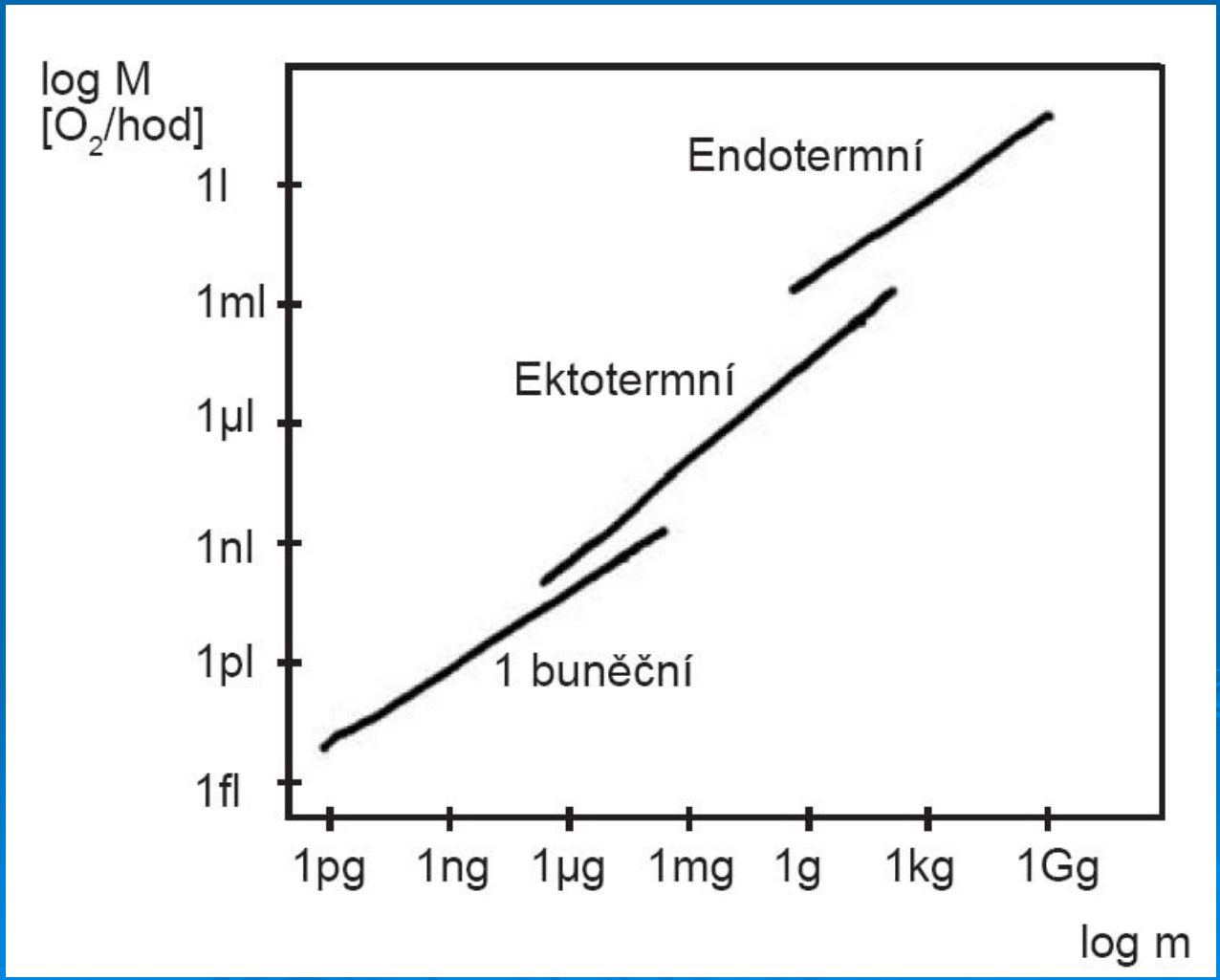
# *Metabolismus a trávení*

Energie k udržení životních pochodů.

# *Metabolismus a trávení*

Odkud brát energii?
Slunce, geotermální energie – závislost živočichů na producentech.

Mnohobuněčnost znamená větší povrch těla a vyšší metabolismus..



Aerobní a anaerobní způsob získávání energie.

Oxidativní způsob převažuje.

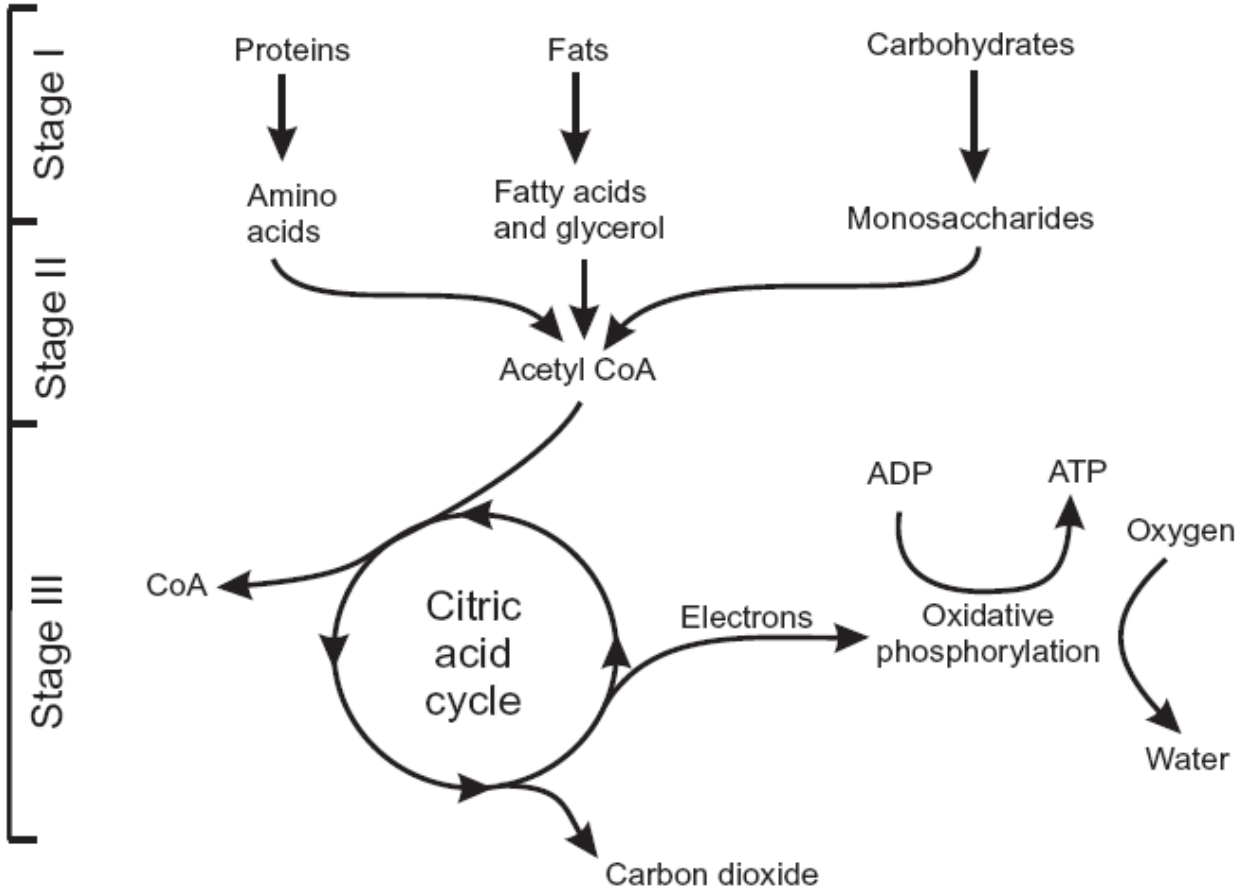
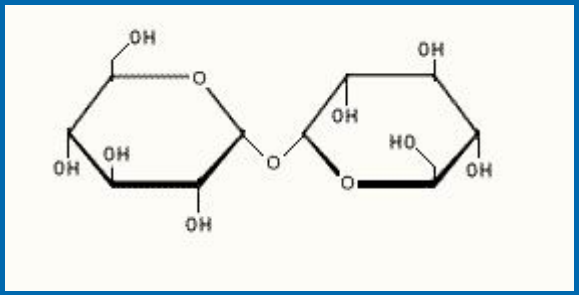


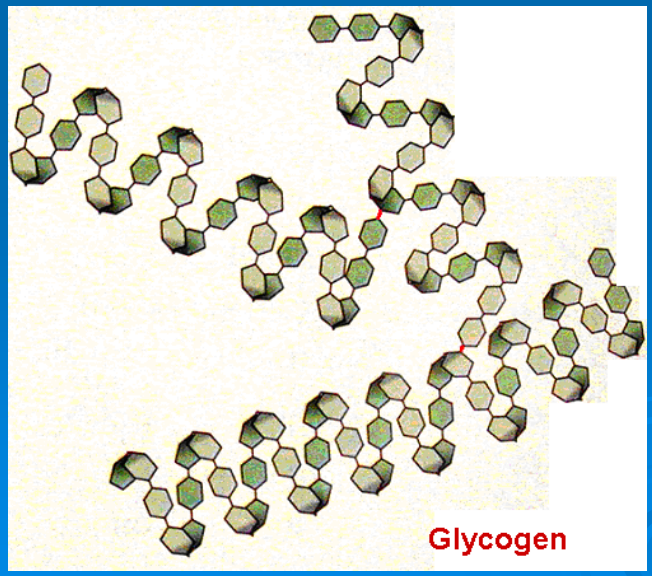

FIGURE 6.19. Stages in the oxidation of food. In stage I, proteins, fats, and carbohydrates are broken down into their constituents. In stage II, these building blocks are reduced to two carbon molecules for entry in the citric acid cycle. In stage III, the two carbon molecules enter the citric acid cycle, with carbon dioxide and water produced along with the bulk of the energy transfer to ATP.

# Metabolicky aktivní tkáně hmyzu

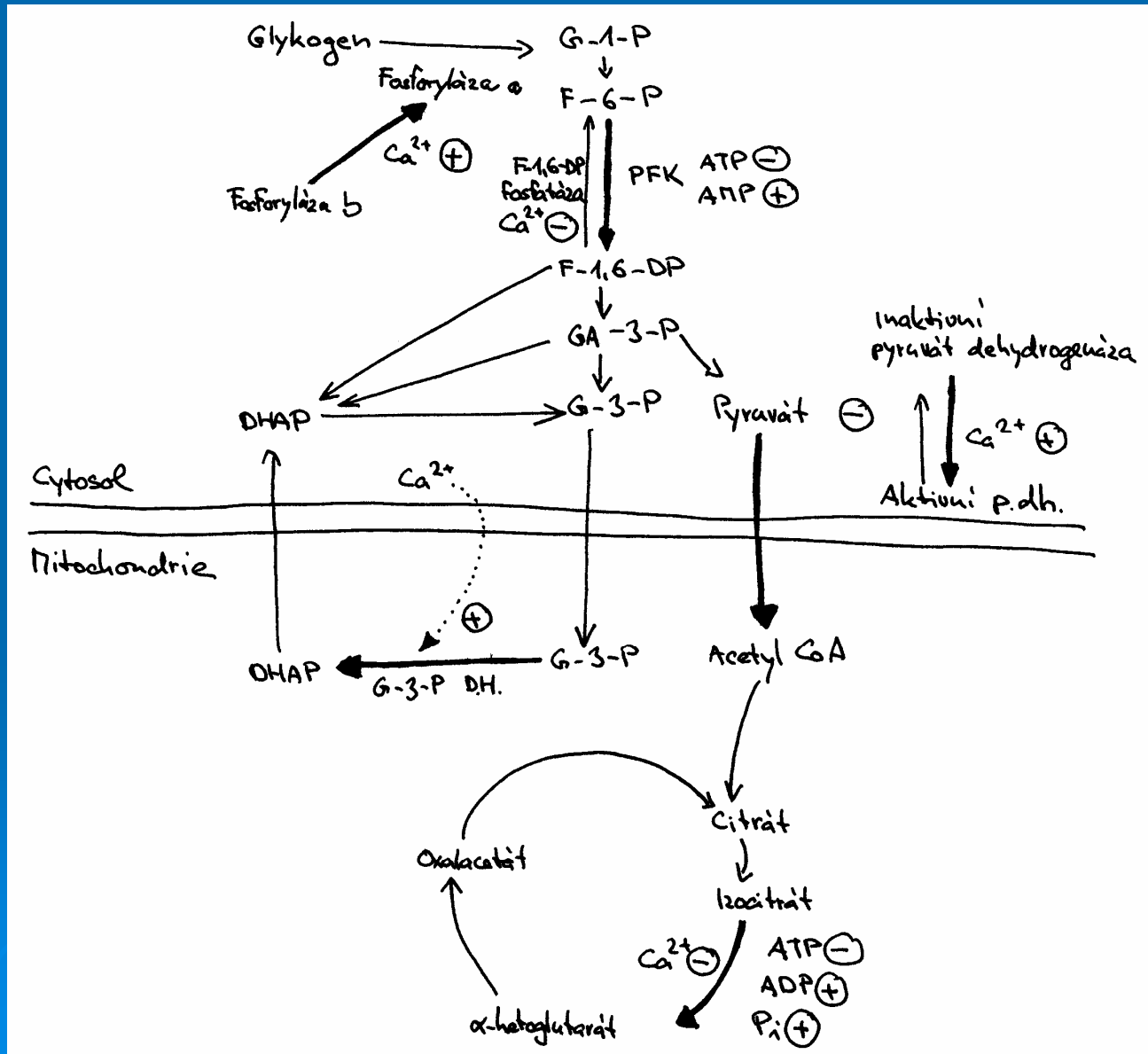
# Metabolismus sacharidů

## Glykogen a trehalóza



Řízení rychlosti sacharidového metabolismu.
Okamžité zrychlení uvolňování energie.



# Glycerol–3–P Shuttle

Specialita hmyzu, který pro let využívá sacharidy.
Dopravuje NADH z cytoplasmy do DŘ mitochodrií.
Brání hromadění kys. mléčné při nedostatku kyslíku.

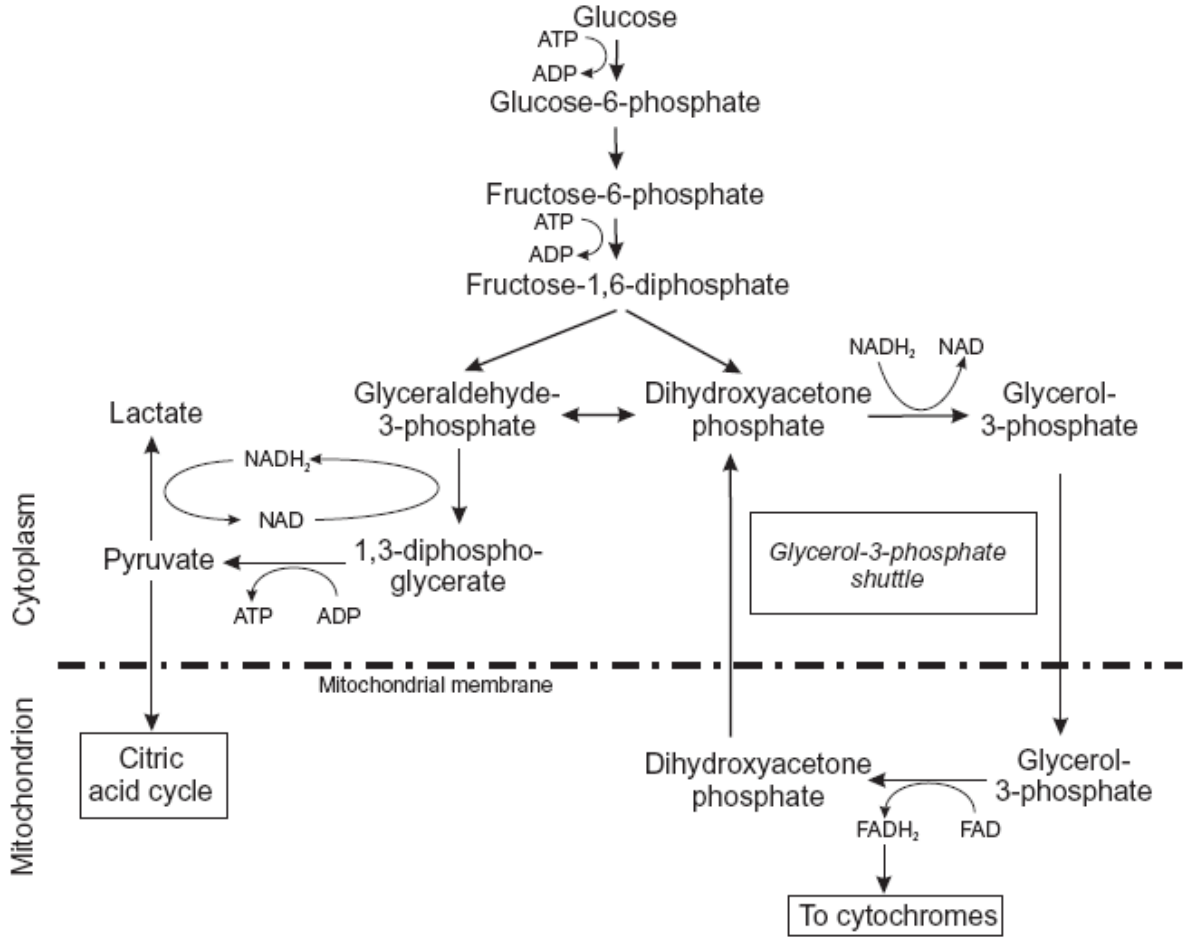
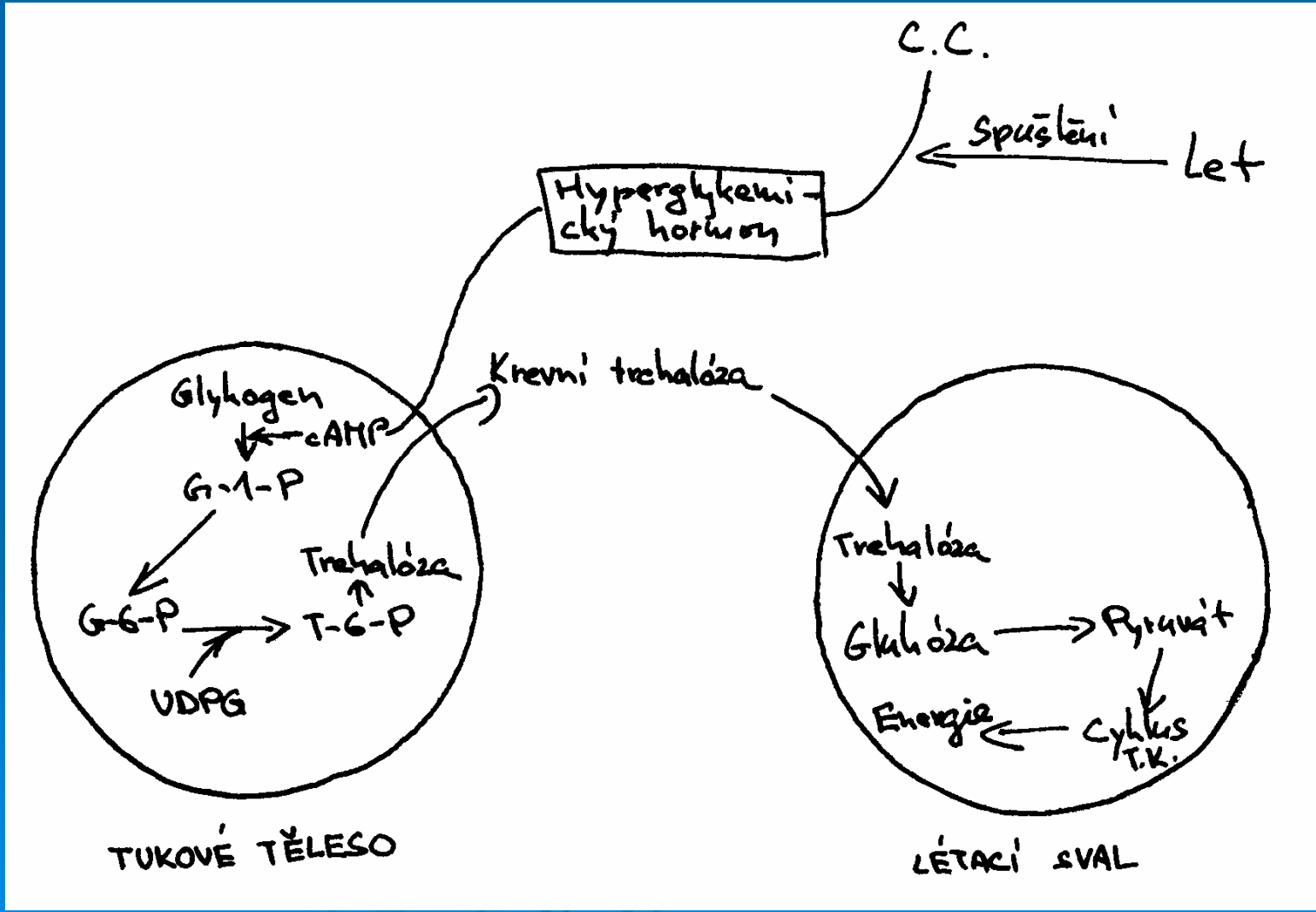



FIGURE 6.25. The glycerol-3-phosphate shuttle that operates in insect flight muscles.

Hormonální signál k zásobení létacích svalů energií.



# Metabolismus proteinů

Moucha Tse-tse

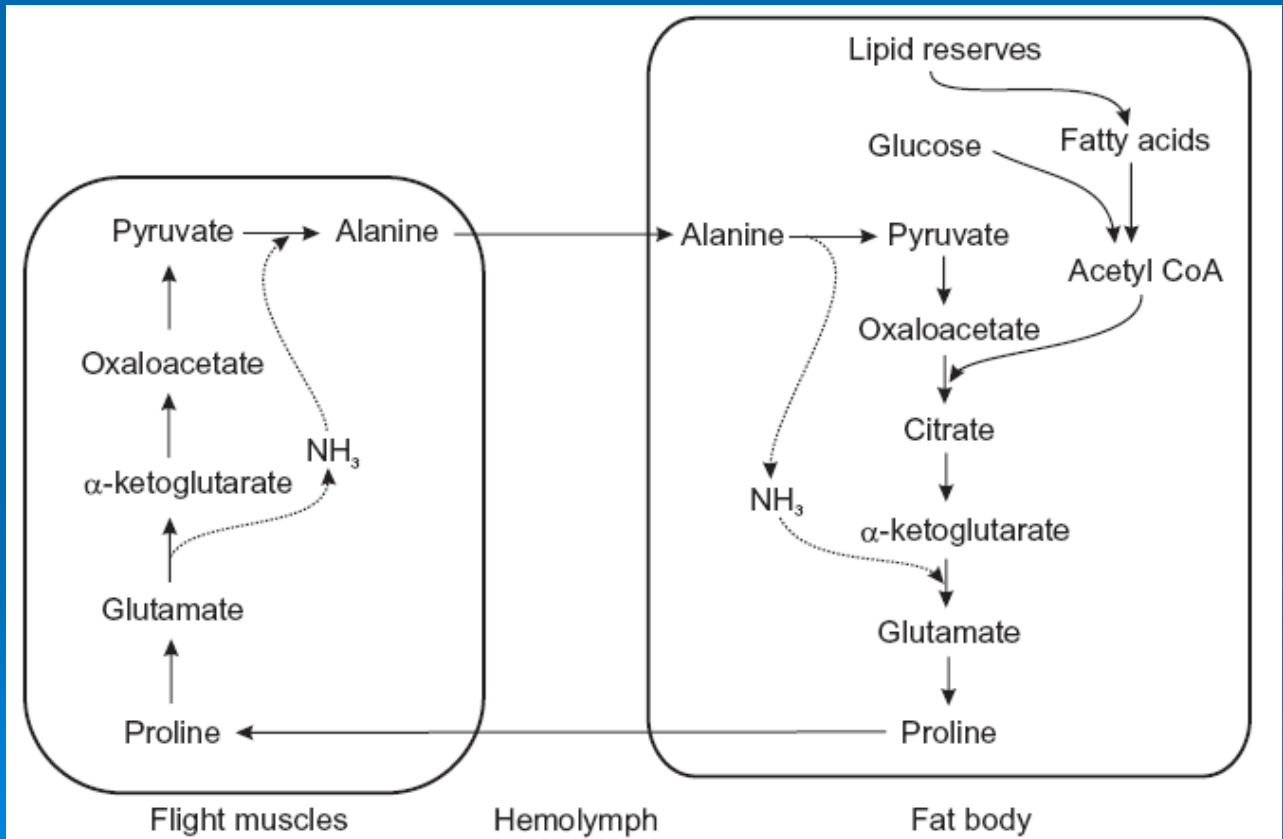
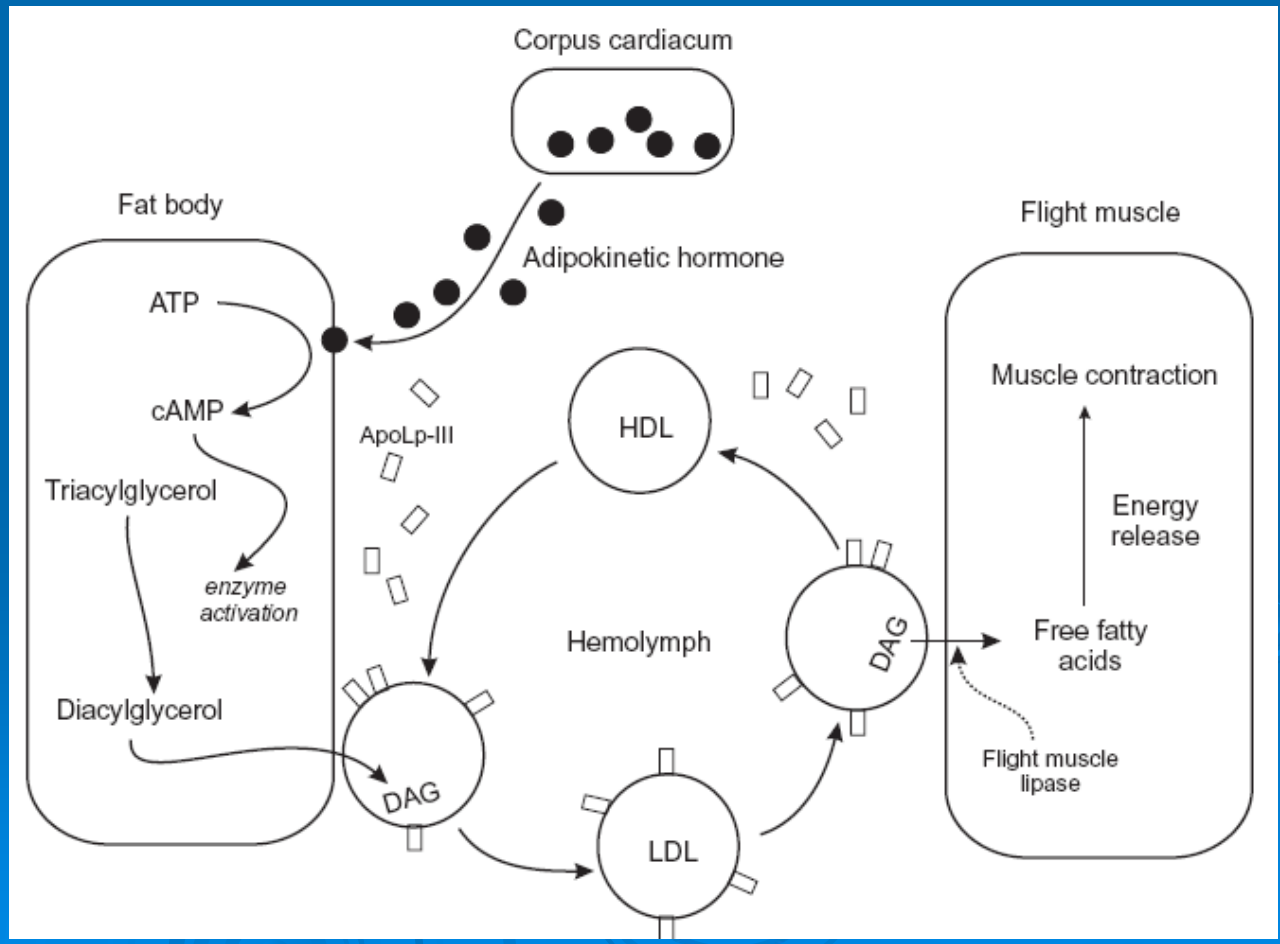
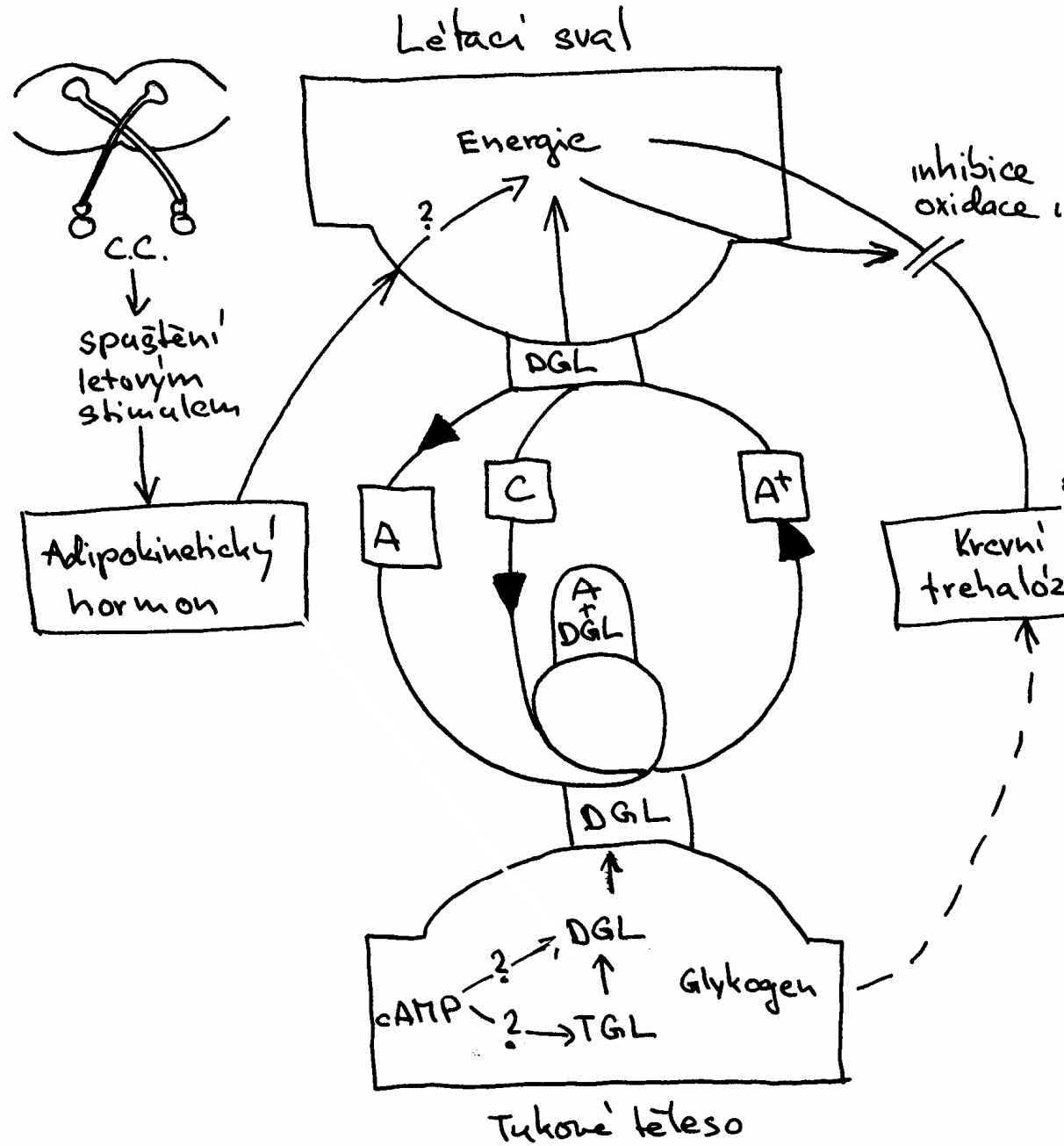
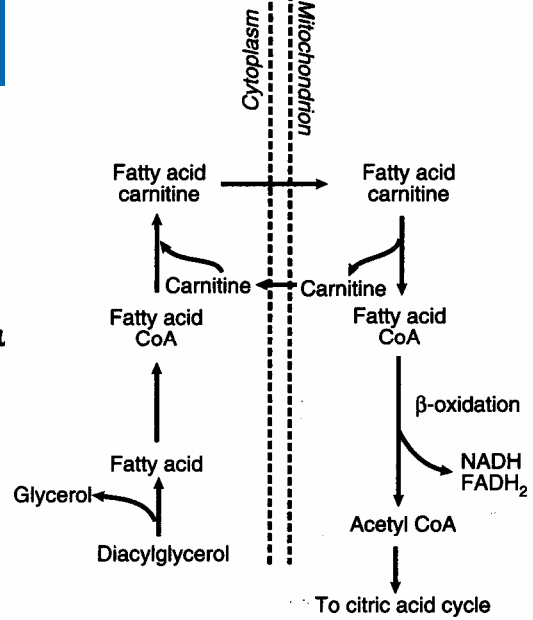



FIGURE 6.29. Utilization of fat body proline for flight.

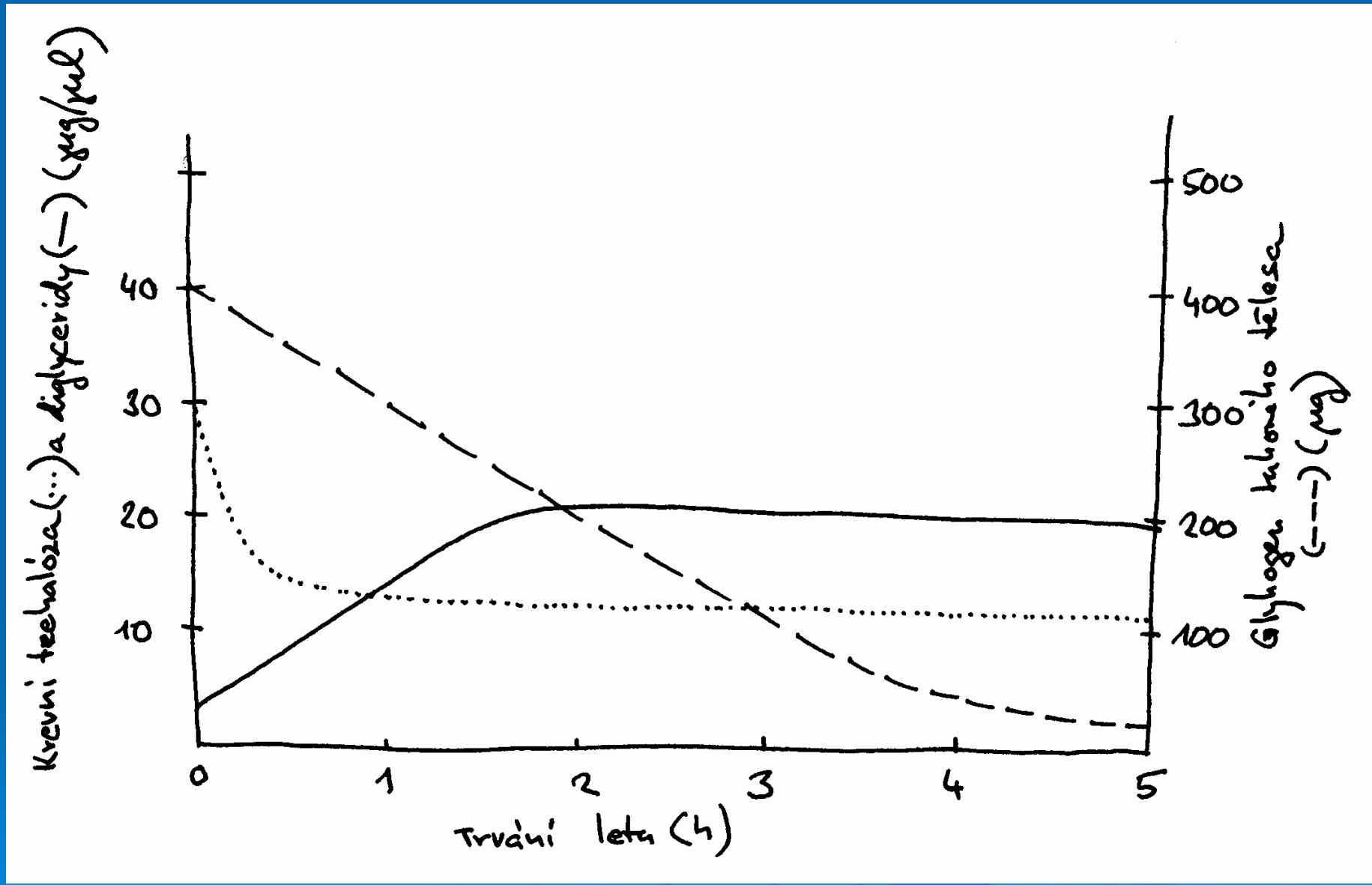
# Metabolismus lipidů






8 The entry of fatty acids into the mitochondrion, using carnitine for transport.


Krevní hladina (...) a triglyceridy (—) (µg/µl)
40
30
20
10
0
1
2
3
4
5
Trvání letu (h)
500
400
300
200
100
Glykogen kosterního svalu (---) (mg)

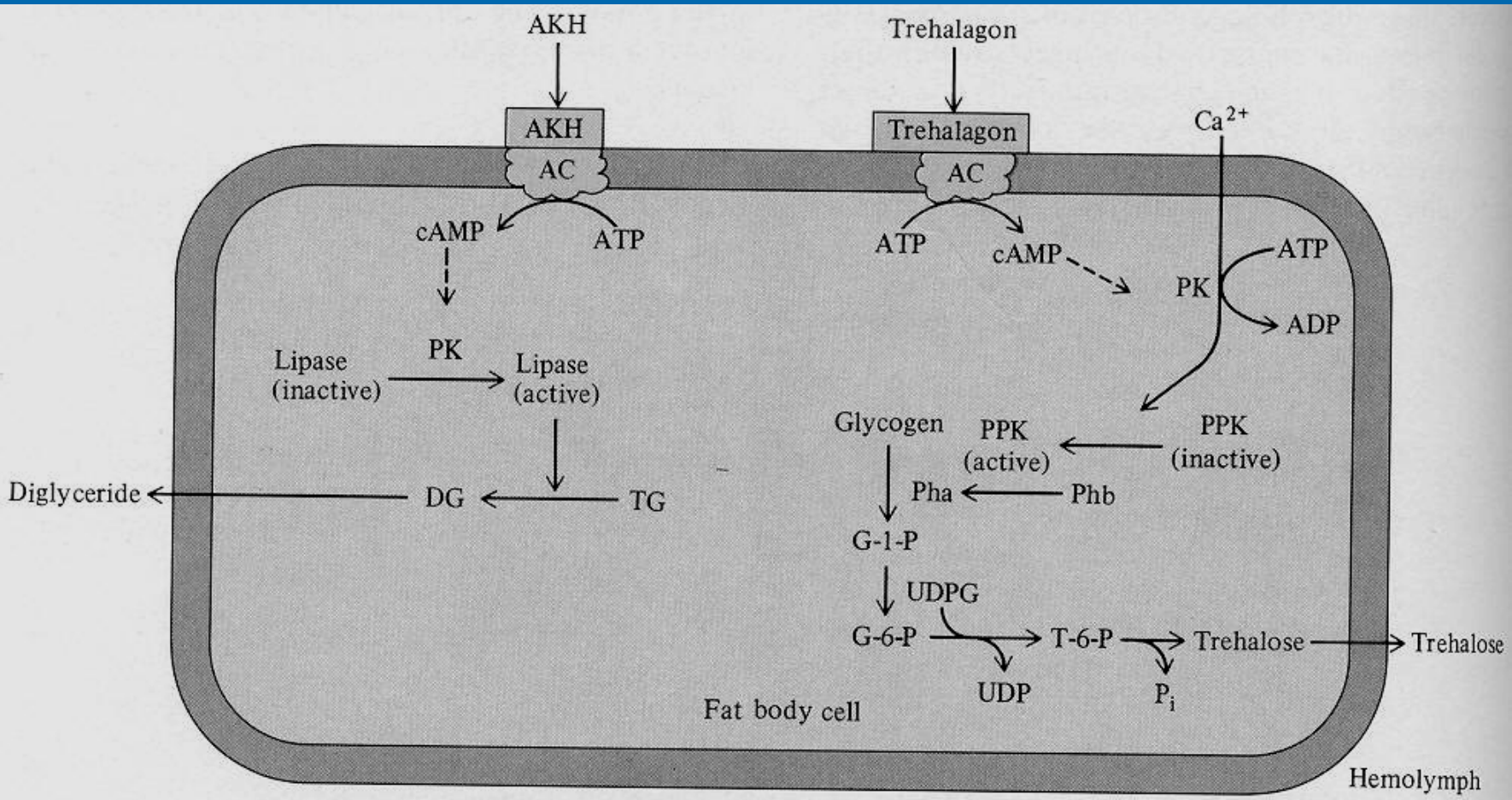
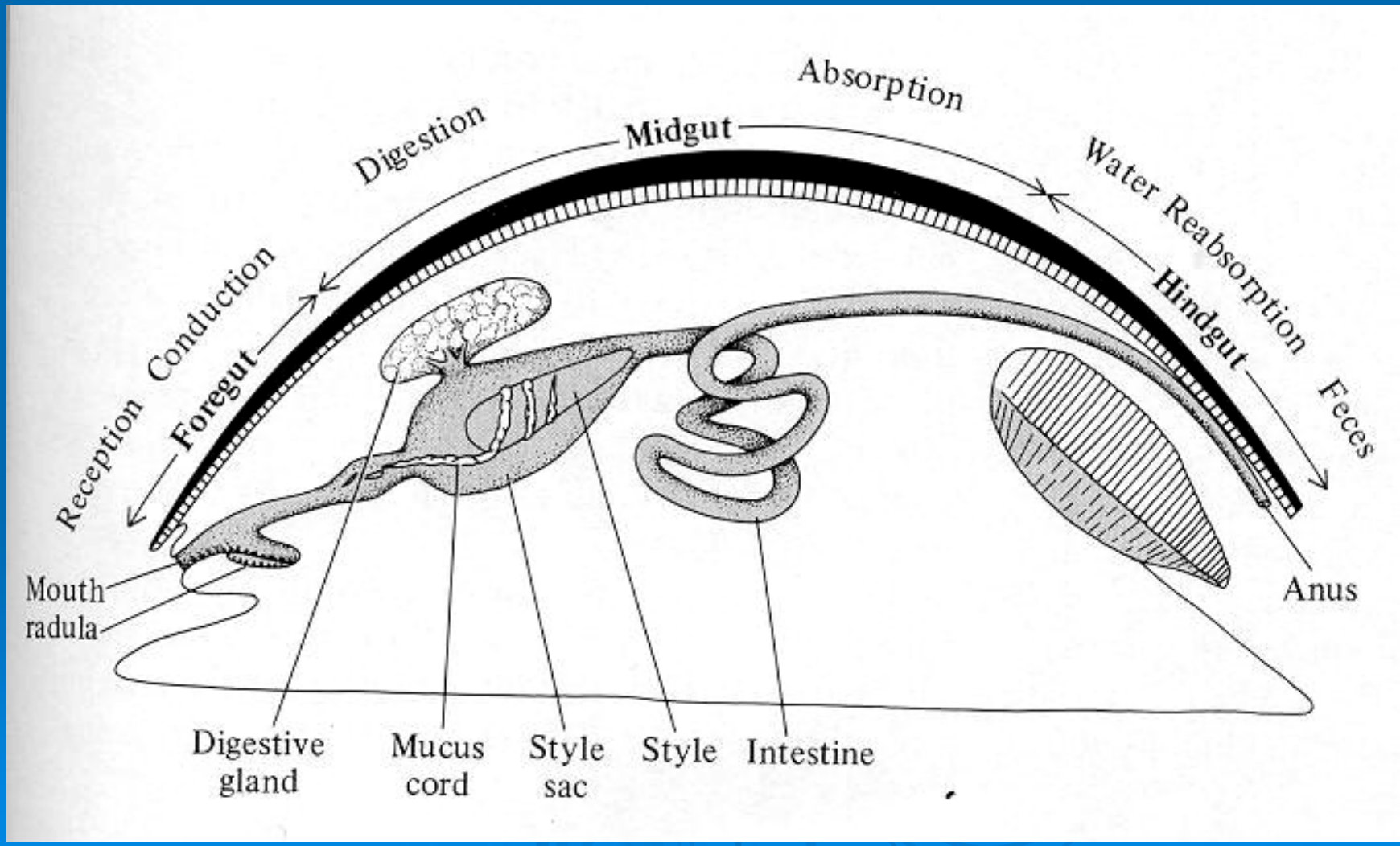
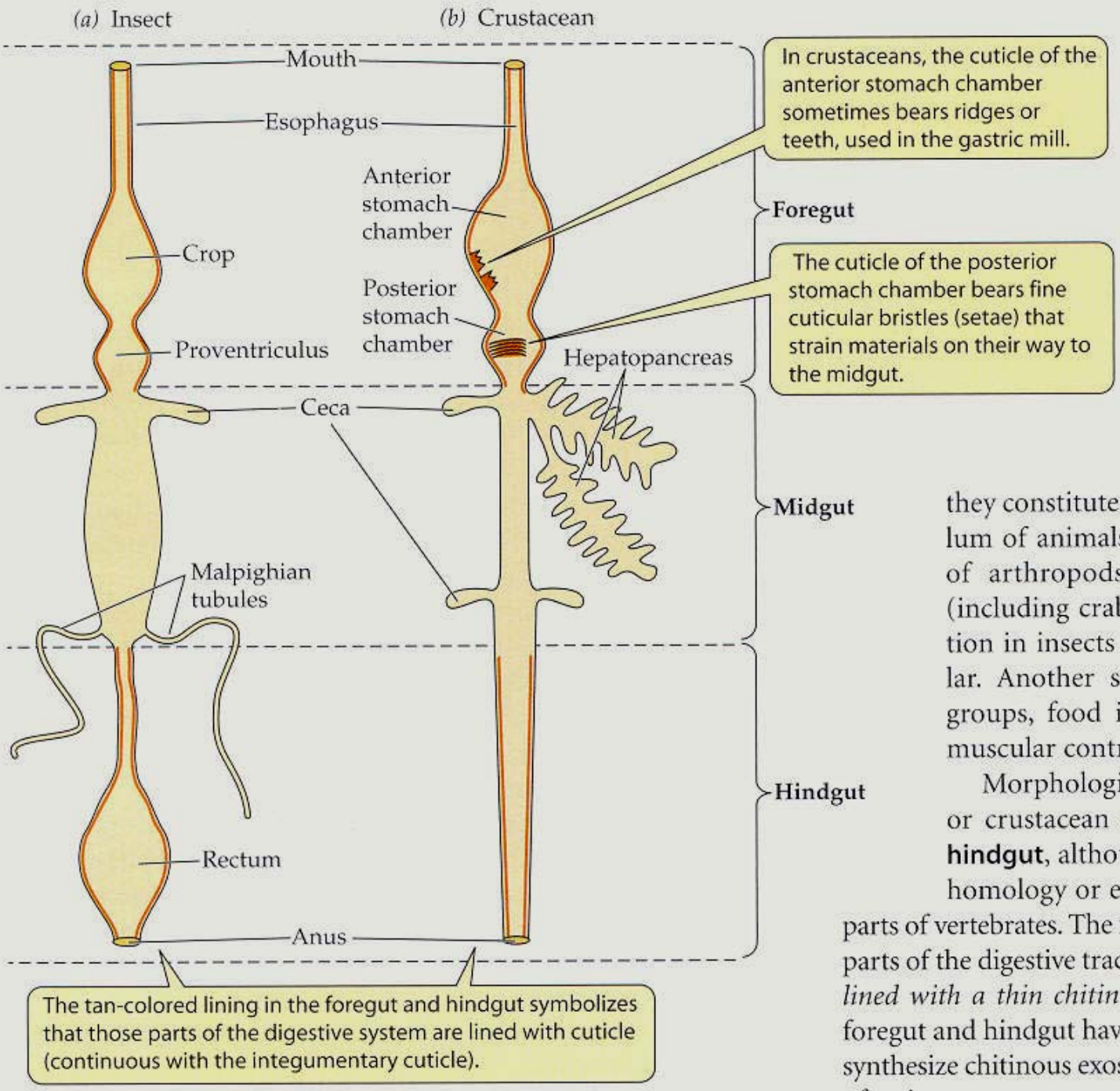



**FIGURE 11–25** Possible scheme for mode of action of adipokinetic hormone (AKH) in stimulating diglyceride production, and trehalagon in stimulating trehalose release from fat body cells. Abbreviations are as follows: AC, adenyl cyclase; TG, triglyceride; DG, diglyceride; PK, protein kinase; PPK, Phosphorylase kinase; Ph, phosphorylase; G-1-P, glucose-1-phosphate; G-6-P, glucose-6-phosphate; UDPG, uridine diphosphophosphate; UDP, uridine diphosphate; T-6-P, trehalose-6-phosphate. *(Modified from Steele 1985.)*

# Metabolismus během diapauzy a quiescence

# Trávení


Absorption
Digestion
Midgut
Water Reabsorption
Conduction
Hindgut
Reception
Foregut
Feces
Mouth
radula
Anus
Digestive gland
Mucus cord
Style sac
Style
Intestine




they constitute
lum of animals
of arthropods
(including crab
tion in insects
lar. Another si
groups, food i
muscular contr

Morphologi
or crustacean
**hindgut**, althou
homology or e
parts of vertebrates. The f
parts of the digestive trac
*lined with a thin chitin*
foregut and hindgut have
synthesize chitinous exos
of an insect or crustacean

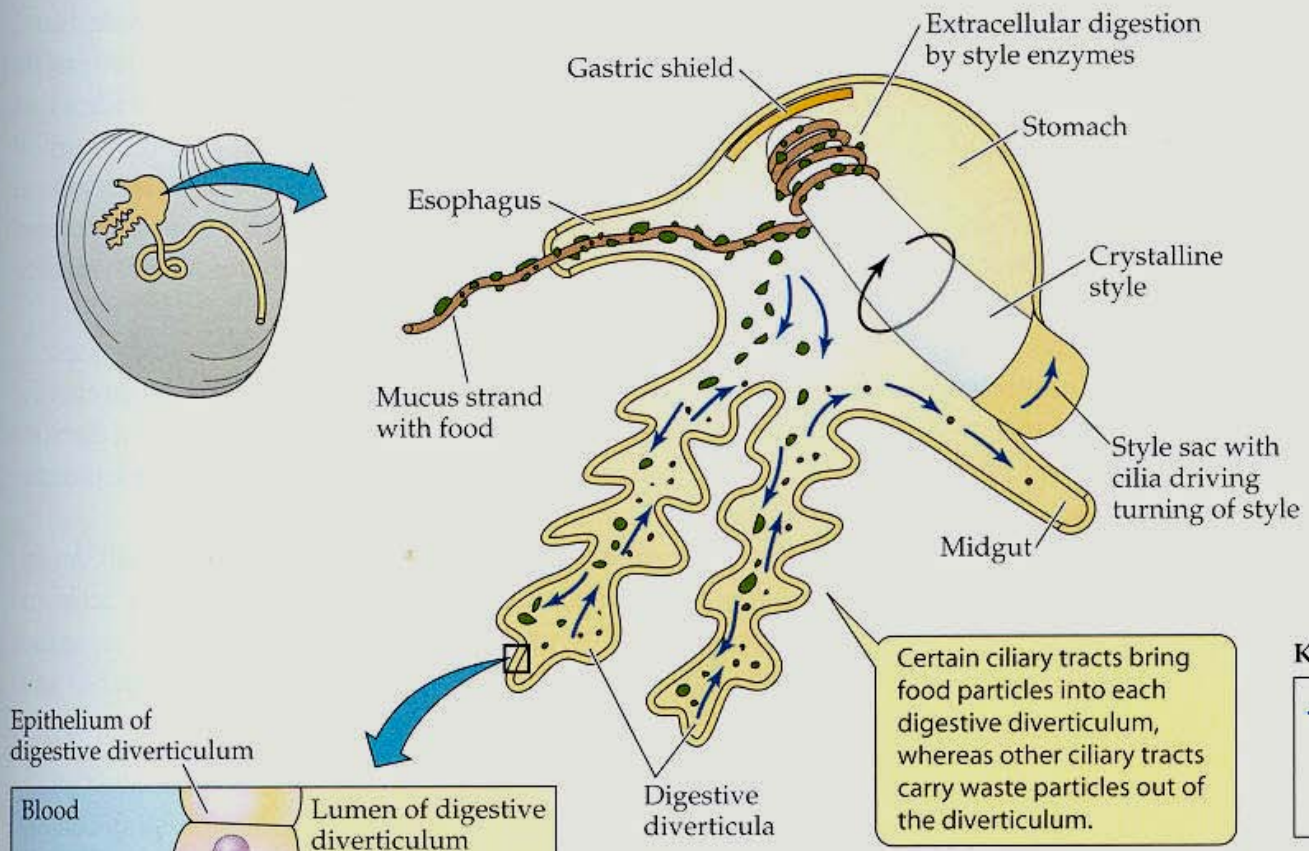



**Figure 4.17 The sto**
In bivalve molluscs, s
stomach and associa
diverticula are the m
of the digestive syste
species, digestion oc
epithelial cells of the
ticula. Certain ciliary
particles to those ep
the stomach; other c
waste particles from
the stomach. The dig
the clam is presente
ly, not realistically.

stomach. Food particles from the midgut also *ent*
creas, and much extracellular digestion and absor
*in* the hepatopancreas. In addition, the cells of th
play important storage and sequestration roles; li
are stored in the hepatopancreas, and toxins may
hepatopancreas cells. Current evidence indica
patopancreas is both the principal source of dig
crustaceans and the principal site of nutrient abso

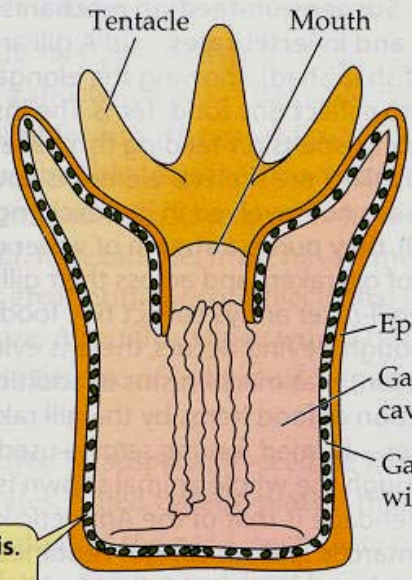
**THE DIGESTIVE SYSTEM OF BIVALVE MOLLUSCS** The b
which include clams, mussels, oysters, and scall
outstanding example of how very different from

**Figure 4.12 The reef-building corals of warm waters need light because they are symbiotic with algae** Reef-building corals *(a)* are colonies of polyps *(b)* that secrete skeletal material. The polyps of warm-water species maintain a symbiosis with dinoflagellate algae (zooxanthellae). In addition to gaining nutrition from algal photosynthesis, polyps have stinging cells with nematocysts and use them to capture small animals, which are taken into the gastrovascular cavity for absorption and digestion.

(*a*)

(*b*)

About a dozen polyps

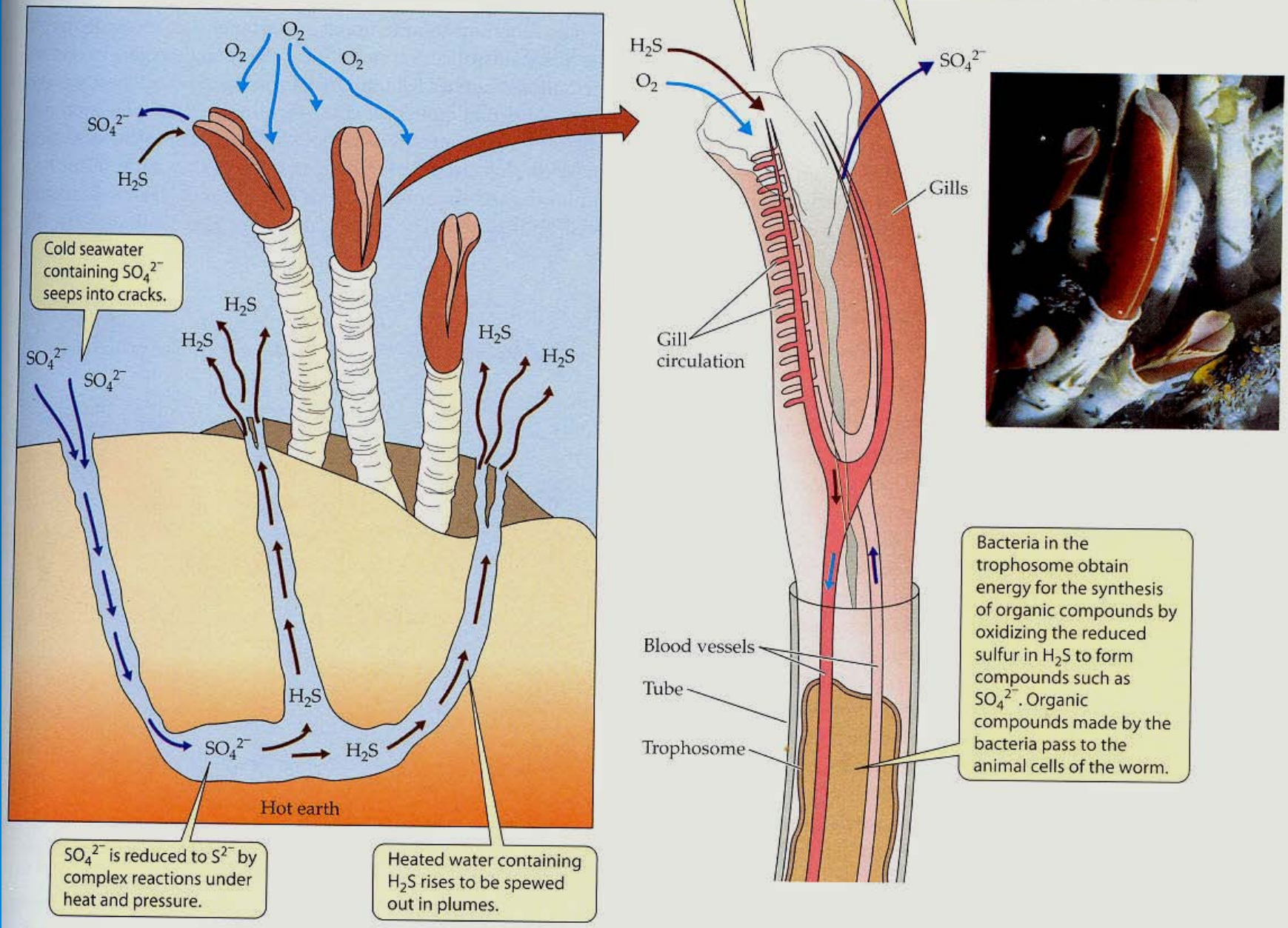


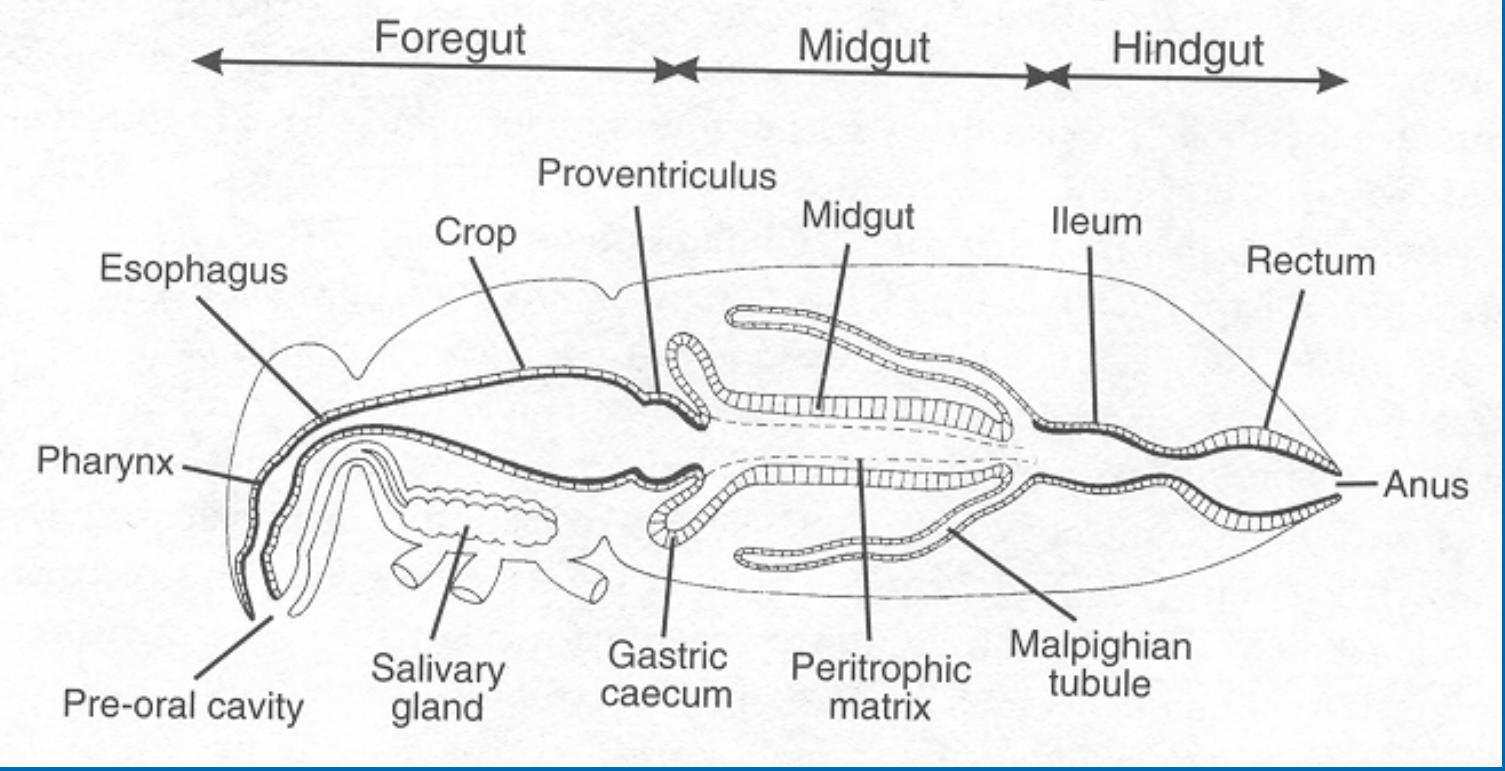

A single polyp in cross section

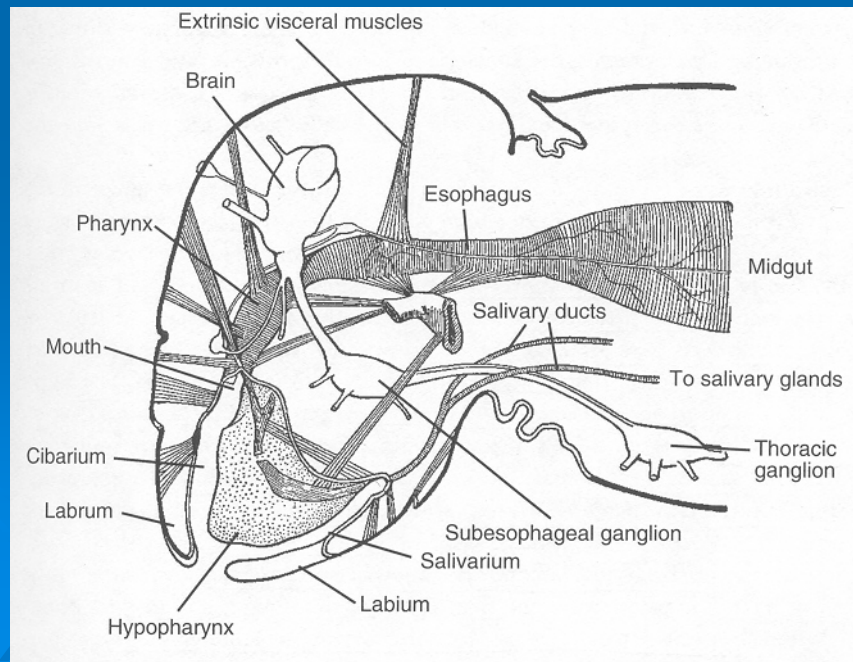
The algal populations live in the **gastrodermis**. Photosynthetic products from the algae pass directly to the animal cells in each polyp.

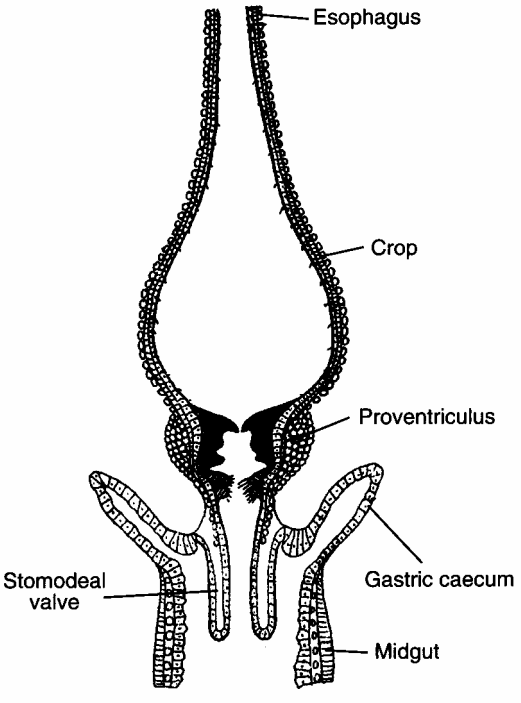
exemplified by the giant clams, the young start without symbionts and become "infected" with them during early development.

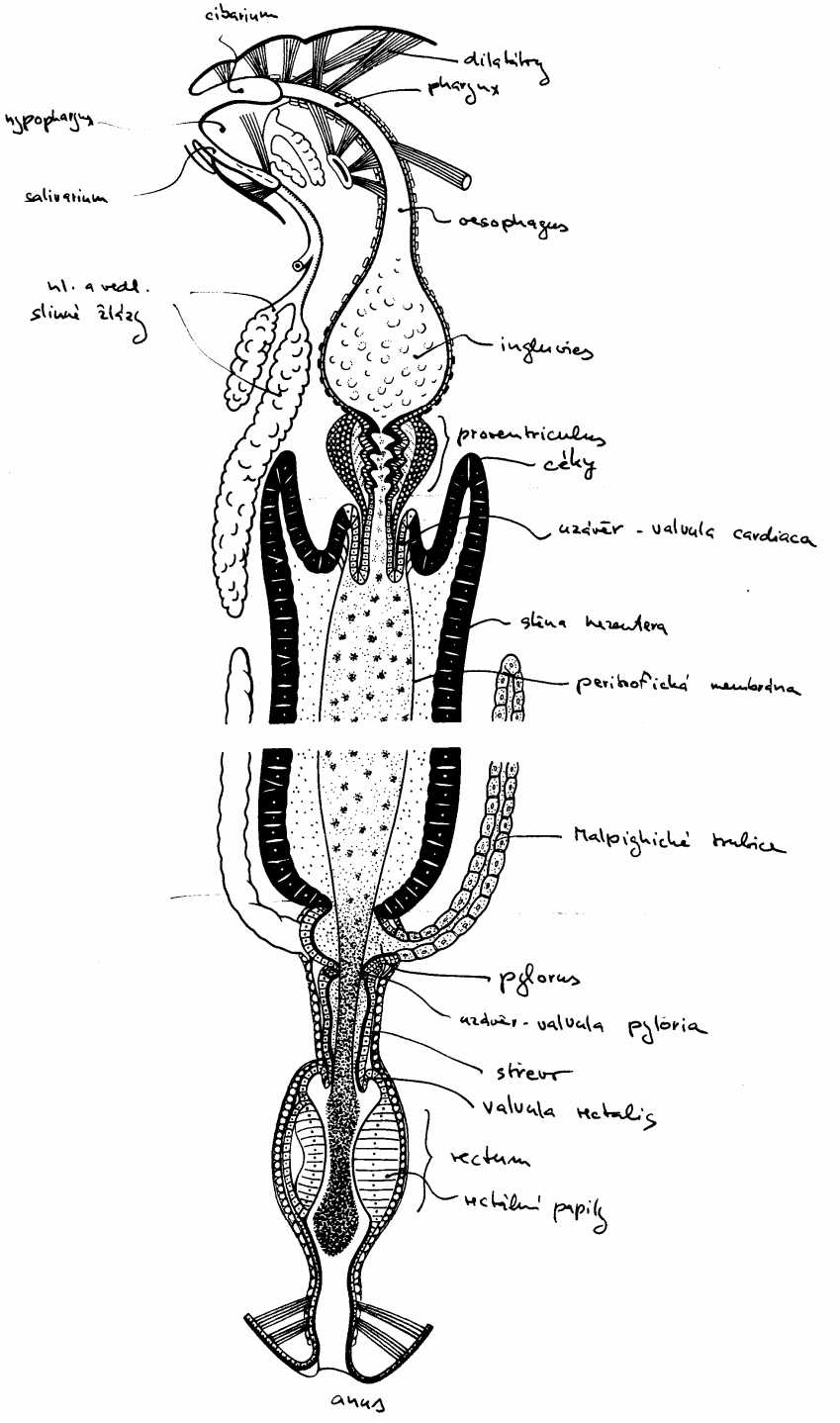
All animals that depend on algal symbionts for nutrition must ensure that their symbionts receive adequate light for photosynthe-


Blood circulates between the gills and the trophosome, carrying $O_2$ and $H_2S$ from seawater to the bacterial symbionts, and carrying oxidized sulfur products (such as $SO_4^{2-}$) from the symbionts back to the gills for loss into the seawater.
$O_2$
$O_2$
$O_2$
$SO_4^{2-}$
$H_2S$
Cold seawater containing $SO_4^{2-}$ seeps into cracks.
$SO_4^{2-}$
$SO_4^{2-}$
$H_2S$
$H_2S$
$H_2S$
$H_2S$
$H_2S$
$SO_4^{2-}$
$SO_4^{2-}$
$H_2S$
Hot earth
$SO_4^{2-}$ is reduced to $S^{2-}$ by complex reactions under heat and pressure.
Heated water containing $H_2S$ rises to be spewed out in plumes.
$H_2S$
$O_2$
$SO_4^{2-}$
Gills
Gill circulation
Blood vessels
Tube
Trophosome
Bacteria in the trophosome obtain energy for the synthesis of organic compounds by oxidizing the reduced sulfur in $H_2S$ to form compounds such as $SO_4^{2-}$. Organic compounds made by the bacteria pass to the animal cells of the worm.


Foregut
Midgut
Hindgut
Proventriculus
Crop
Midgut
Ileum
Rectum
Esophagus
Pharynx
Anus
Pre-oral cavity
Salivary gland
Gastric caecum
Peritrophic matrix
Malpighian tubule


Extrinsic visceral muscles
Brain
Esophagus
Pharynx
Midgut
Salivary ducts
Mouth
To salivary glands
Thoracic ganglion
Cibarium
Labrum
Subesophageal ganglion
Salivarium
Labium
Hypopharynx


Esophagus
Crop
Proventriculus
Stomodeal valve
Gastric caecum
Midgut


cibarium
dilatátory
pharynx
hypopharynx
salivarium
oesophagus
hl. a vedl. slinné žlázy
ingluvies
proventriculus
céky
uzávěr - valvula cardiaca
stěna mezentera
peritrofická membrána
Malpighické trubice
pylorus
uzávěr - valvula pylória
střevo
valvula rectalis
rectum
rektální papily
anus

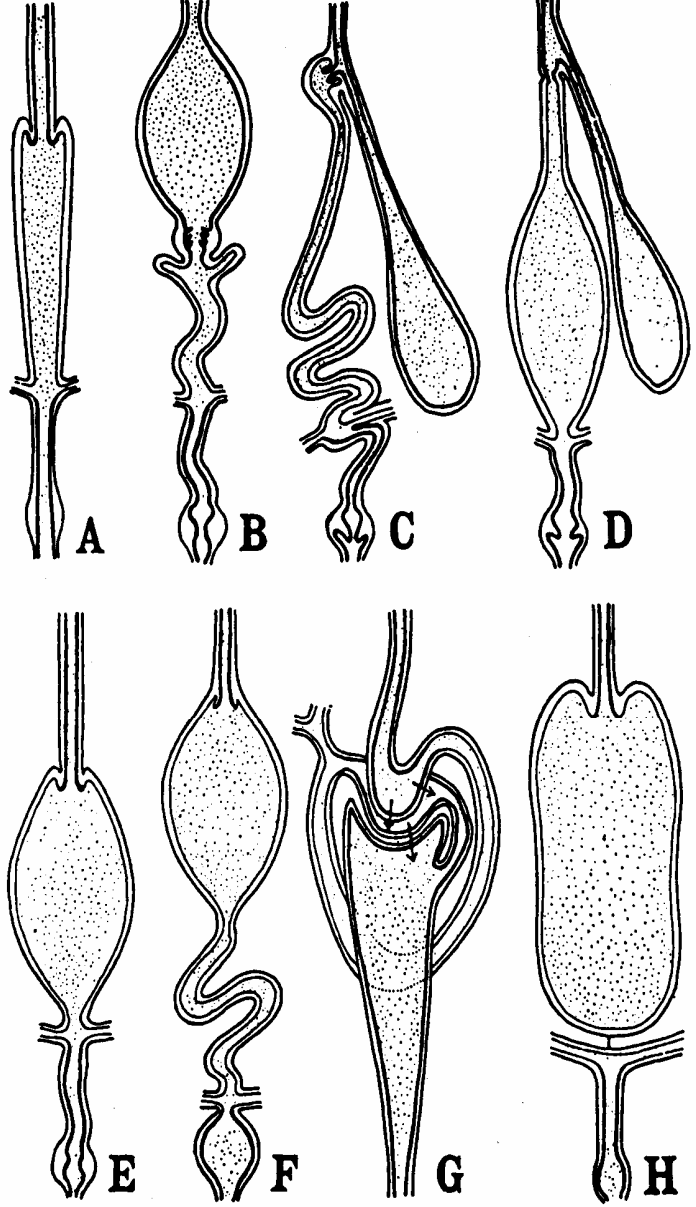
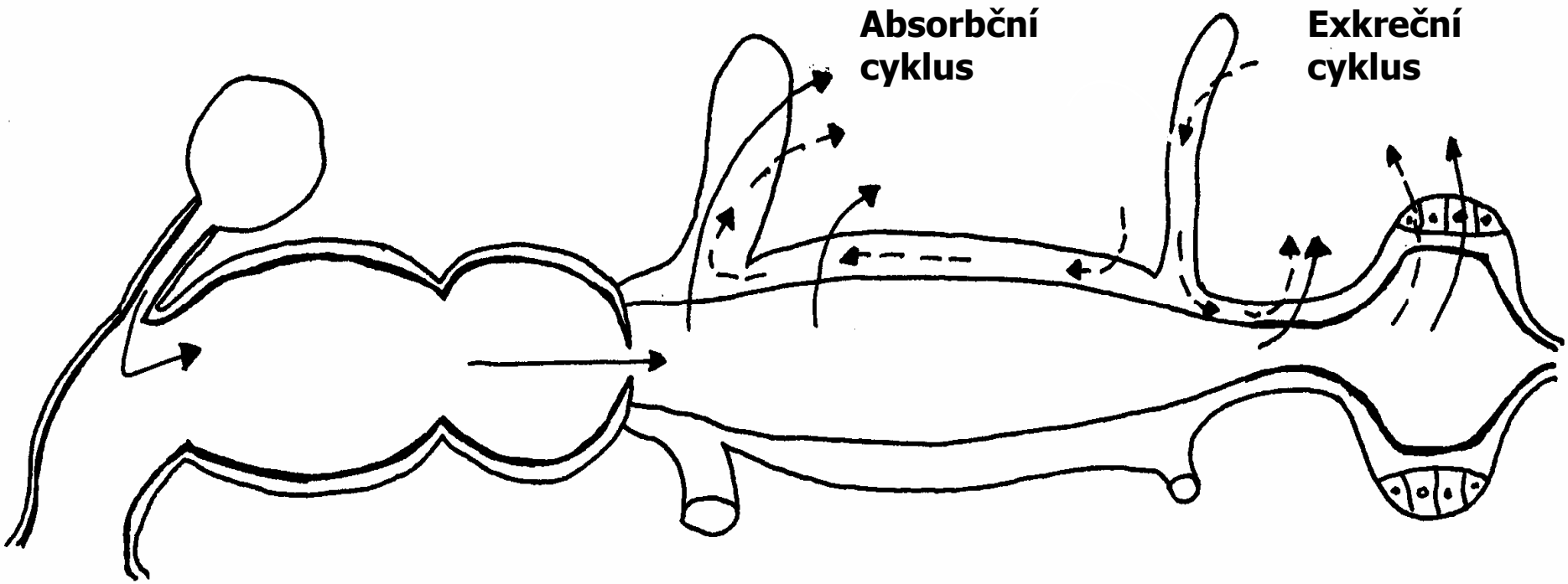



FIG. 2. Diagrams showing some of the modifications of the alimentary system. Foregut and hindgut indicated by a heavy line internally. *A*, in primitive insects and many larvae; *B*, in Orthoptera, Odonata, Hymenoptera, and many Coleoptera; *C*, in higher Diptera; *D*, in Diptera, Nematocera, Lepidoptera; *E*, in Siphonaptera, Siphunculata; *F*, in many Hemiptera Heteroptera; *G*, in Coccidae; *H*, in larvae of Hymenoptera Apocrita and in larvae of *Myrmeleon* and other Neuroptera. From Wigglesworth (1950).

# Koloběh vody a látek




Soluty

$H_2O$

# Fermentace a symbióza

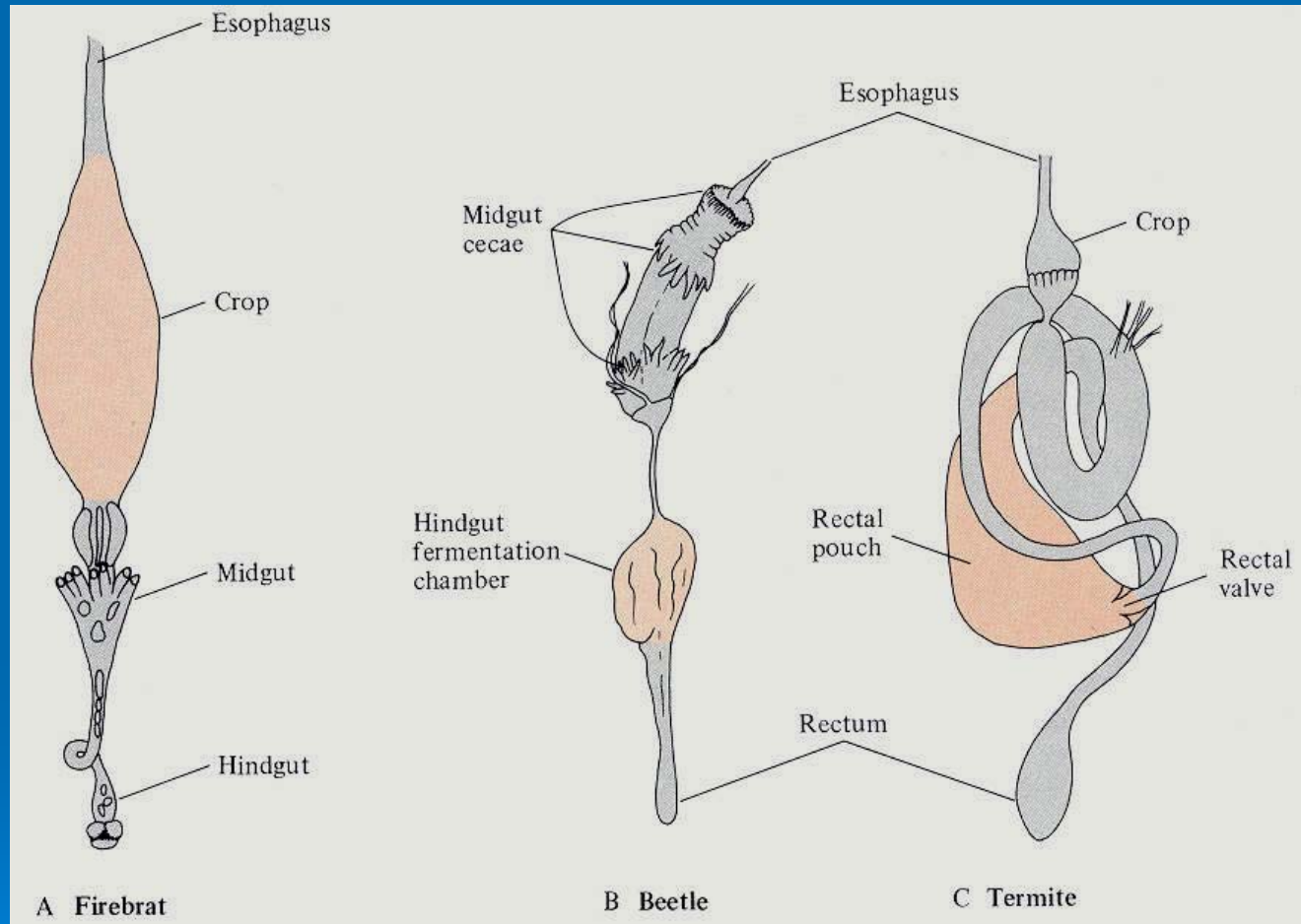



**FIGURE 18–29** Specialized gut structures of invertebrates for fermentation by symbiotic bacteria or protozoans showing the main location of the symbionts (in color). **(A)** The relatively unspecialized gut of the firebrat *Thermobia* has cellulase activity in the crop. **(B)** The hindgut bacterial fermentation chamber of a lamellicorn beetle *Oryctes* is lined by cuticle with branched spines and pierced by fine canals. **(C)** The hindgut pouch of the wood-feeding termite *Eutermes* contains flagellate protozoans. *(From Zinkler and Gotze 1987; Wigglesworth 1935.)*