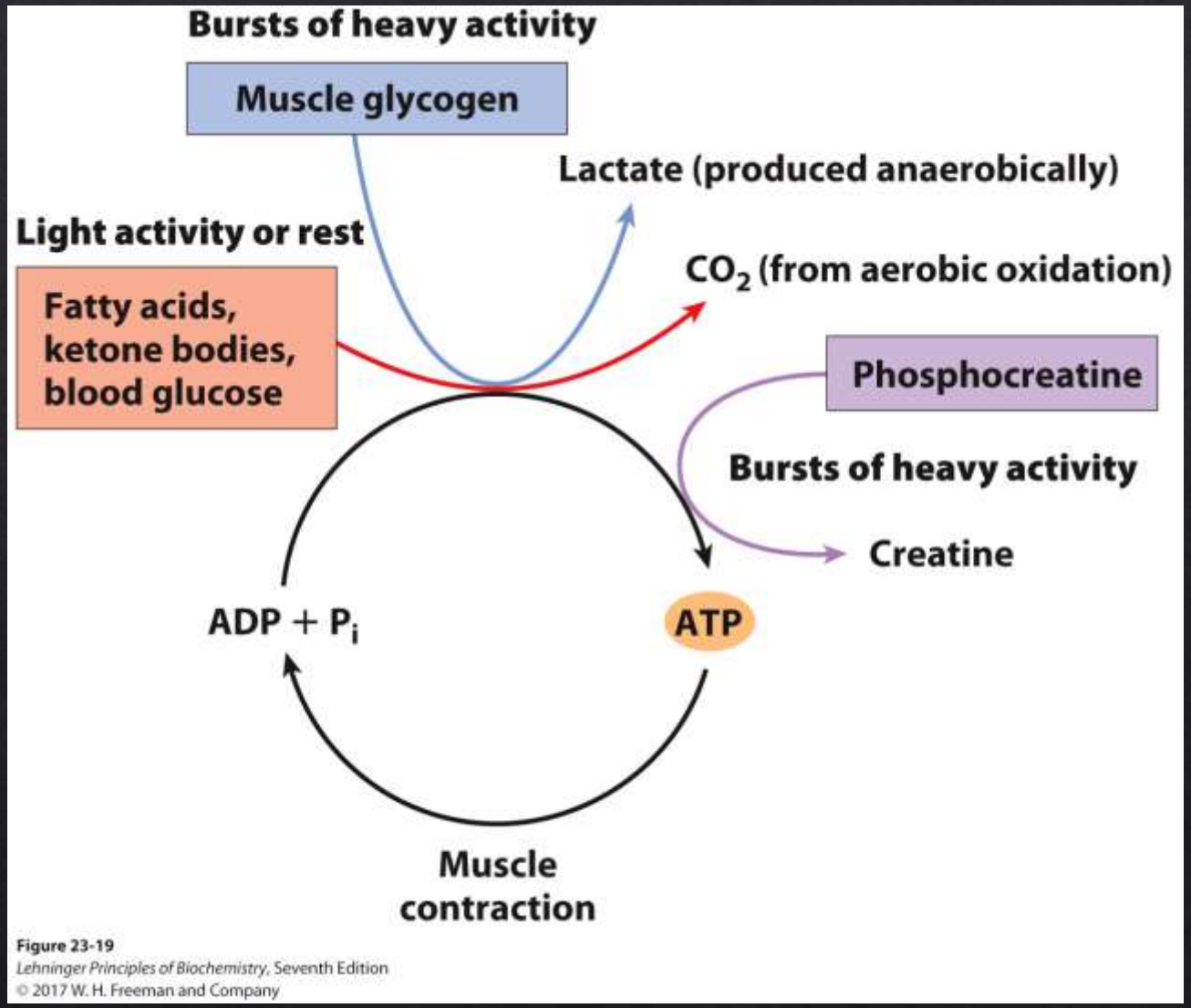


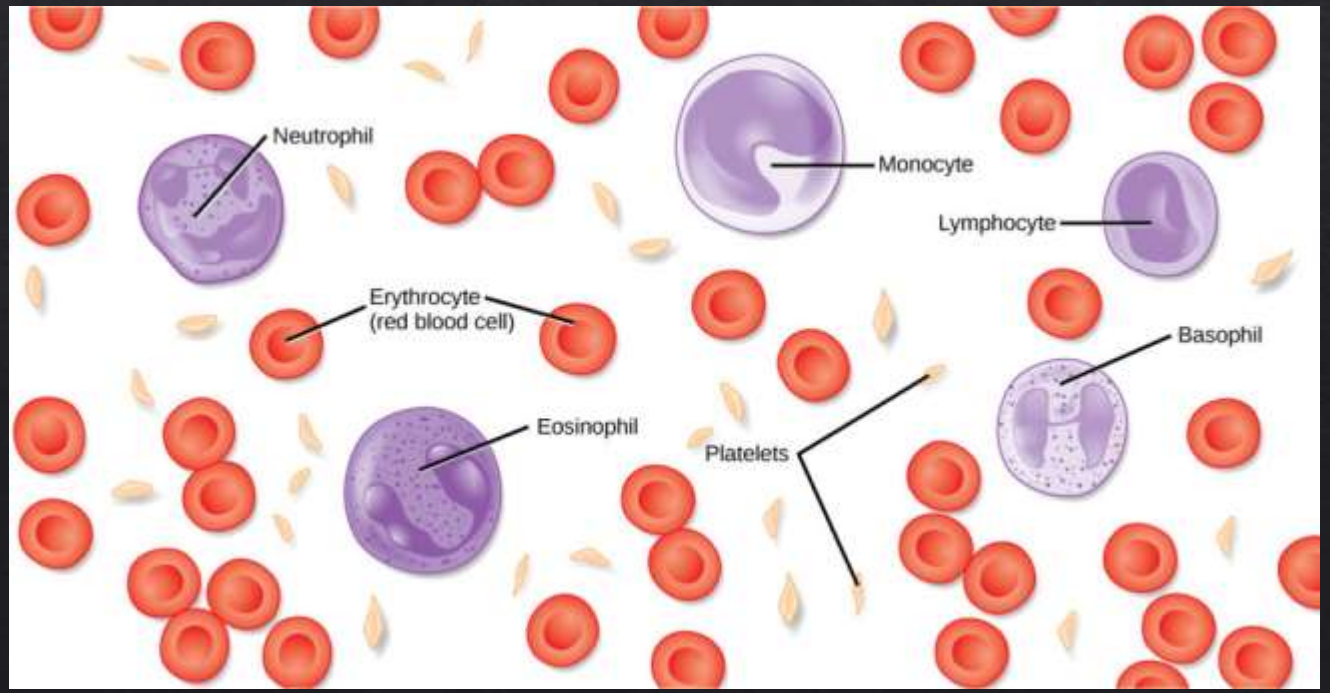
Figure 23-19
Lehninger Principles of Biochemistry, Seventh Edition

Brain

- Made of neurons and glial cells
- Neurons predominantly use glucose (can use ketone bodies if starving)
- Astrocytes can use fatty acids
- Uses almost 20% of the total O_2 consumption (at rest)
- ATP is used to maintain electrical potential across membranes
- Constantly dependent on incoming glucose

Blood

- Mediates interactions among tissues (nutrients, waste, O_2, CO_2, hormonal signals)
- Erythrocytes, leukocytes and platelets almost half of the volume
- Concentrations of many compounds is kept constant



Picture from LumenLearning