Life's Common Challenges

Nutritional Needs

The Need to Feed

- All life forms ("need to feed") they must acquire essential elements
- All organisms require nutrients...
  - ...take in, take apart and take up
- Nutrients must satisfy 3 needs
  - chemical energy
  - organic building blocks
  - essential elements

Chemical Energy

- The activities of cells, tissues, organs or even whole organisms depend on chemical energy
- This chemical energy is used to produce ATP ("cellular gasoline")
- The ultimate source of energy used by cells to produce ATP and the mechanism of ATP production does vary somewhat between life forms

Carbon: Life's Building Blocks

- All cells require carbon and other atoms to build organic molecules that make up cells.
  - Cells to large organisms use these raw materials to build, grow, repair and reproduce.
- **Once again, like energy, the source of these raw materials (mainly carbon) can and do vary from one life form to another.**

Essential Elements

- In addition to chemical energy and building blocks some organisms require essential elements from their environment...
  - ...**atoms / molecules that cells themselves can not synthesize**
  - ...**they are needed to drive chemical reactions and complete the production of large organic molecules**
- All living organisms require at least 17 essential elements. For all life together that number might be as high as 30. Some organisms require elements that others do not and how much each requires also varies.

Major Nutritional Modes

- Phototrophs: obtain energy from light
- Chemotrophs: obtain energy from chemicals
- Autotrophs: obtain carbon from CO_2
- Heterotrophs: obtain carbon from organic sources
- Combining the different sources of energy and carbon results in 4 major nutritional modes.

Table 27.1 Major Nutritional Modes

Mode of Nutrition	Energy Source	Carbon Source	Types of Organisms
Autotroph			
Photoautotroph	Light	CO_2	Photosynthetic prokaryotes (for example, cyanobacteria); plants; certain protists (for example, algae)
Chemoautotroph	Inorganic chemicals	CO_2	Certain prokaryotes (for example, *Sulfolobus*)
Heterotroph			
Photoheterotroph	Light	Organic compounds	Certain prokaryotes (for example, *Rhodobacter, Chloroflexus*)
Chemoheterotroph	Organic compounds	Organic compounds	Many prokaryotes (for example, *Clostridium*) and protists; fungi; animals; some plants

Animals

Nutritional Requirements

Diverse Diets

- All animals eat other organisms...dead or alive
- Animals must eat for both energy and building blocks
  - Herbivores- eat plants or algae
  - Carnivores- eat other animals
  - Omnivores- eat either plants, algae and/ or animals
- Most animals are opportunistic feeders, eating foods outside their standard diet when usual foods are unavailable

Nutritional Needs

- Animals must acquire nutrients for both **energy** and **building blocks**
  - Animals must consume sugars, fats and proteins
- These macromolecules provide the energy for cellular respiration and provide the raw materials for biosynthesis
  - In addition animals require certain specific **essential elements** usually needed in much smaller amounts

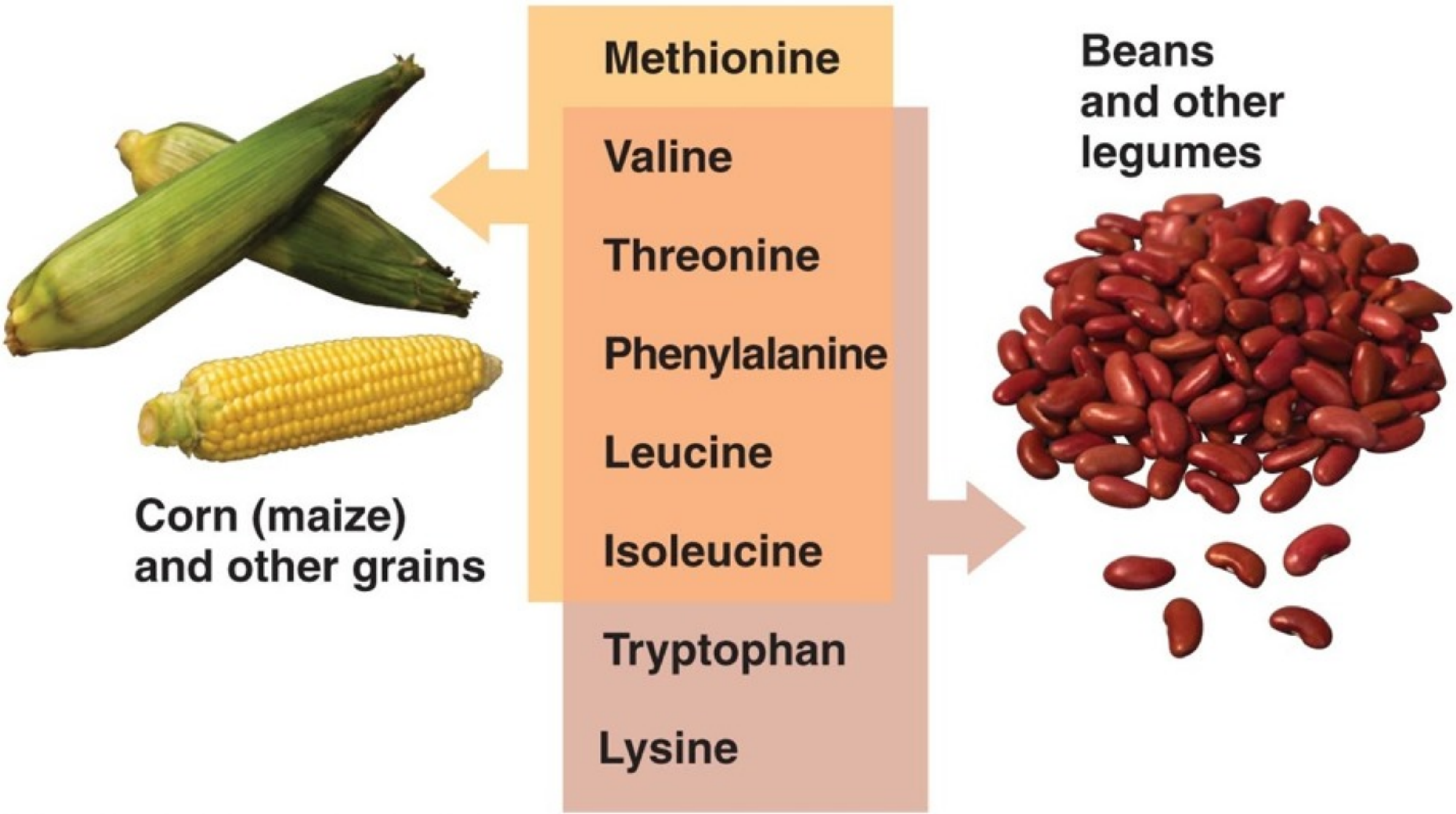
Essential Nutrients

- Animals require 4 classes of essential nutrients
  - Essential amino acids
  - Essential fatty acids
  - Vitamins
  - Minerals

Essential Amino Acids

- Animals require 20 amino acids to make proteins
  - Most animals can make 12 of the 20 amino acids
  - However the remaining 8 "essential amino acids" can only be obtained through diet
  - Some animal proteins are called "complete proteins" because they have all 20 amino acids
    - for example meat, eggs and cheese
  - Vegetarians can get all 20 amino acids by eating a varied diet of plant proteins

Essential amino acids for adults



Essential Fatty Acids

- Animals can make most, but not all fatty acids
  - for example omega-3's and omega-6 fatty acids
  - found in canola oil, fish, walnut, pumpkin seeds, sunflower seeds, shellfish, leafy veggies

Vitamins

- Organic molecules with diverse functions usually needed in small amounts
  - important for many metabolic processes, including cellular respiration

Table 41.1 Vitamin Requirements of Humans

Vitamin	Major Dietary Sources	Major Functions in the Body	Symptoms of Deficiency or Extreme Excess
Fat-Soluble Vitamins			
Vitamin A (retinol)	Provitamin A (beta-carotene) in deep green and orange vegetables and fruits; retinal in dairy products	Component of visual pigments; maintenance of epithelial tissues; antioxidant; helps prevent damage to cell membranes	Blindness and increased death rate **Headache, irritability, vomiting, hair loss, blurred vision, liver and bone damage**
Vitamin D	Dairy products, egg yolk; also made in human skin in presence of sunlight	Aids in absorption and use of calcium and phosphorus; promotes bone growth	Rickets (bone deformities) in children, bone softening in adults **Brain, cardiovascular, and kidney damage**
Vitamin E (tocopherol)	Vegetable oils, nuts, seeds	Antioxidant; helps prevent damage to cell membranes	Degeneration of the nervous system
Vitamin K (phylloquinone)	Green vegetables, tea; also made by colon bacteria	Important in blood clotting	Defective blood clotting **Liver damage and anemia**

Table 41.1 Vitamin Requirements of Humans

Vitamin	Major Dietary Sources	Major Functions in the Body	Symptoms of Deficiency or Extreme Excess
Water-Soluble Vitamins			
Vitamin B_1 (thiamine)	Pork, legumes, peanuts, whole grains	Coenzyme used in removing CO_2 from organic compounds	Beriberi (nerve disorders, emaciation, anemia)
Vitamin B_2 (riboflavin)	Dairy products, meats, enriched grains, vegetables	Component of coenzymes FAD and FMN	Skin lesions such as cracks at corners of mouth
Niacin (B_3)	Nuts, meats, grains	Component of coenzymes NAD^+ and $NADP^+$	Skin and gastrointestinal lesions, nervous disorders **Liver damage**
Vitamin B_6 (pyridoxine)	Meats, vegetables, whole grains	Coenzyme used in amino acid metabolism	Irritability, convulsions, muscular twitching, anemia **Unstable gait, numb feet, poor coordination**
Pantothenic acid (B_5)	Most foods: meats, dairy products, whole grains, etc.	Component of coenzyme A	Fatigue, numbness, tingling of hands and feet
Folic acid (folacin) (B_9)	Green vegetables, oranges, nuts, legumes, whole grains	Coenzyme in nucleic acid and amino acid metabolism	Anemia, birth defects **May mask deficiency of vitamin B_{12}**
Vitamin B_{12}	Meats, eggs, dairy products	Coenzyme in nucleic acid metabolism; maturation of red blood cells	Anemia, nervous system disorders
Biotin	Legumes, other vegetables, meats	Coenzyme in synthesis of fat, glycogen, and amino acids	Scaly skin inflammation, neuromuscular disorders
Vitamin C (ascorbic acid)	Fruits and vegetables, especially citrus fruits, broccoli, cabbage, tomatoes, green peppers	Used in collagen synthesis (such as for bone, cartilage, gums); antioxidant; aids in detoxification; improves iron absorption	Scurvy (degeneration of skin, teeth, blood vessels), weakness, delayed wound healing, impaired immunity **Gastrointestinal upset**

Minerals

- Inorganic molecules with diverse functions usually needed in small amounts
  - important for many metabolic processes, including enzymes, nerve impulses, building bone

Table 41.2 Mineral Requirements of Humans

	Mineral	Major Dietary Sources	Major Functions in the Body	Symptoms of Deficiency*
Greater than 200 mg per day required	Calcium (Ca)	Dairy products, dark green vegetables, legumes	Bone and tooth formation, blood clotting, nerve and muscle function	Retarded growth, possibly loss of bone mass
	Phosphorus (P)	Dairy products, meats, grains	Bone and tooth formation, acid-base balance, nucleotide synthesis	Weakness, loss of minerals from bone, calcium loss
	Sulfur (S)	Proteins from many sources	Component of certain amino acids	Symptoms of protein deficiency
	Potassium (K)	Meats, dairy products, many fruits and vegetables, grains	Acid-base balance, water balance, nerve function	Muscular weakness, paralysis, nausea, heart failure
	Chlorine (Cl)	Table salt	Acid-base balance, formation of gastric juice, nerve function, osmotic balance	Muscle cramps, reduced appetite
	Sodium (Na)	Table salt	Acid-base balance, water balance, nerve function	Muscle cramps, reduced appetite
	Magnesium (Mg)	Whole grains, green leafy vegetables	Cofactor; ATP bioenergetics	Nervous system disturbances
	Iron (Fe)	Meats, eggs, legumes, whole grains, green leafy vegetables	Component of hemoglobin and of electron carriers in energy metabolism; enzyme cofactor	Iron-deficiency anemia, weakness, impaired immunity

*All of these minerals are also harmful when consumed in excess.

Table 41.2 Mineral Requirements of Humans

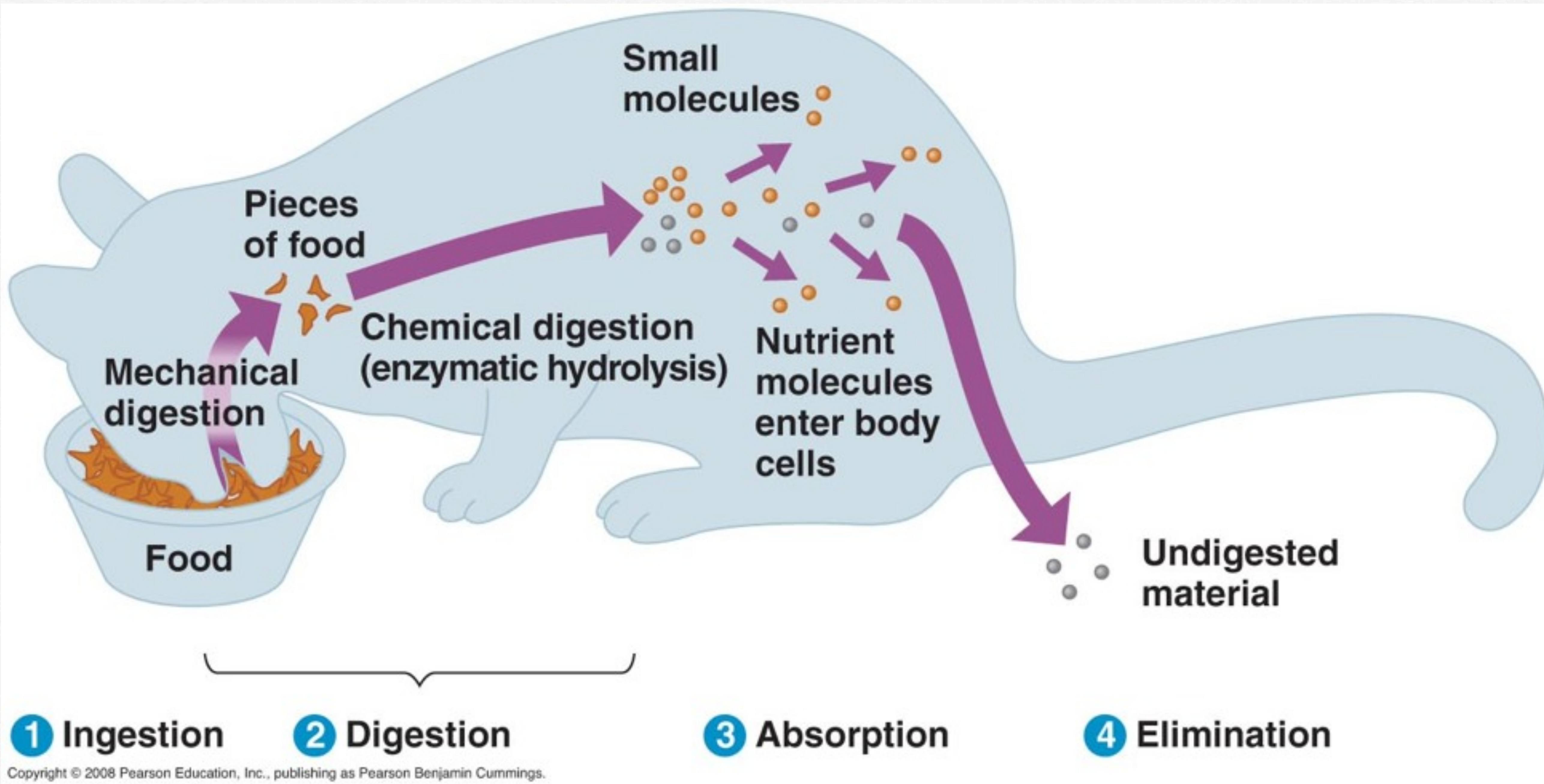
Mineral	Major Dietary Sources	Major Functions in the Body	Symptoms of Deficiency*
Fluorine (F)	Drinking water, tea, seafood	Maintenance of tooth (and probably bone) structure	Higher frequency of tooth decay
Zinc (Zn)	Meats, seafood, grains	Component of certain digestive enzymes and other proteins	Growth failure, skin abnormalities, reproductive failure, impaired immunity
Copper (Cu)	Seafood, nuts, legumes, organ meats	Enzyme cofactor in iron metabolism, melanin synthesis, electron transport	Anemia, cardiovascular abnormalities
Manganese (Mn)	Nuts, grains, vegetables, fruits, tea	Enzyme cofactor	Abnormal bone and cartilage
Iodine (I)	Seafood, dairy products, iodized salt	Component of thyroid hormones	Goiter (enlarged thyroid)
Cobalt (Co)	Meats and dairy products	Component of vitamin B_{12}	None, except as B_{12} deficiency
Selenium (Se)	Seafood, meats, whole grains	Enzyme cofactor; antioxidant functioning in close association with vitamin E	Muscle pain, possibly heart muscle deterioration
Chromium (Cr)	Brewer's yeast, liver, seafood, meats, some vegetables	Involved in glucose and energy metabolism	Impaired glucose metabolism
Molybdenum (Mo)	Legumes, grains, some vegetables	Enzyme cofactor	Disorder in excretion of nitrogen-containing compounds

*All of these minerals are also harmful when consumed in excess.

Animals

Nutritional Processing

4 Stages of Food Processing



Ingestion

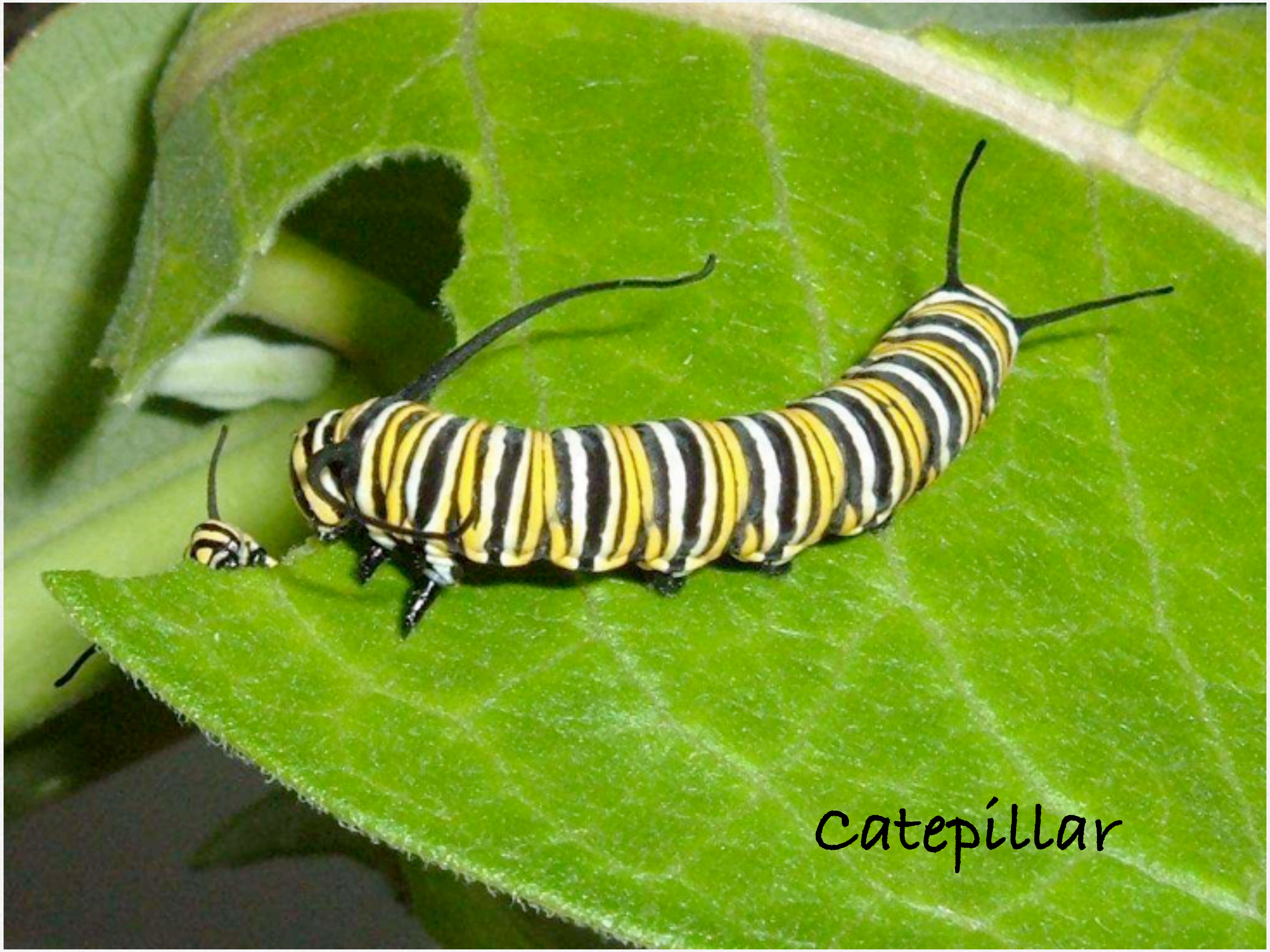
- **INGESTION- the act of feeding or or eating**
- variation in food = variation in feeding mechanisms
  - see slides that follow

Suspension & Filter Feeders

eat small food particles suspended in water

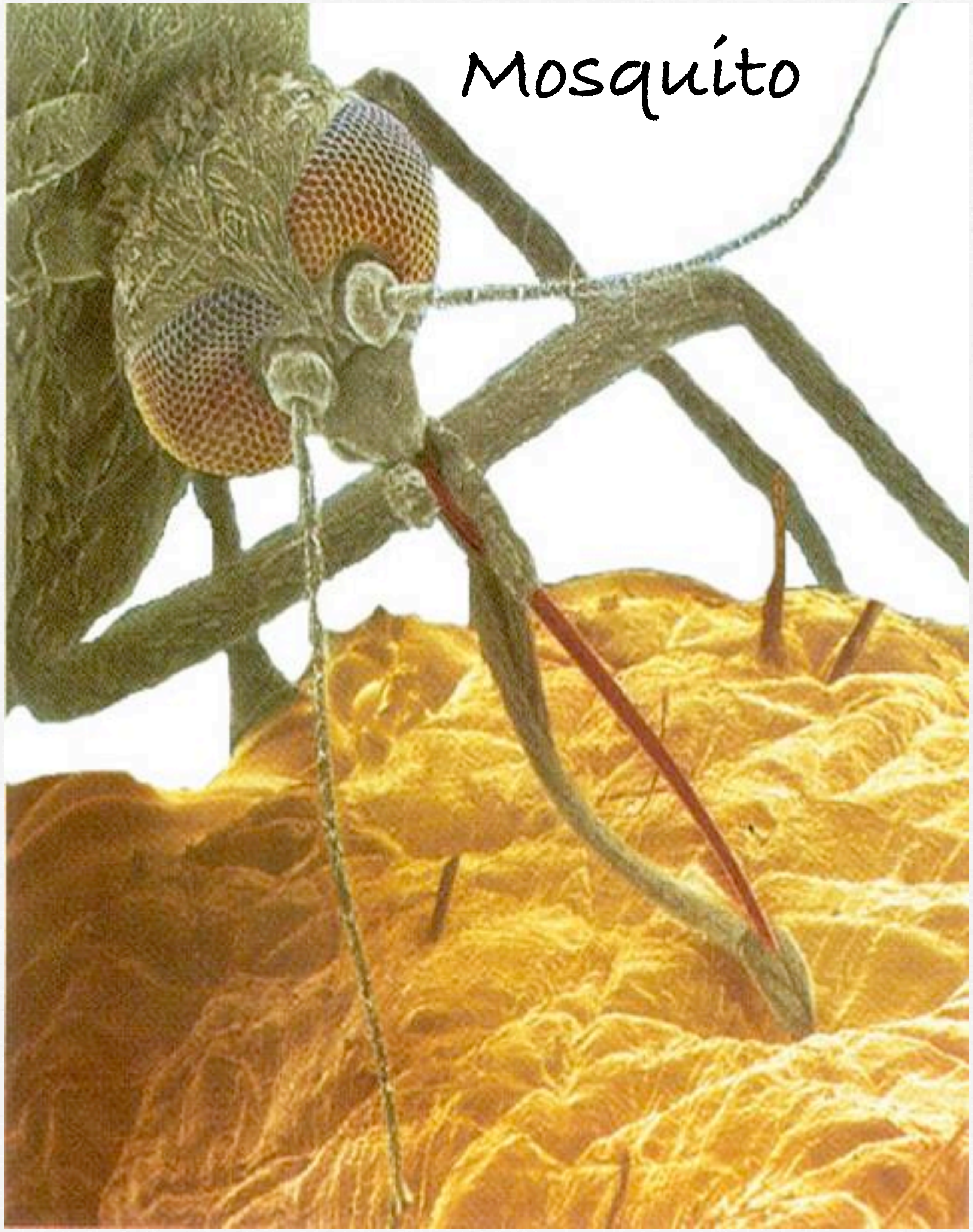
Substrate Feeders

live in or on their food source



Fluid Feeders

suck nutrient rich fluid from a living host



Bulk Feeders

eat relatively large pieces of food

Digestion

- **DIGESTION- breaking food into particles small enough to be absorbed into cells (increases SA:V)**
  - **MECHANICAL DIGESTION**-physical breakdown of food, into smaller pieces...increasing surface area
  - **CHEMICAL DIGESTION**-breakdown of molecules into their subunits
    - this allows passage across membranes
    - and each organism needs to build its own specific molecules

Absorption

- **ABSORPTION- the act of taking up small molecules such as simple sugars and amino acids**

Elimination

- **ELIMINATION- the act of passing undigested material out of the digestive system**

Digestive Compartments

How are animals able to digest molecules that they themselves are made of?

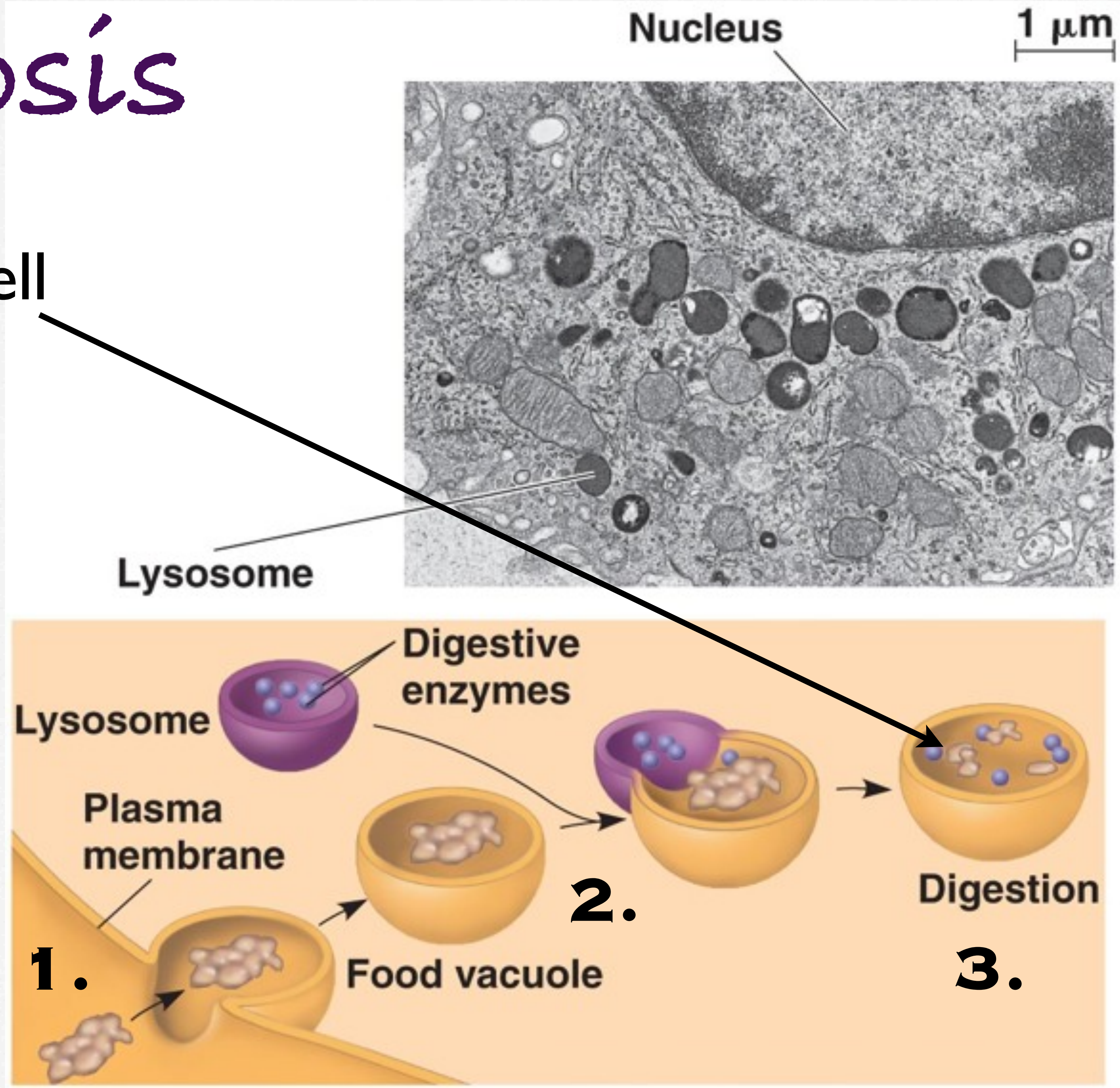
- The evolutionary adaptation found across a wide range of organisms is the processing of food within specialized compartments.
  - These compartments can be intracellular (vacuoles) or extracellular (digestive organs)

Intracellular Compartments

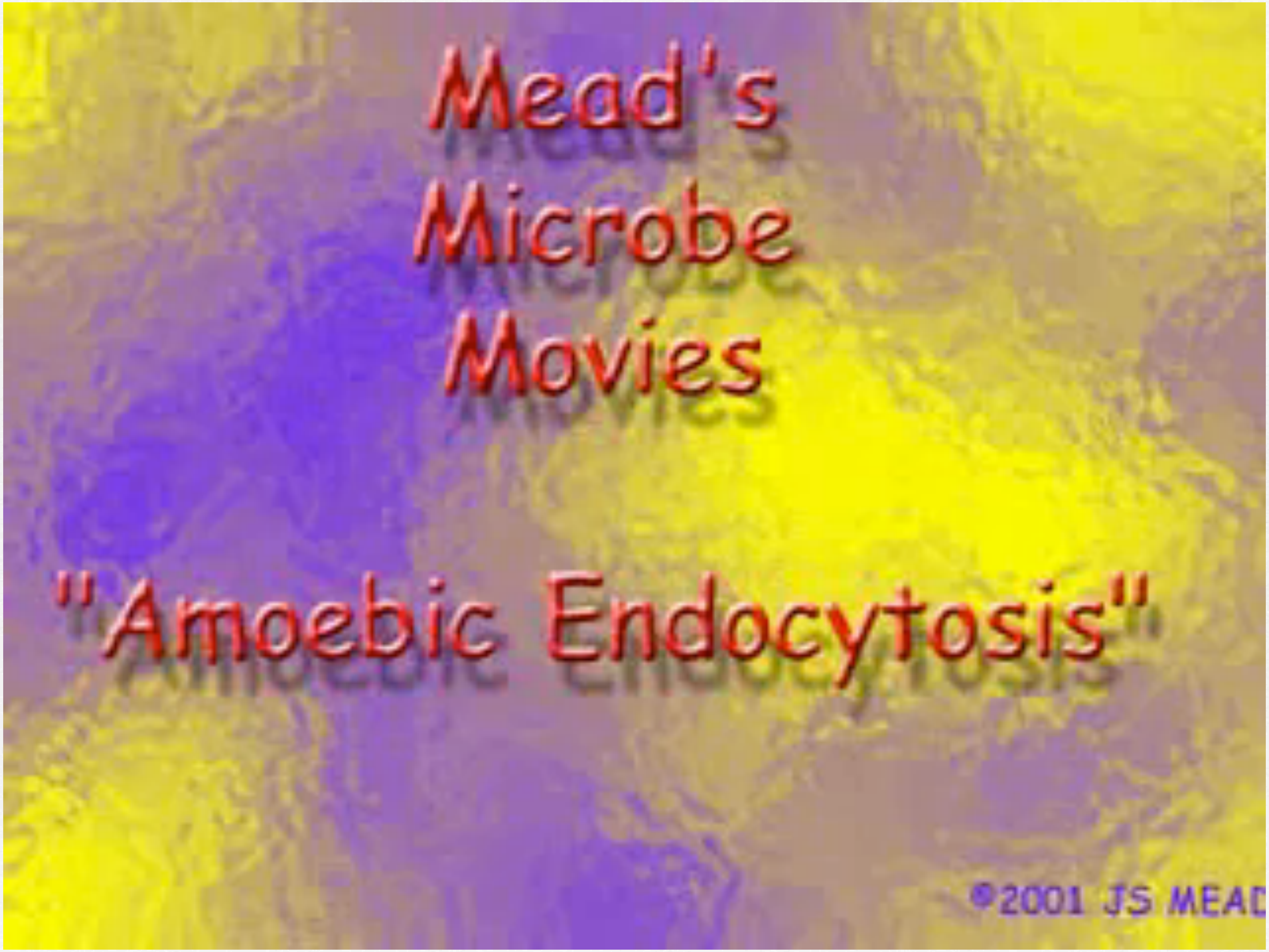
- **Food Vacuoles**- cellular organelles in which enzymes break down food (simplest digestive compartments).
  - Cell engulfs food by **phagocytosis**
  - Food vacuole fuses with **lysosome** (digestive sac)
  - Digestion occurs safely inside compartment
- Few animals digest food exclusively this way, the sponge however is one organism that does.

Phagocytosis

Now nutrients for cell



(a) Phagocytosis


Mead's
Microbe
Movies
"Amoebic Endocytosis"
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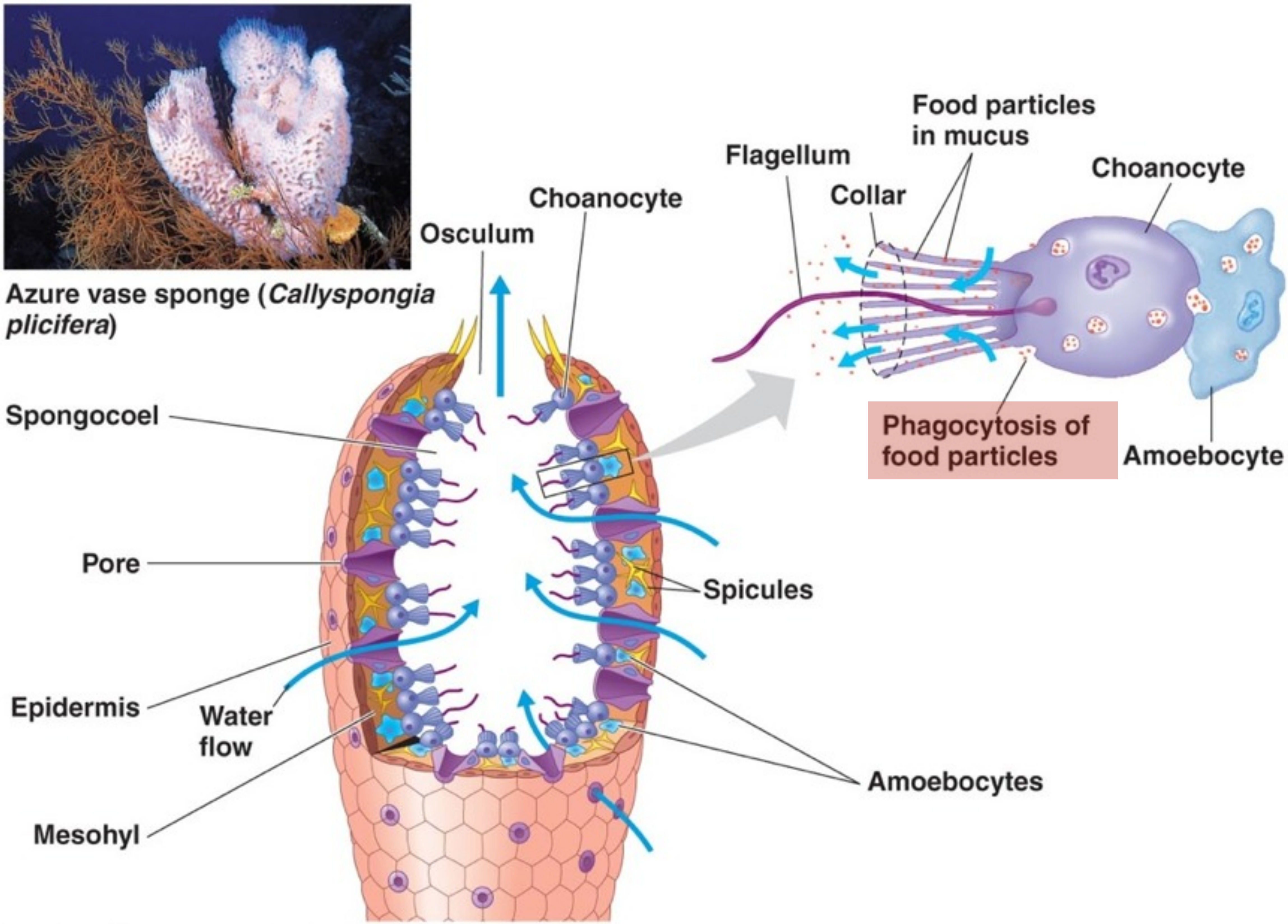
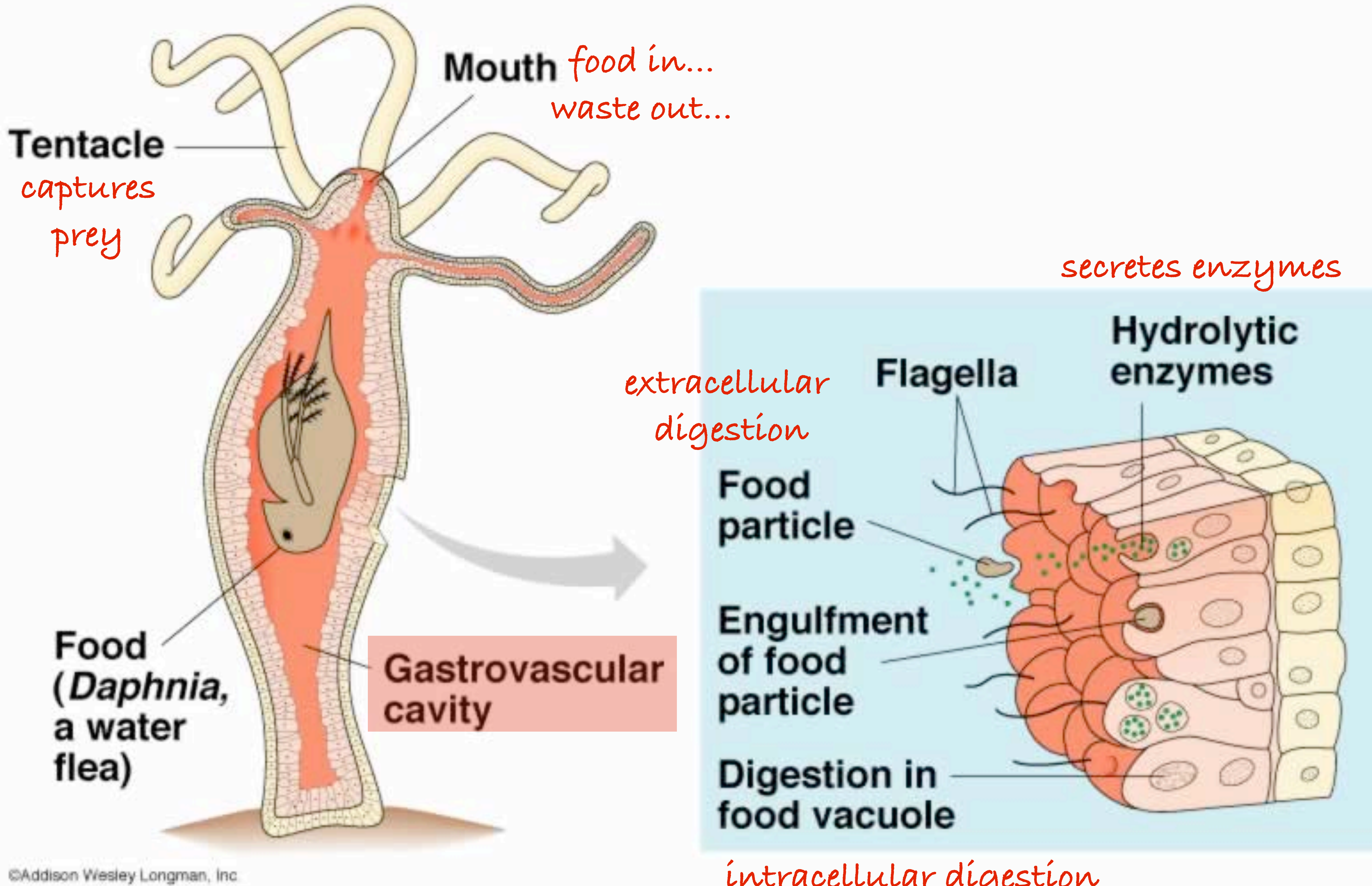


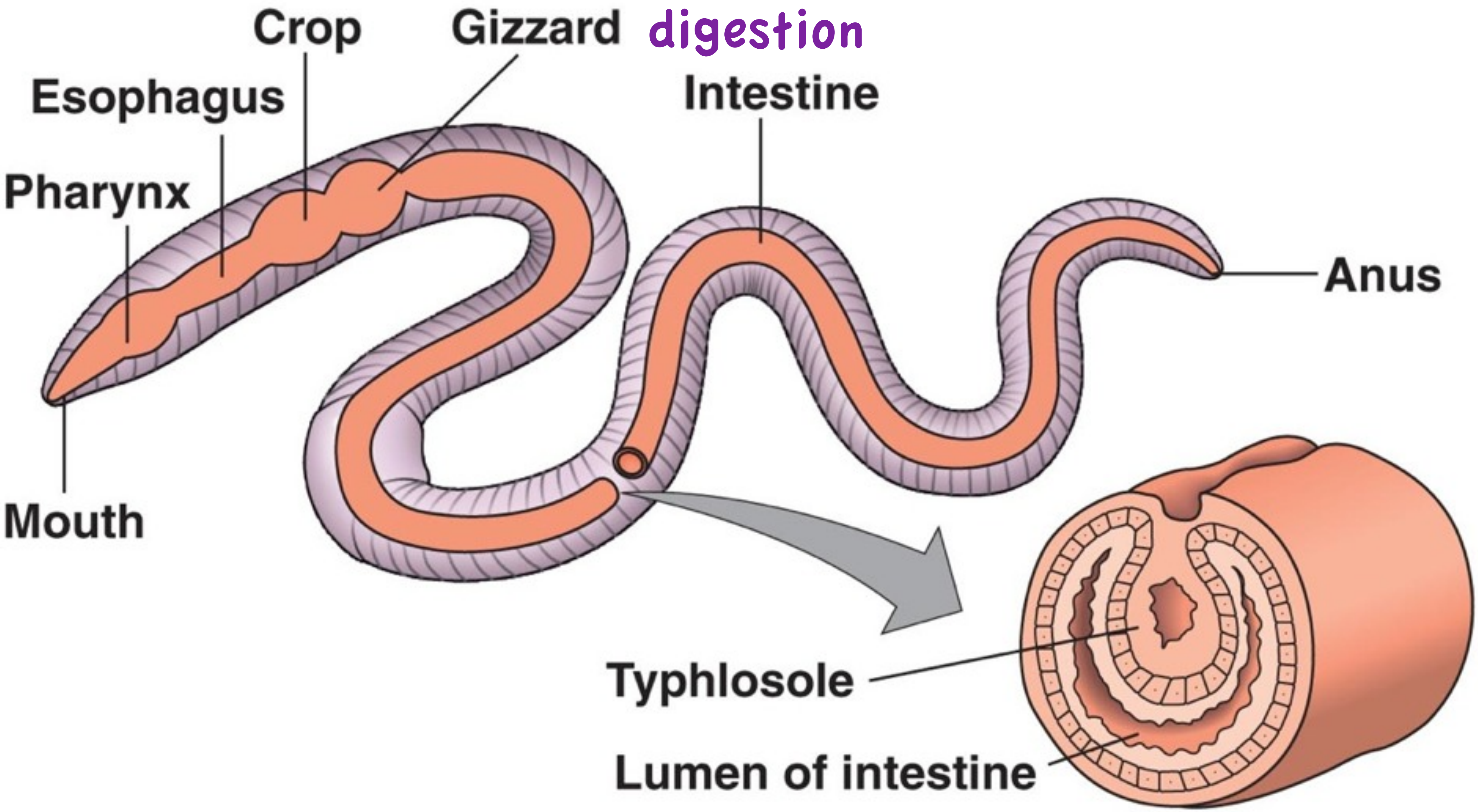
Azure vase sponge (*Callyspongia plicifera*)

Extracellular Compartments

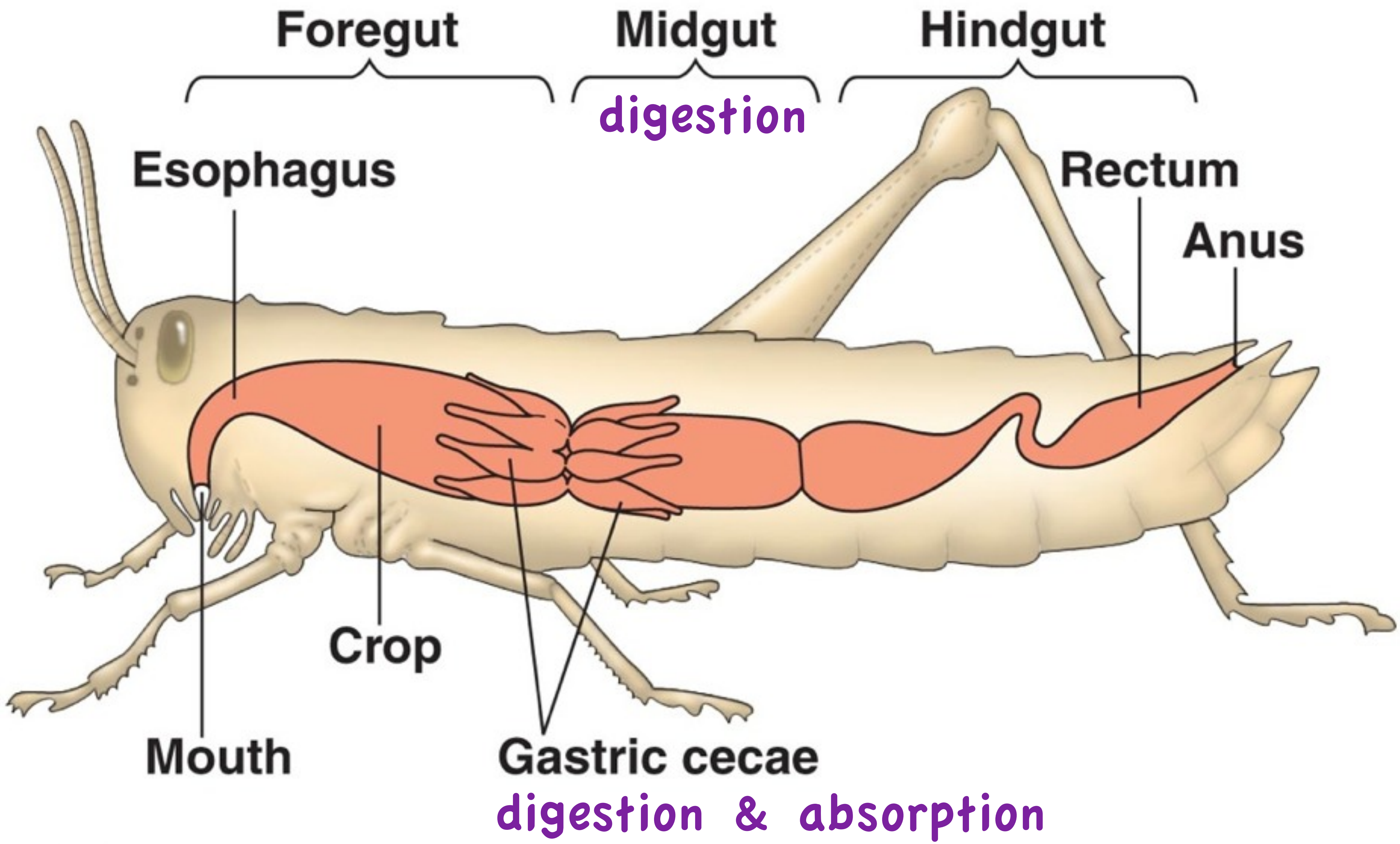
- Most animal species, molecular breakdown occurs by extracellular digestion, in compartments that continuous with outside of the animal's body.
- Some animals with simple body plans have digestive compartments with a single opening
  - ex. Hydra
- Most animals have a digestive tube extending between two openings: mouth and anus.
  - This tube is called **ALIMENTARY CANAL**



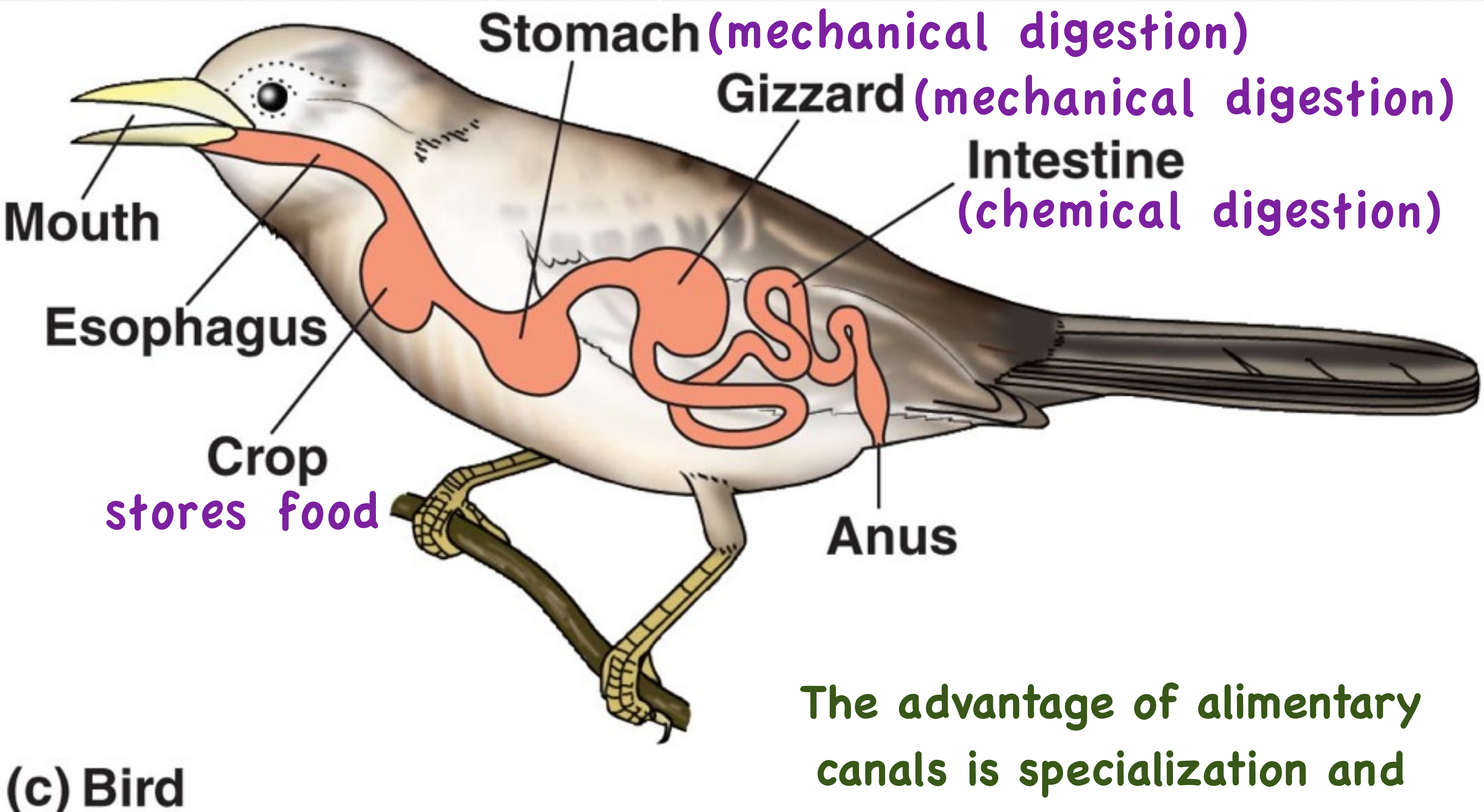
Mouth
food in...
waste out...
Tentacle
captures prey
Food (*Daphnia*, a water flea)
Gastrovascular cavity
secretes enzymes
extracellular digestion
Flagella
Hydrolytic enzymes
Food particle
Engulfment of food particle
Digestion in food vacuole
intracellular digestion


Crop
Gizzard
digestion
Esophagus
Intestine
Pharynx
Anus
Mouth
Typhlosole
Lumen of intestine

(a) Earthworm

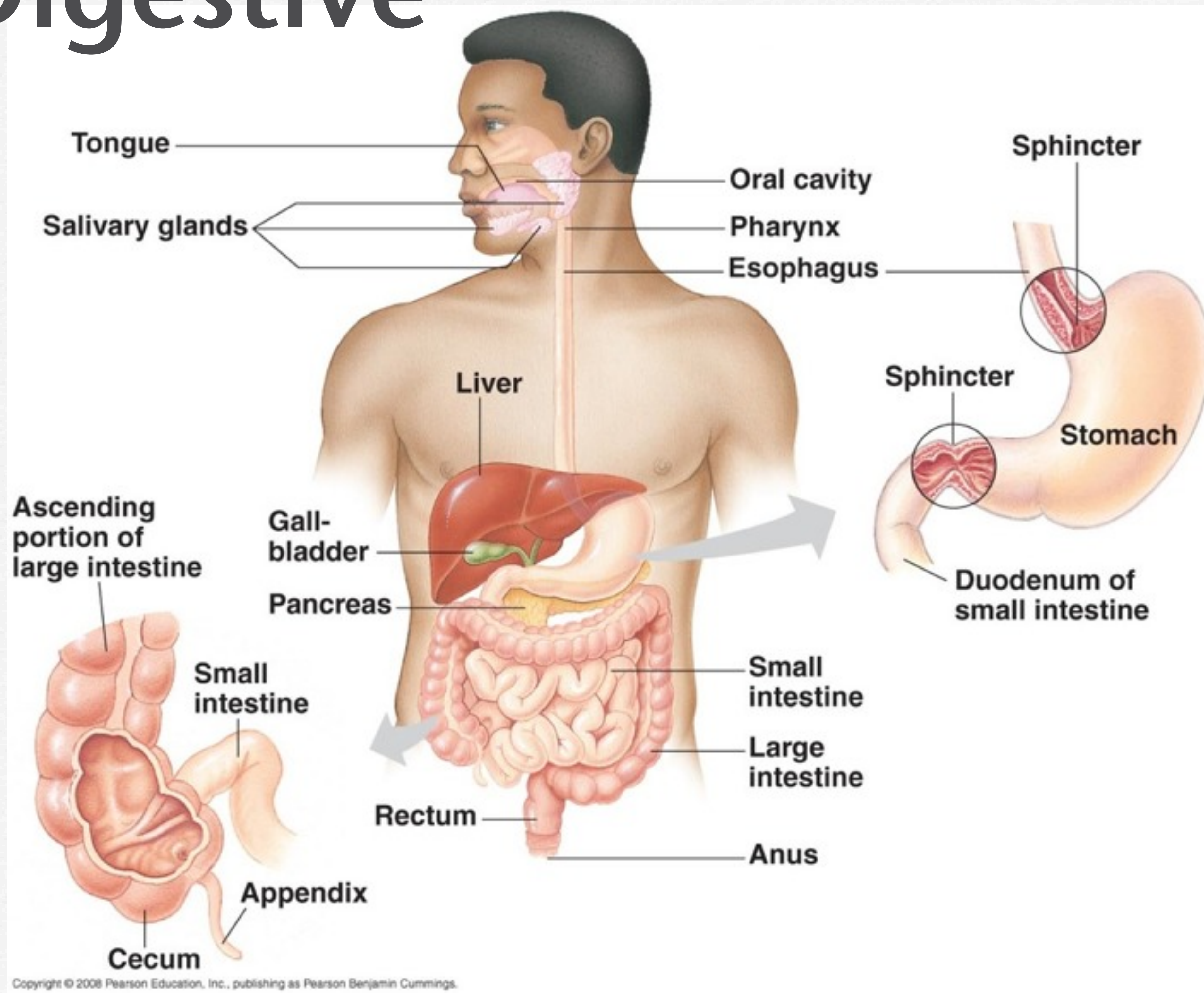


(b) Grasshopper



The advantage of alimentary canals is specialization and food can be digested while an earlier meal is being absorbed

HumanDigestive System

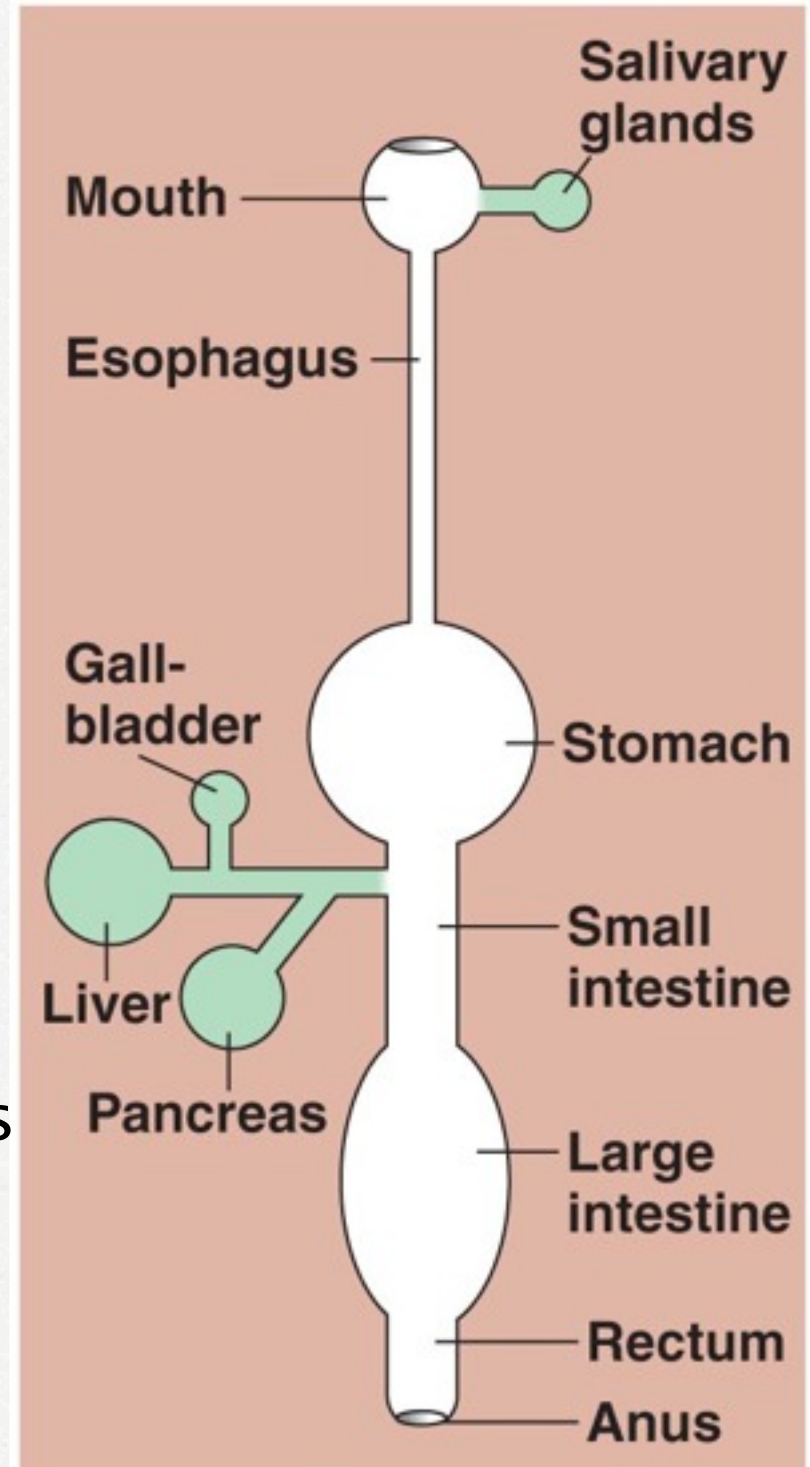


mechanical digestion

stores bile

makes bile
detoxifies

digestive enzymes



A schematic diagram of the human digestive system

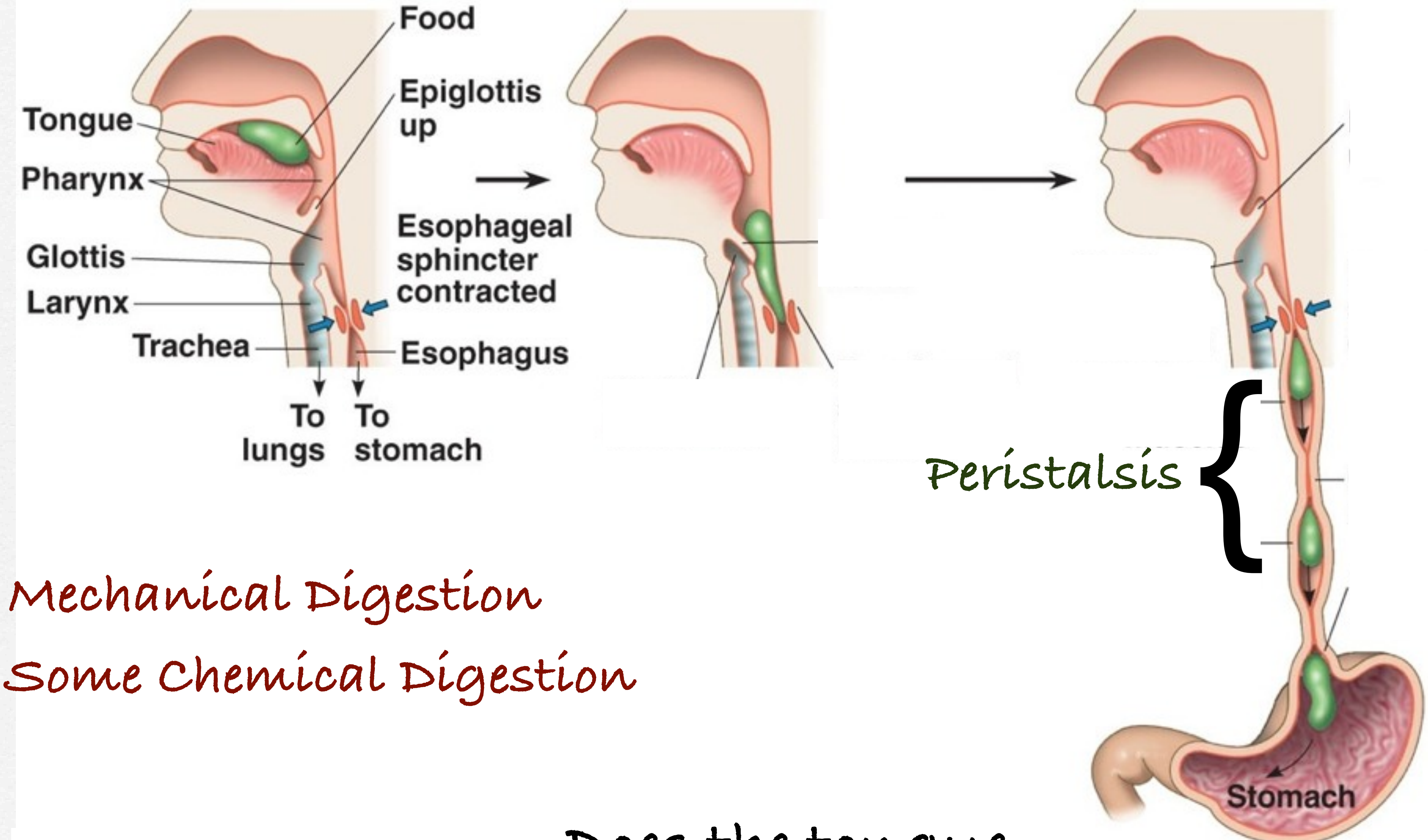
starts chemical
digestion

food storage
mechanical digestion

chemical digestion
absorption

absorption

waste storage



Mechanical Digestion

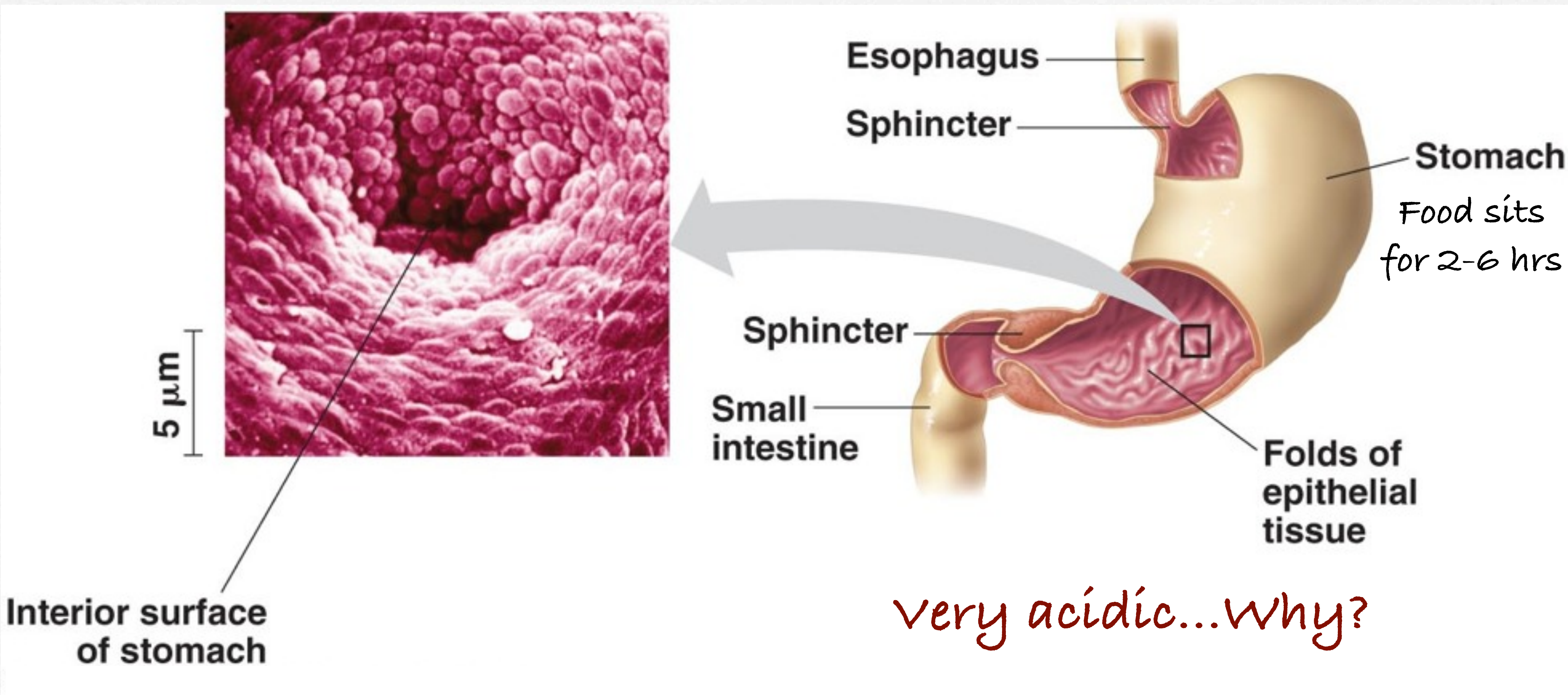
Some Chemical Digestion

Does the tongue have any function?

Mainly Storage

Chemical Digestion

Some Mechanical Digestion



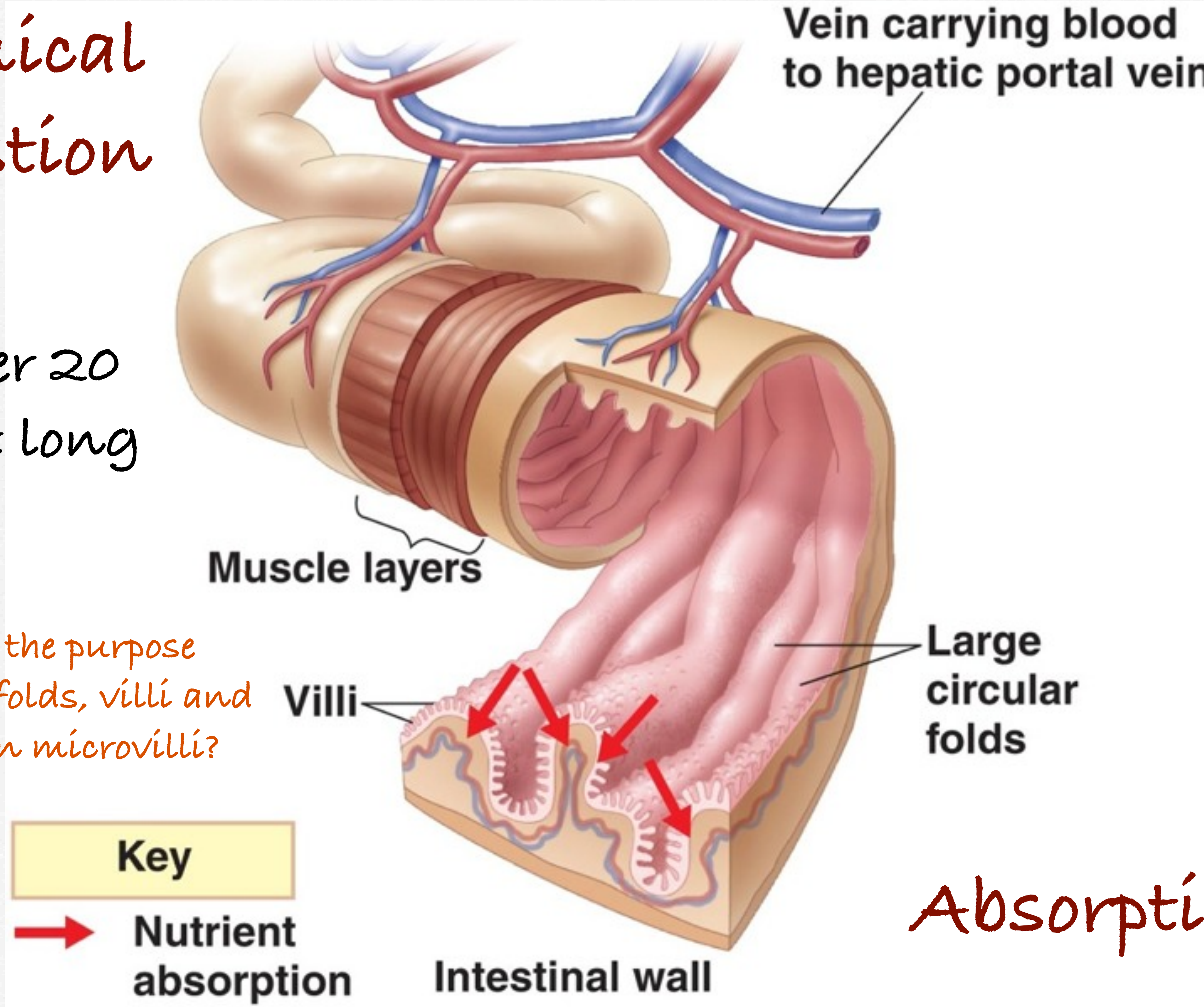
Food sits for 2-6 hrs

Very acidic...Why?

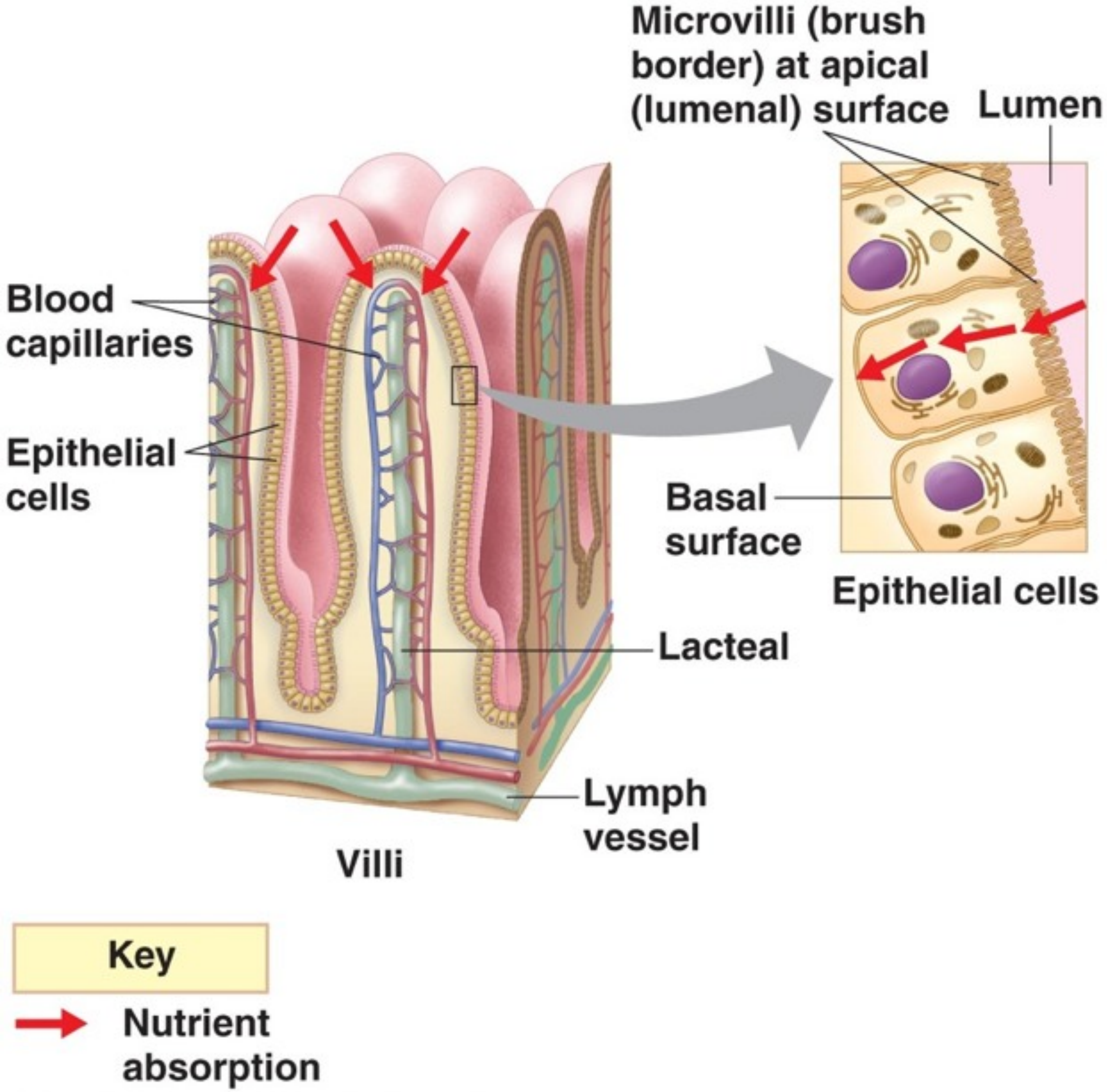
Chemical Digestion

over 20 feet long

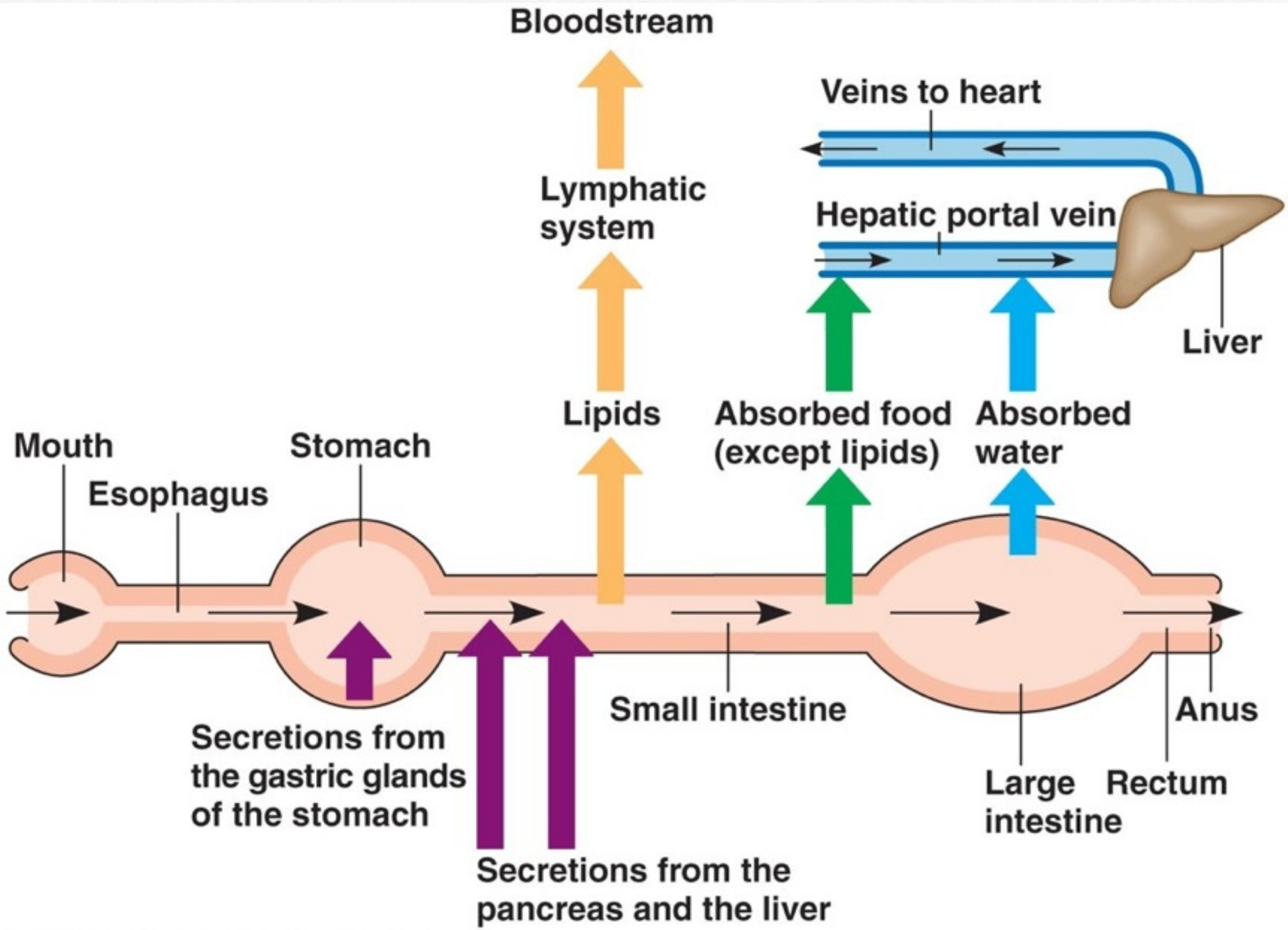
What is the purpose behind the folds, villi and the unseen microvilli?



Absorption

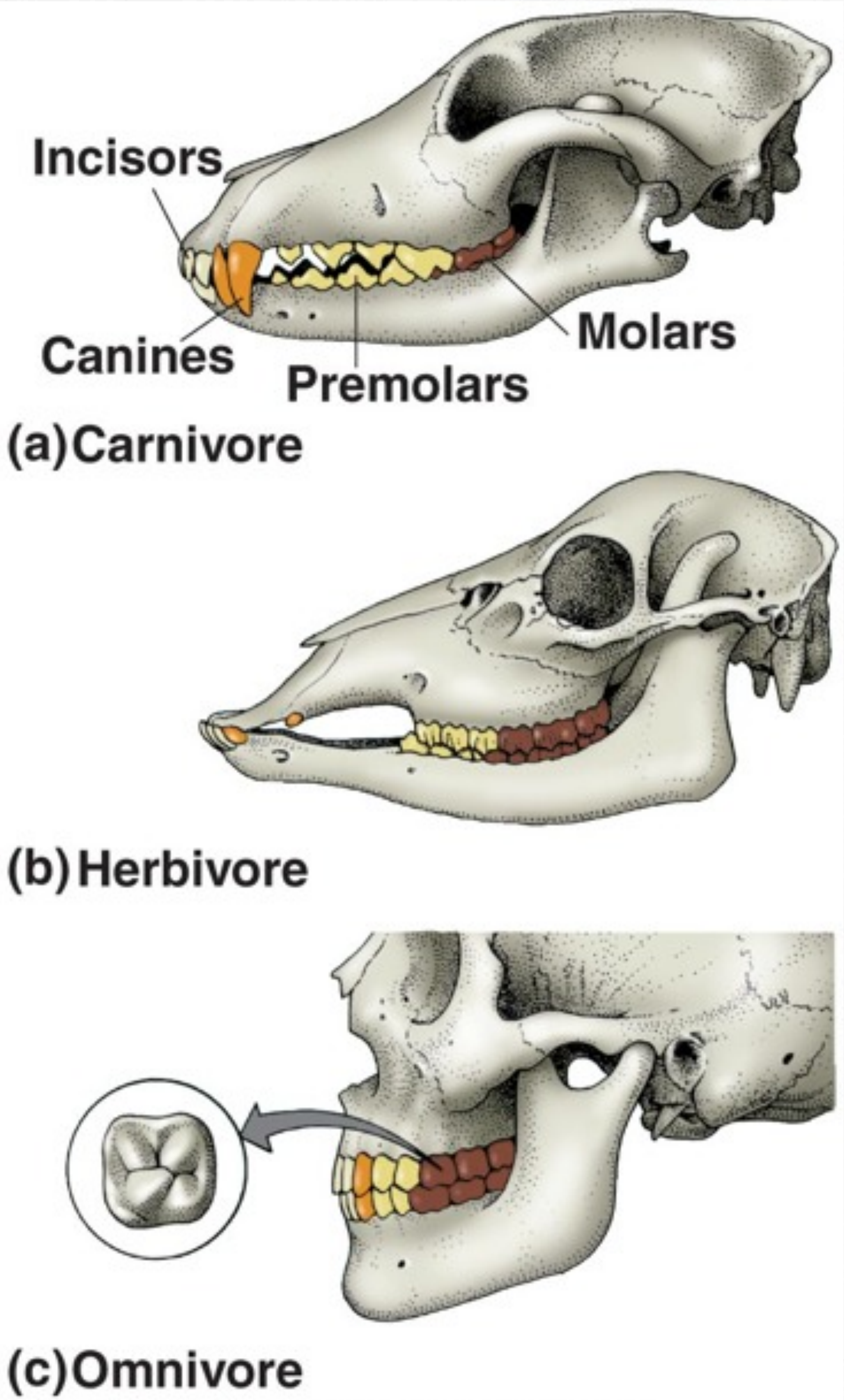


The absorption can be active or passive depending the nutrient


Bloodstream
Veins to heart
Lymphatic system
Hepatic portal vein
Liver
Lipids
Absorbed food (except lipids)
Absorbed water
Mouth
Stomach
Esophagus
Small intestine
Anus
Secretions from the gastric glands of the stomach
Large intestine
Rectum
Secretions from the pancreas and the liver

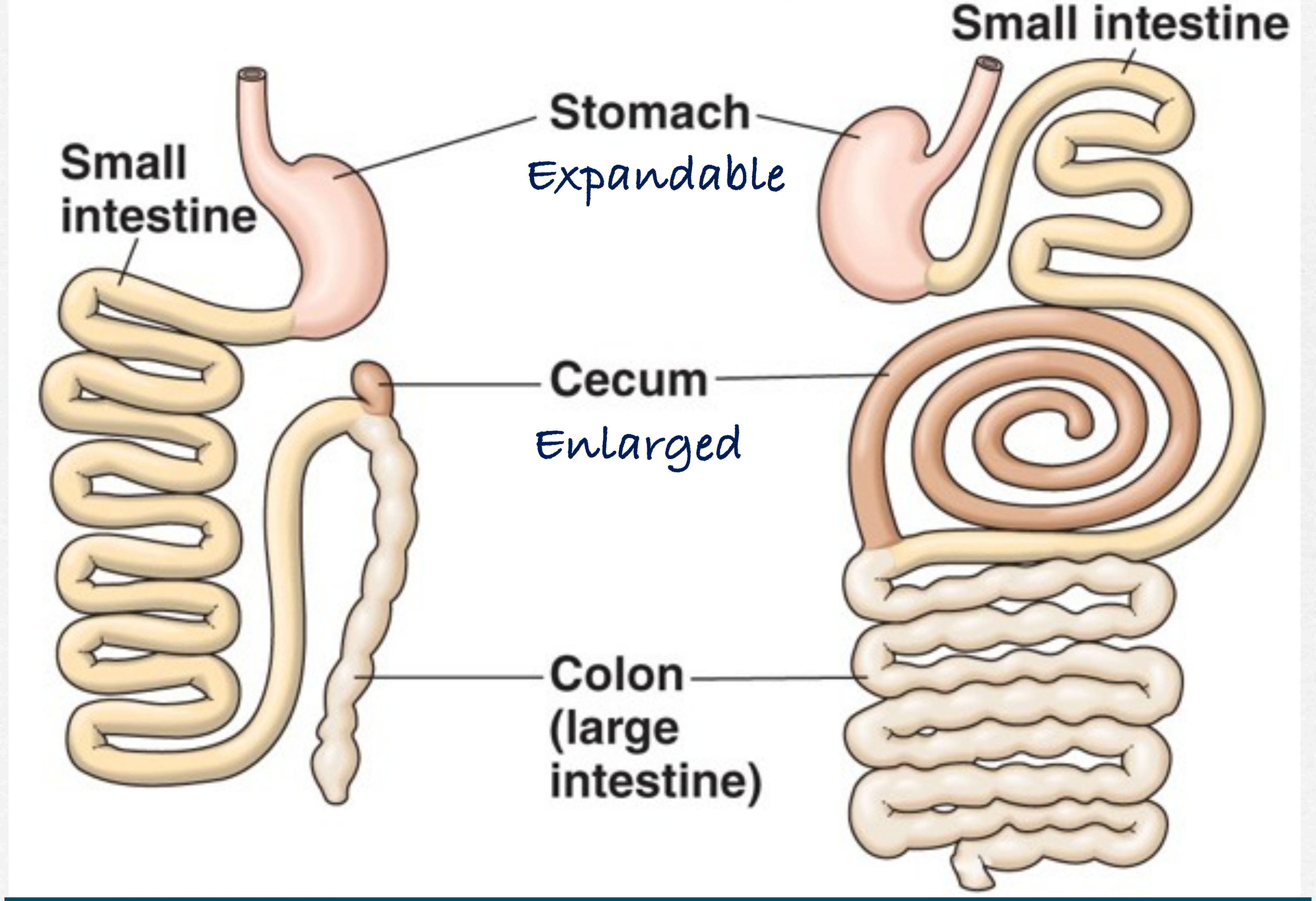
Evolutionary Adaptations

- Dental Adaptations
- Stomach Adaptations
- Intestinal Adaptations
- Mutualistic Adaptations

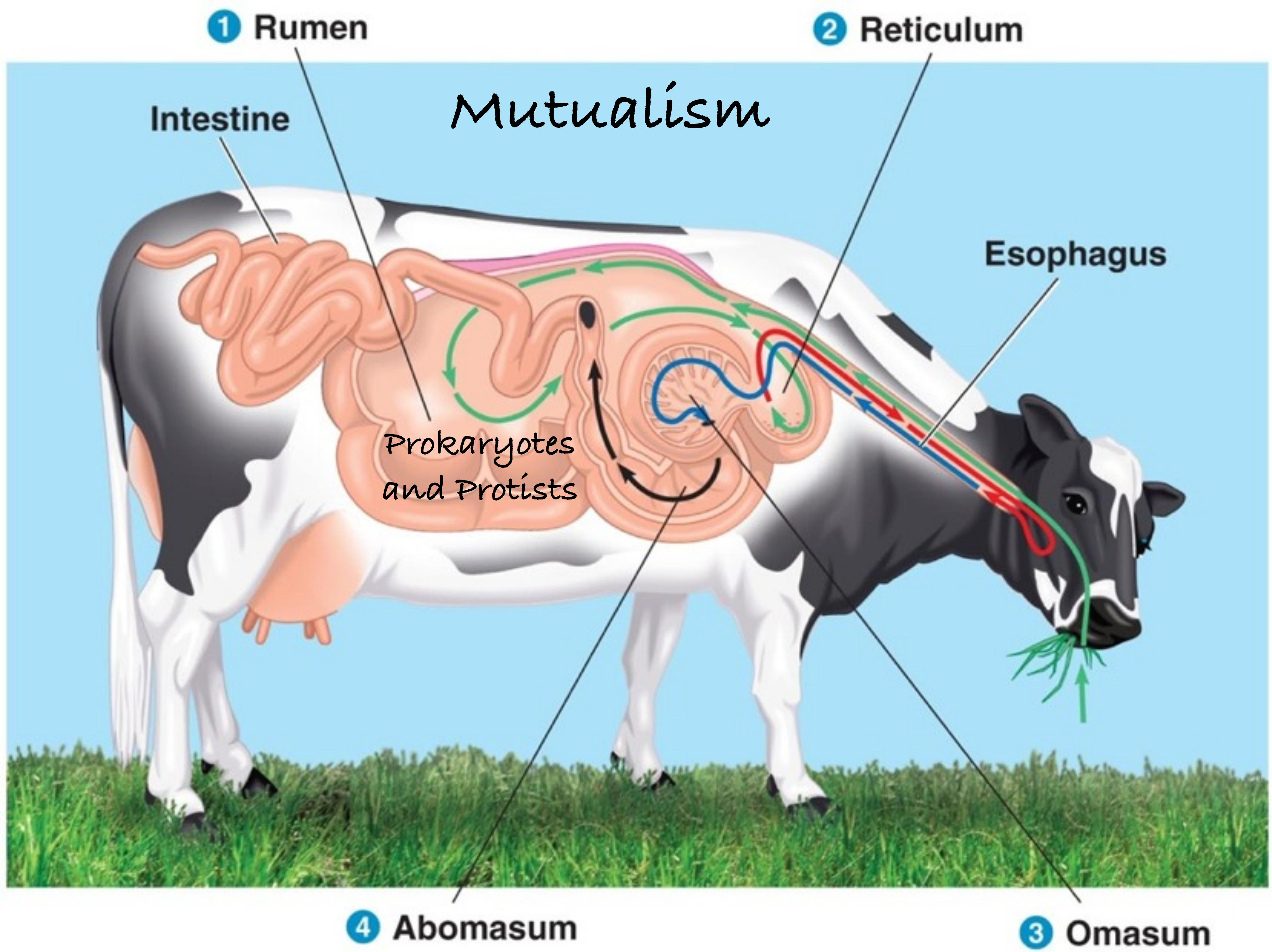


Which digestive tract belongs to the carnivore, the herbivore?

Shorter



Longer


1 Rumen
2 Reticulum
Mutualism
Intestine
Esophagus
Prokaryotes
and Protists
4 Abomasum
3 Omasum

Plants

Nutritional Requirements

Phototrophs

- Plants must acquire 17 essential elements
- Plants do not have to eat, but they must acquire the essential elements so that they make their own "food"
- Plants carry out **photosynthesis**… a process that uses sunlight and CO_2 to make their own sugars (organic compounds)
- No process is more important than photosynthesis to the welfare of life on earth.

Nutritional Needs

- Plants produce sugars (organic molecules) that provide **energy** and **building blocks** not only for themselves but for most the food webs above them.
- These macromolecules provide the energy for cellular respiration and provide the raw materials for biosynthesis
    - In addition plants require certain specific **essential micro-elements** usually needed in much smaller amounts

Essential Nutrients

- Plants require 2 classes of essential nutrients
  - Macro-elements
  - Micro-elements
- Plants acquire 3 essential elements from the air and the remaining 14 from the soil.

Table 37.1 Essential Elements in Plants

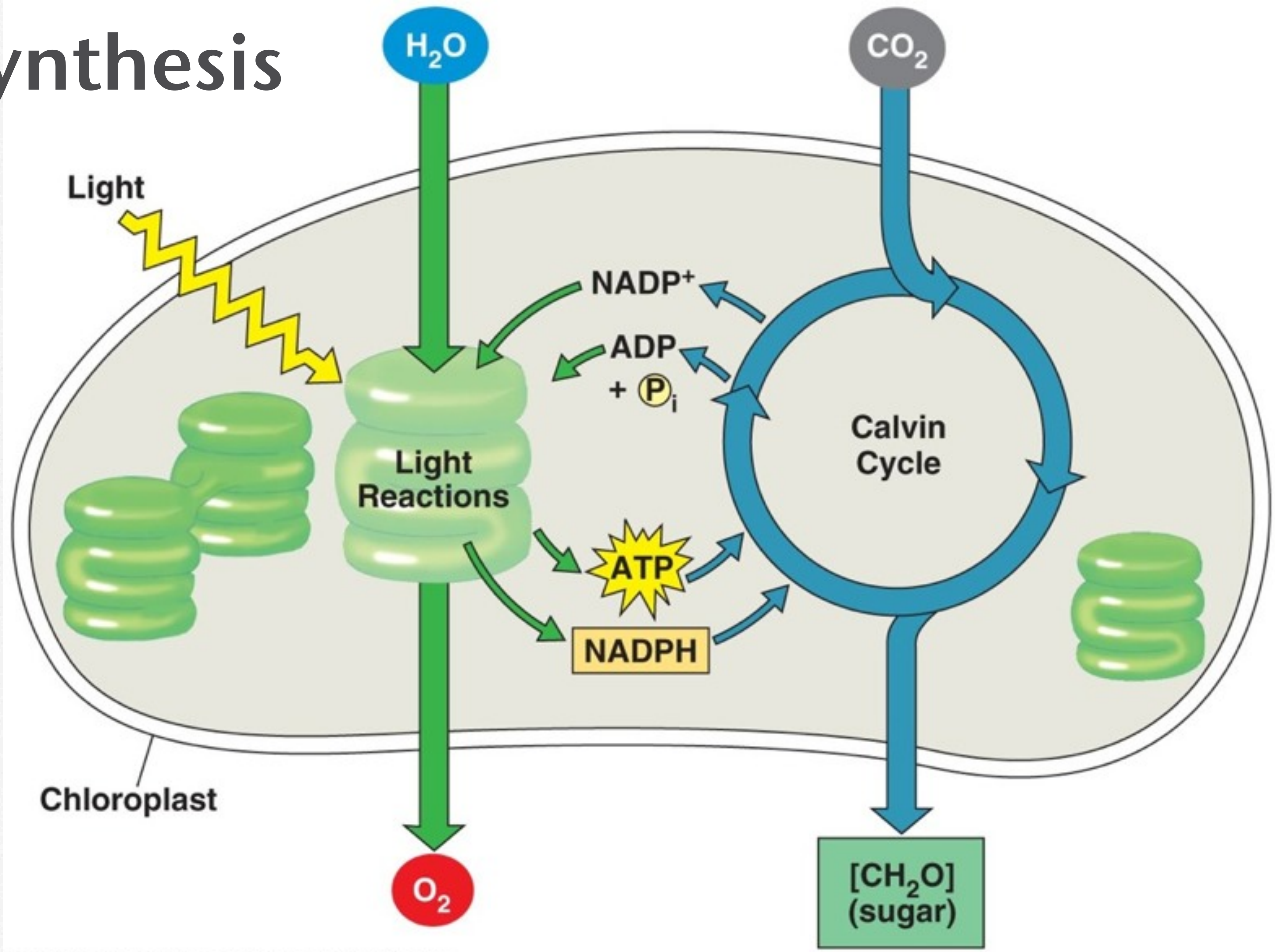
Element	Form Available to Plants	% Mass in Dry Tissue	Major Functions
Macronutrients			
Carbon	CO_2	45%	Major component of plant's organic compounds
Oxygen	CO_2	45%	Major component of plant's organic compounds
Hydrogen	H_2O	6%	Major component of plant's organic compounds
Nitrogen	NO_3^-, NH_4^+	1.5%	Component of nucleic acids, proteins, hormones, chlorophyll, coenzymes
Potassium	K^+	1.0%	Cofactor that functions in protein synthesis; major solute functioning in water balance; operation of stomata
Calcium	Ca^{2+}	0.5%	Important in formation and stability of cell walls and in maintenance of membrane structure and permeability; activates some enzymes; regulates many responses of cells to stimuli
Magnesium	Mg^{2+}	0.2%	Component of chlorophyll; activates many enzymes
Phosphorus	$H_2PO_4^-$, HPO_4^{2-}	0.2%	Component of nucleic acids, phospholipids, ATP, several coenzymes
Sulfur	SO_4^{2-}	0.1%	Component of proteins, coenzymes
Micronutrients			
Chlorine	Cl^-	0.01%	Required for water-splitting step of photosynthesis; functions in water balance
Iron	Fe^{3+}, Fe^{2+}	0.01%	Component of cytochromes; activates some enzymes
Manganese	Mn^{2+}	0.005%	Active in formation of amino acids; activates some enzymes; required for water-splitting step of photosynthesis
Boron	$H_2BO_3^-$	0.002%	Cofactor in chlorophyll synthesis; may be involved in carbohydrate transport and nucleic acid synthesis; role in cell wall function
Zinc	Zn^{2+}	0.002%	Active in formation of chlorophyll; activates some enzymes
Copper	Cu^+, Cu^{2+}	0.001%	Component of many redox and lignin-biosynthetic enzymes
Nickel	Ni^{2+}	0.001%	Cofactor for an enzyme functioning in nitrogen metabolism
Molybdenum	MoO_4^{2-}	0.0001%	Essential for symbiotic relationship with nitrogen-fixing bacteria; cofactor in nitrate reduction

Plants

Nutritional Processing

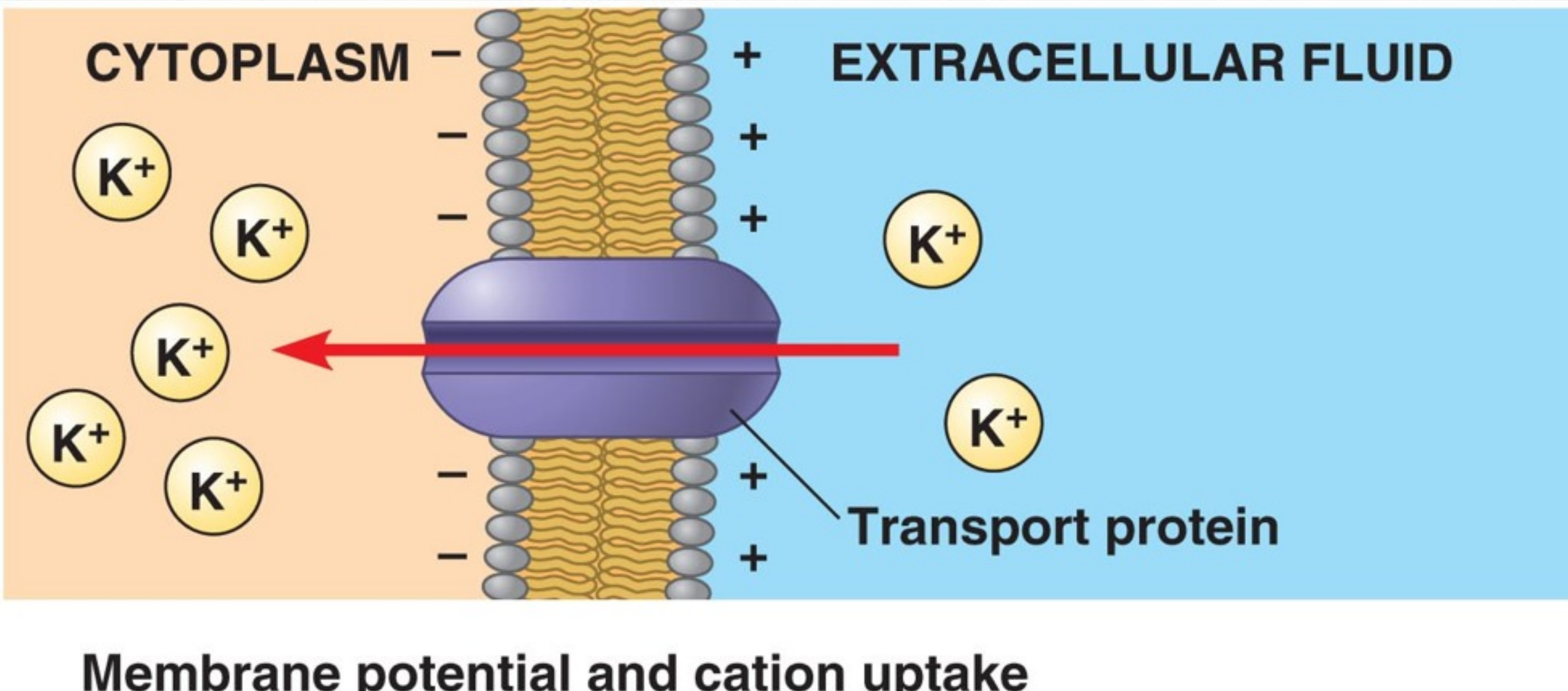
Photosynthesis

addresses the energy demand



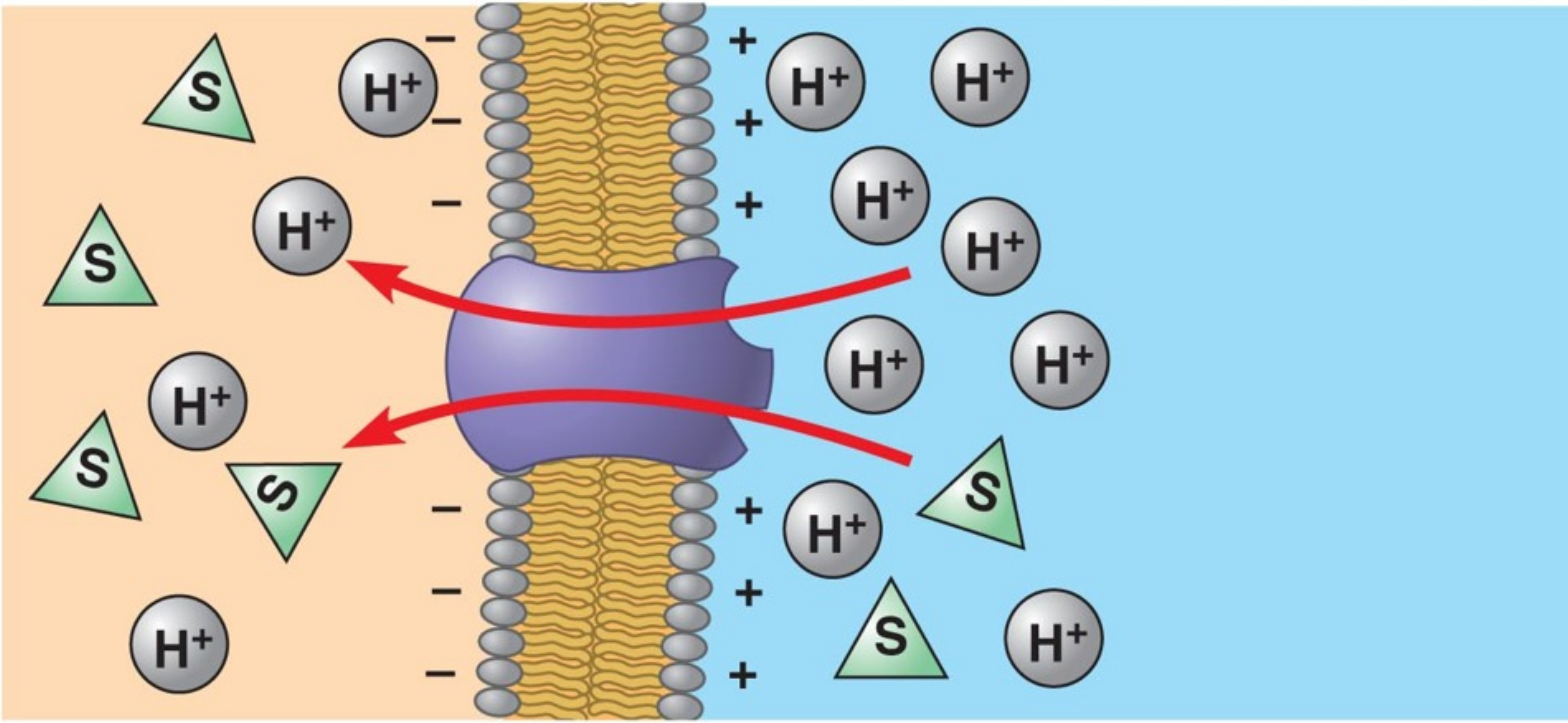
Potassium (Facilitated Diffusion)

addresses the demand for essential elements



Sulfur (Co-transport)

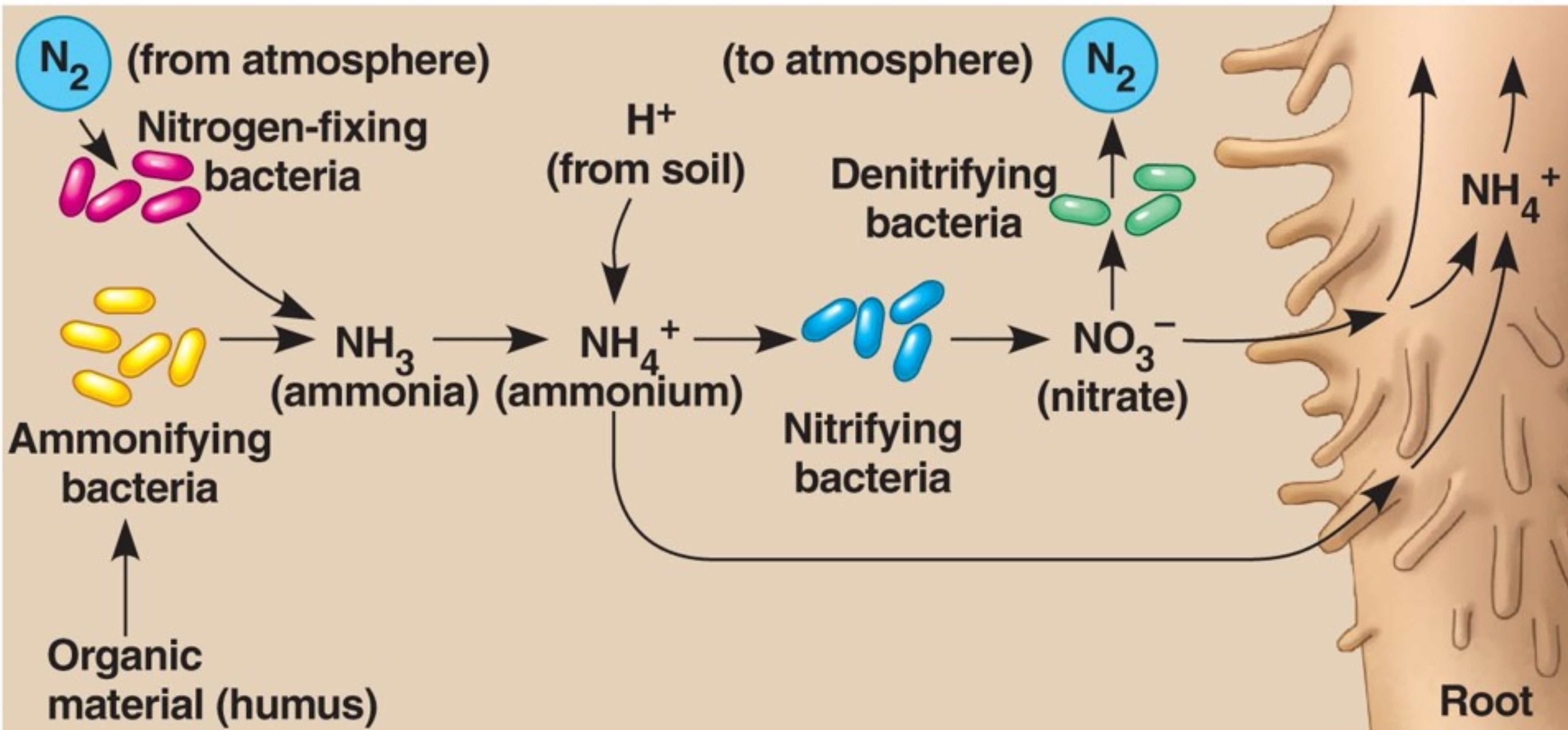
addresses the demand for essential elements



Cotransport of a neutral solute with H^+

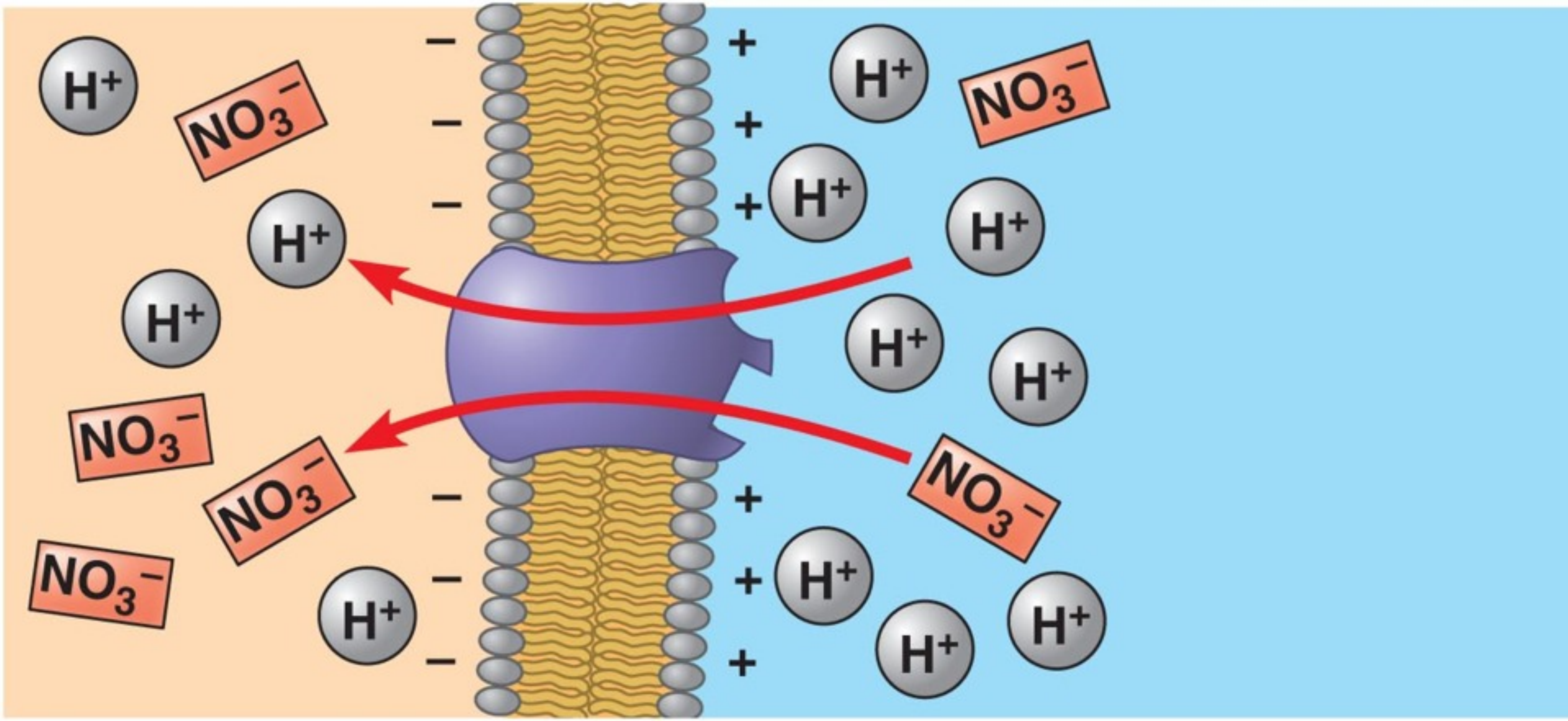
Nitrogen Fixation

addresses the demand for essential elements



Nitrogen (Co-transport)

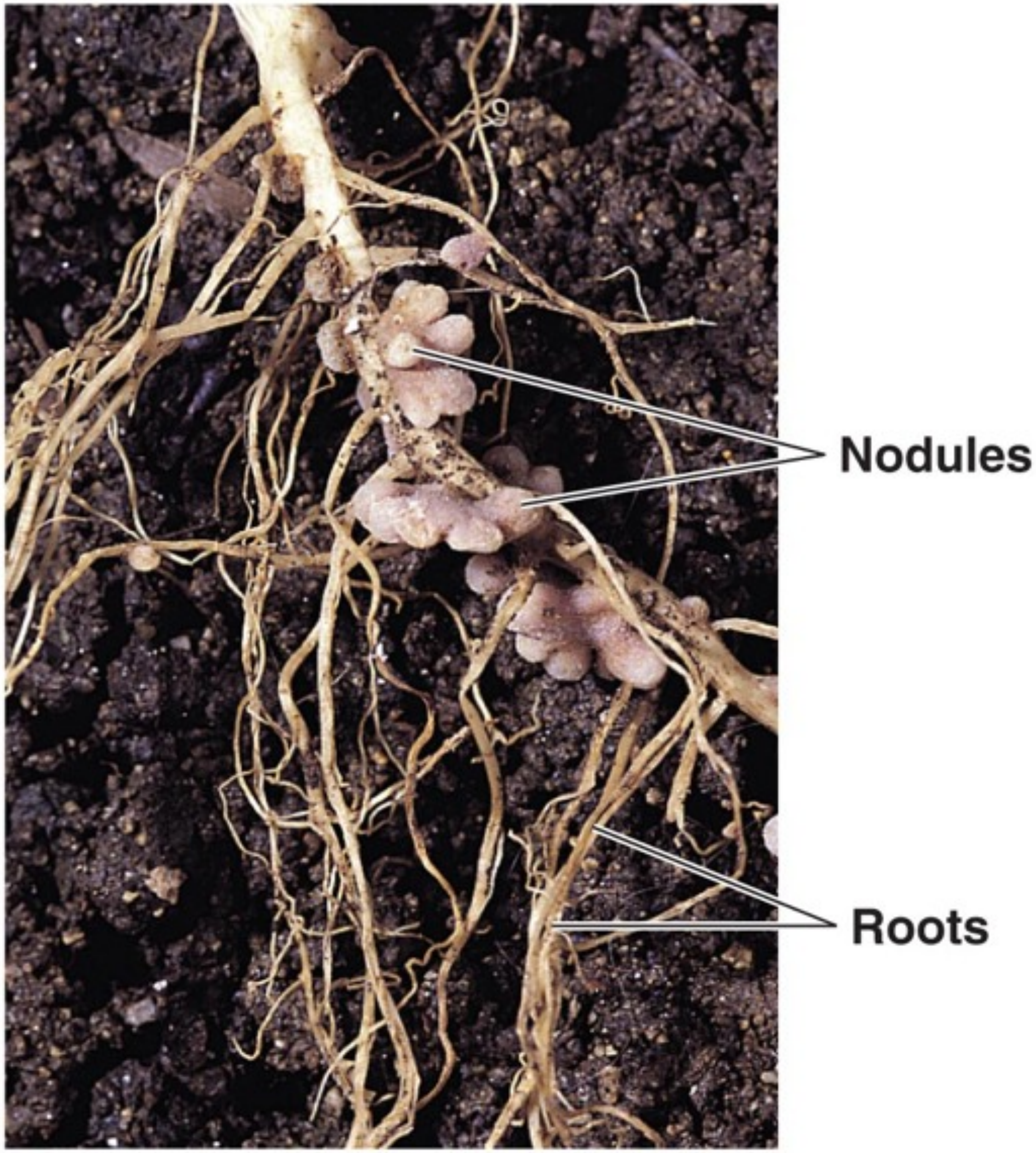
addresses the demand for essential elements



Cotransport of an anion with H^+

Evolutionary Adaptations

- Mutualistic Adaptations
- Unusual Feeding Adaptations
- Many other adaptations exist but will be addressed at a later date



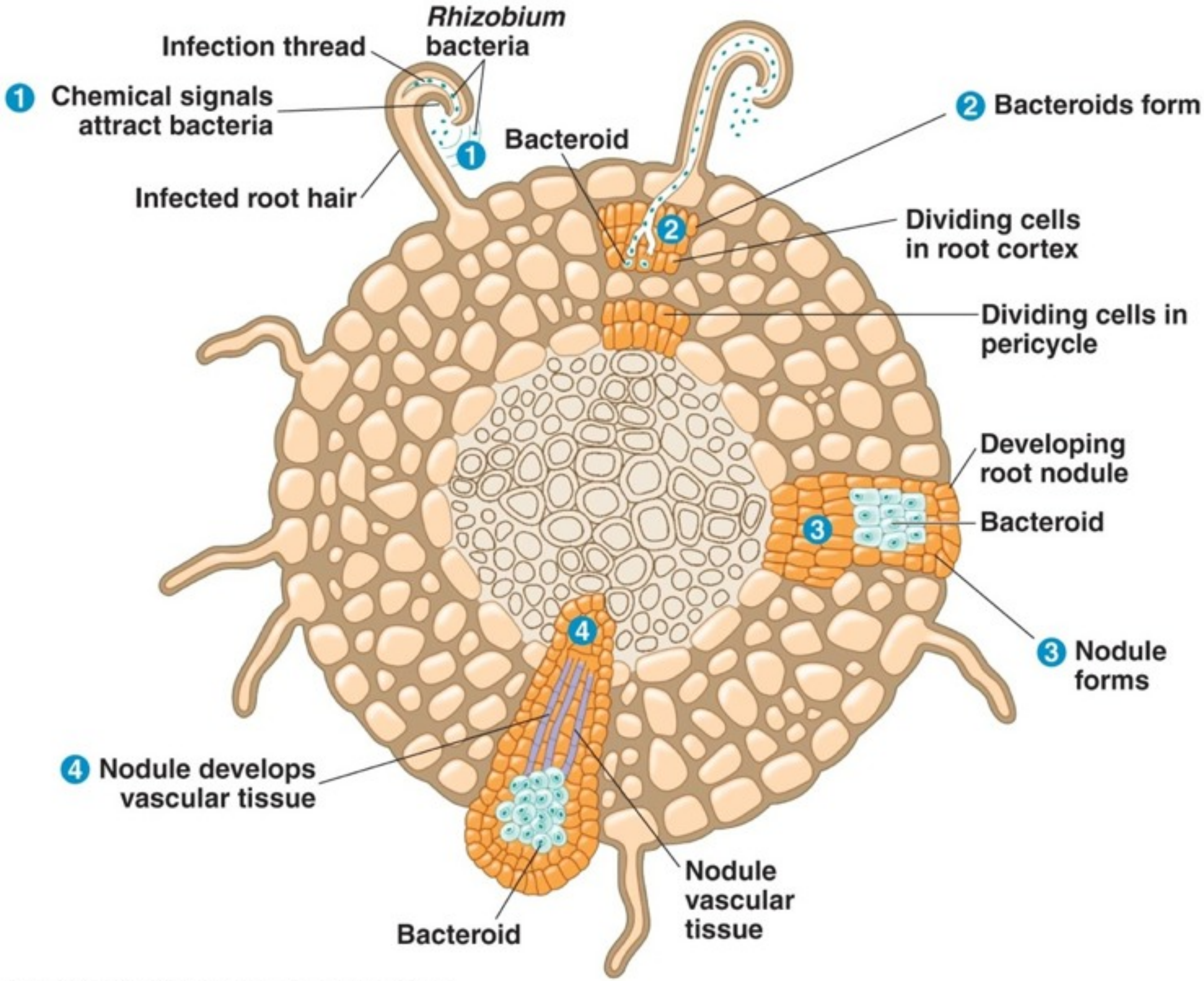
(a) Pea plant root

Root Nodules

Plants

&

Prokaryotes



Plant provides sugar to the bacteria

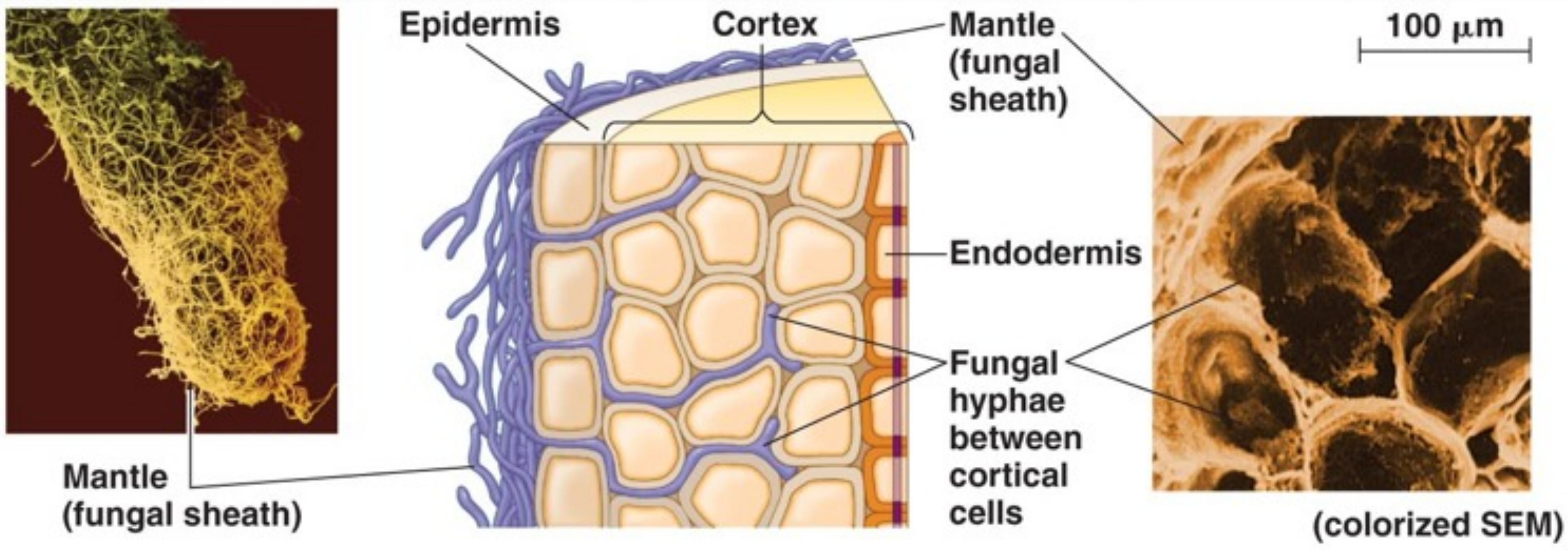
Bacteria provides nitrogen to the plant

Mycorrhizae

Plants

&

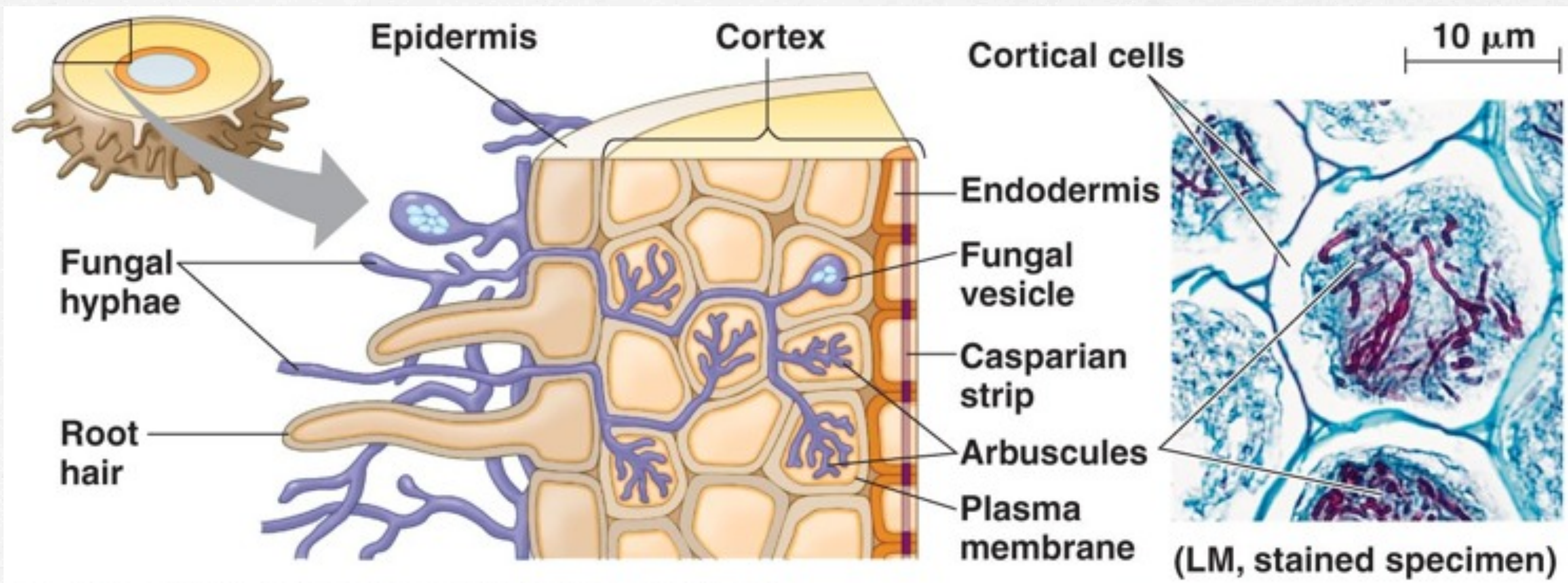
Fungi



(a) Ectomycorrhizae

Plant provides sugar to the fungi

Fungi provides water to the plant



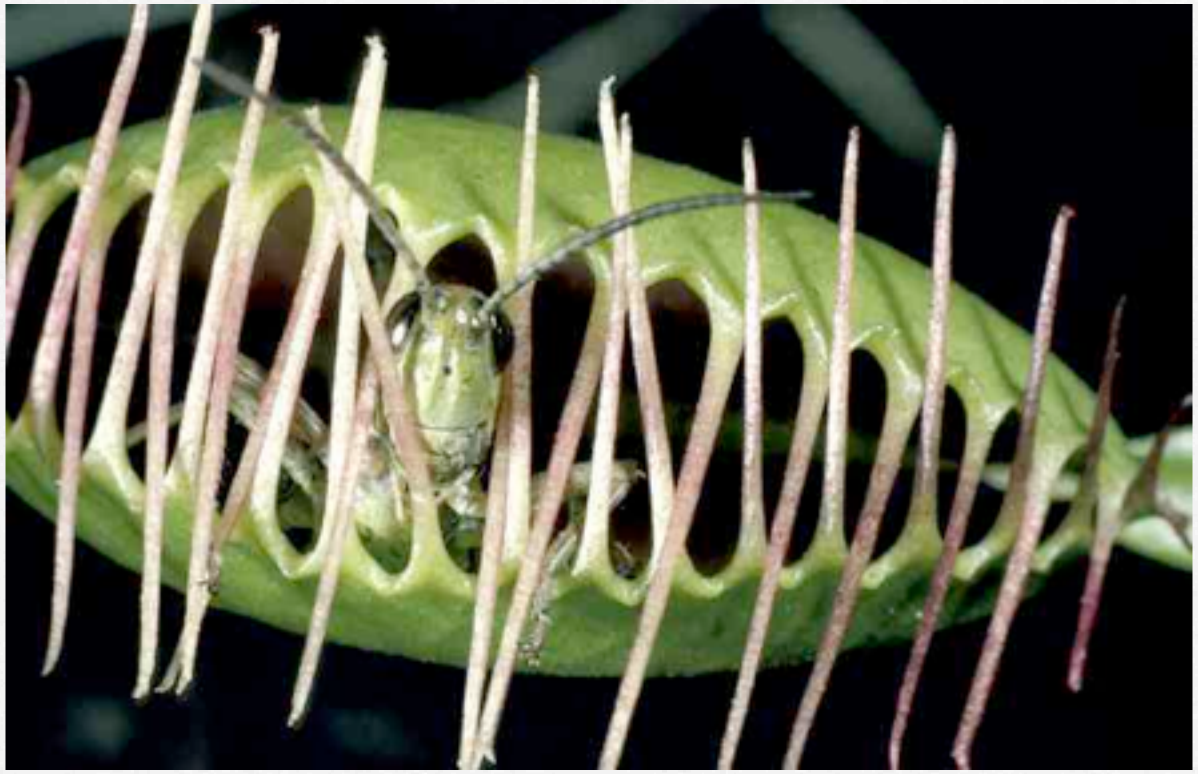
(b) Arbuscular mycorrhizae (endomycorrhizae)

Epiphytes

Staghorn Fern

Parasitic Plants

Carnivorous Plants



Pitcher Plant

Venus Fly Trap

Fungi

Nutritional Requirements

Heterotrophs

- Fungi must acquire the 17 essential elements
- Fungi have to eat, they can not make their own "food"
- Fungi **digest their "food" outside their body** and then absorb the sugars and organic compounds from their environment
- Fungi are **decomposers**, they are very important in an ecological standpoint because they **recycle matter** in ecosystems.

Nutritional Needs

- Fungi must acquire sugars (organic molecules) that provide **energy** and **building blocks**.
- These macromolecules provide the energy for cellular respiration and provide the raw materials for biosynthesis
    - In addition fungi require certain specific **essential nutrients** usually needed in much smaller amounts

Essential Nutrients

- Fungi require 2 classes of essential elements
  - Macro-Elements
  - Micro-Elements

Essential Mineral Nutrients of Fungi

Table 1. Essential Mineral Nutrients of Fungi

Element	Utilizable Form	Concentration (M)	Functions and Comment
Macronutrients			
Potassium	KCl, K_2HPO_4	10^{-3}	Enzyme activity; carbohydrate metabolism; ionic balance
Phosphorus	KH_2PO_4	10^{-3}	Nucleic acids; energy transfer; intermediary metabolism
Magnesium	$MgCl_2$	10^{-3}	Enzyme activation; ATP metabolism
Nitrogen	$NaNO_3$, NH_4Cl	10^{-3}	Amino acids, nucleotides and vitamins
Sulfur	K_2SO_4	10^{-4}	Amino acids, vitamins and other sulfhydryl compounds
Calcium	$CaCl_2$	10^{-4}	Enzyme activity, membrane structure; not universally required
Micronutrients			
Iron	$FeCl_3$, $FeSO_4$	10^{-6}	Cytochromes and heme apoenzymes; pigments
Copper	$CuSO_4$	10^{-6}–10^{-7}	Enzyme activity; pigments
Manganese	$MnCl_2$	10^{-7}	Enzyme activity; TCA cycle, nucleic acid synthesis
Zinc	$ZnCl_2$	10^{-8}	Enzyme activity; organic acid and other intermediary metabolism
Molybdenum	Na_2MoO_4	10^{-9}	Enzyme activity; nitrate metabolism; vitamin B_{12}

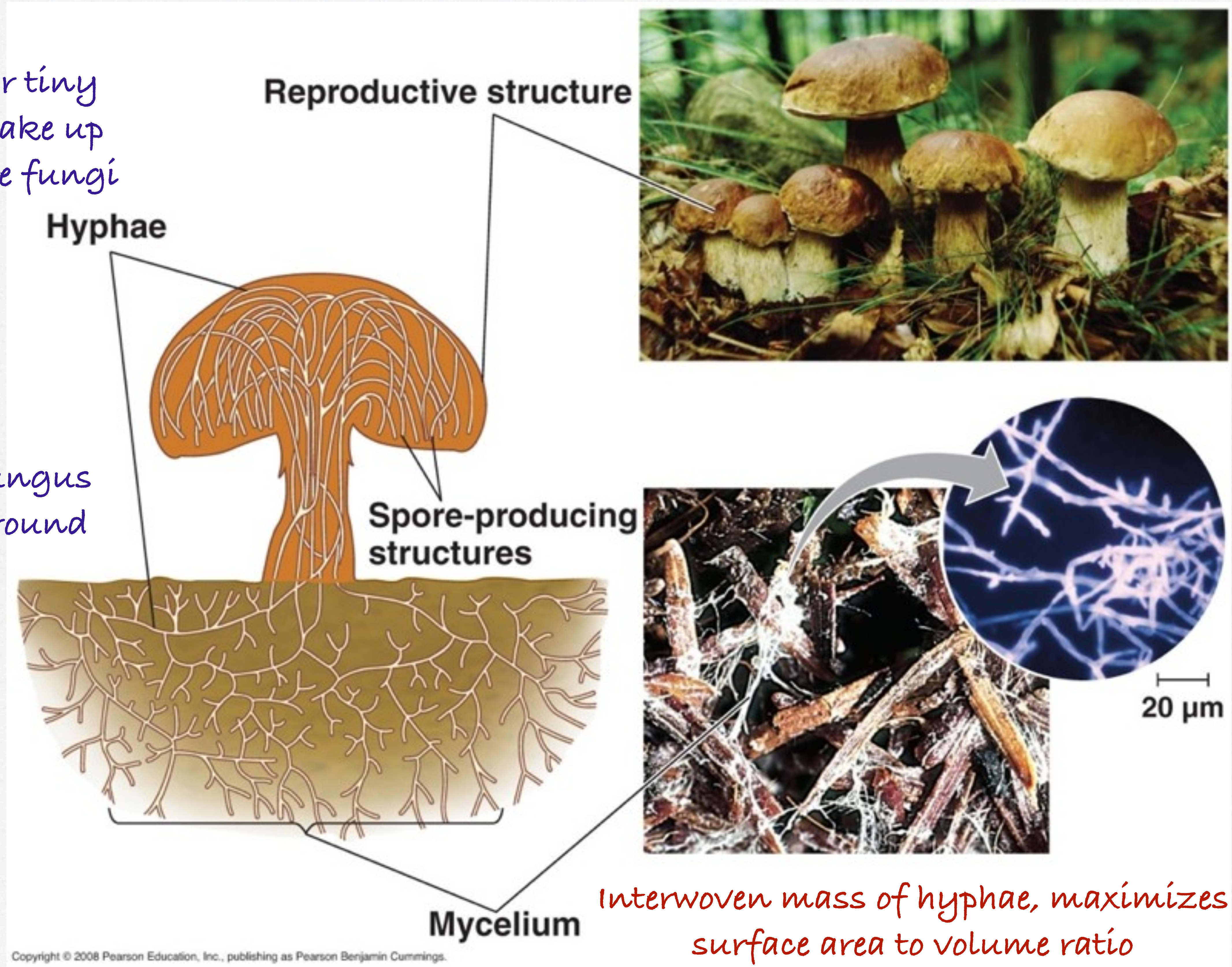
Some evidence suggests that these elements are also essential to fungi Cobalt, Scandium, Vanadium and Gallium

Fungi

Nutritional Processing

Multicellular tiny filaments make up the body of the fungi

Most of the fungus lives underground



Interwoven mass of hyphae, maximizes surface area to volume ratio

Fungi as Decomposers

- Fungi can digest and absorb many carbon containing substances: dead organisms, cellulose, jet fuel and house paint.
- They return all elements back to soil and complete the cycle of matter in ecosystems.
- Without decomposers like fungi life on earth would not continue.

Fungi as Mutualists

- Some fungi derive important nutrients from mutualistic relationships between photosynthetic organisms.
- These relationships often involve fungi providing the water and minerals and the autotroph providing the sugars.

Fungi as Mutualists

- LICHENS- a mutualistic relationship where fungi provide water and minerals and algae provide sugars
- MYCORRHIZAE- a mutualistic relationship where a fungi provide water and minerals and plants provide sugars
- Fungus-gardening insects- leaf cutting ants feed the ants while the fungus digest the cellulose for the ants

A fruticose (shrublike) lichen

Crustose (encrusting) lichens

A foliose (leaflike) lichen

LICHEN

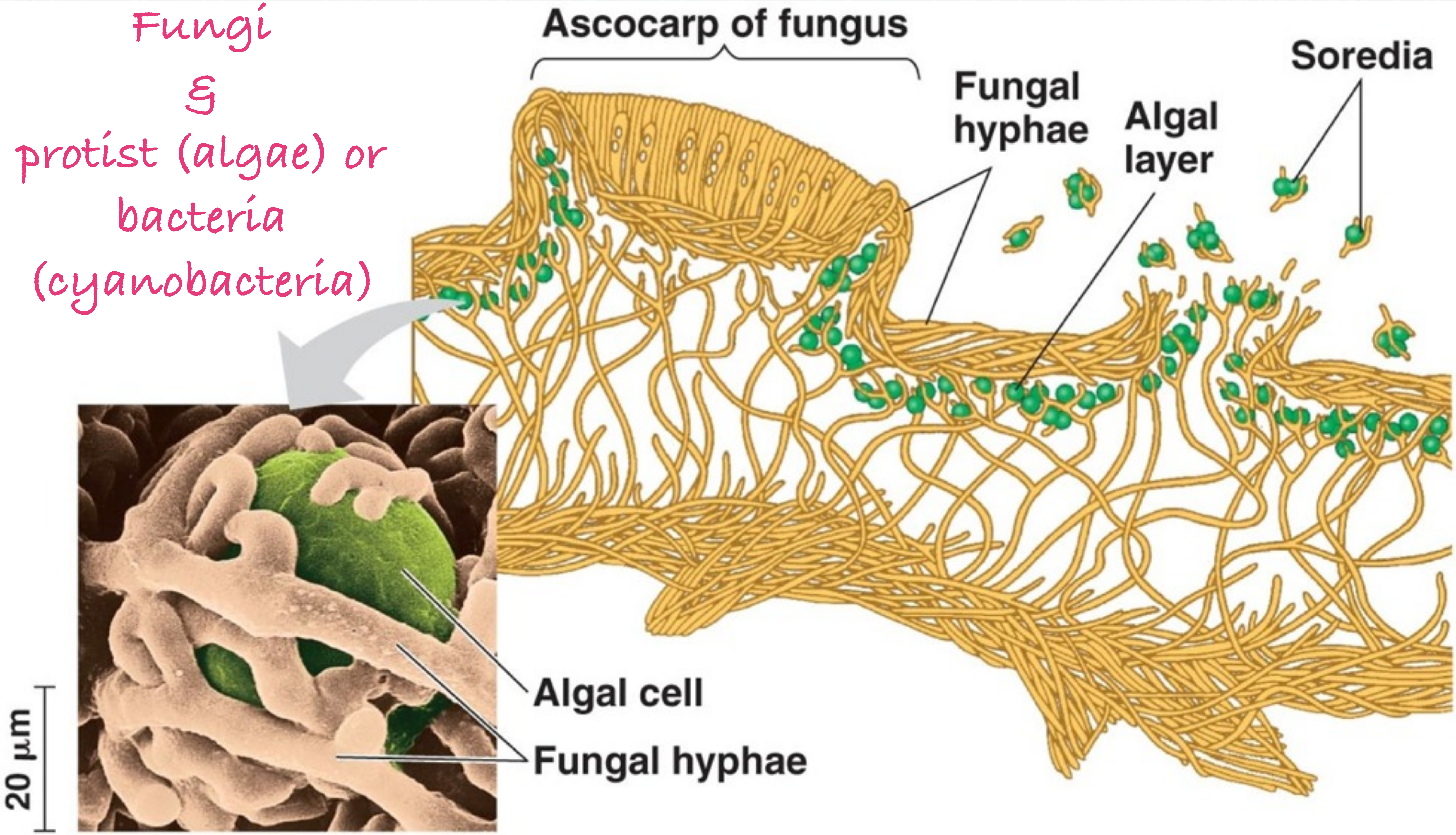
Fungi

&

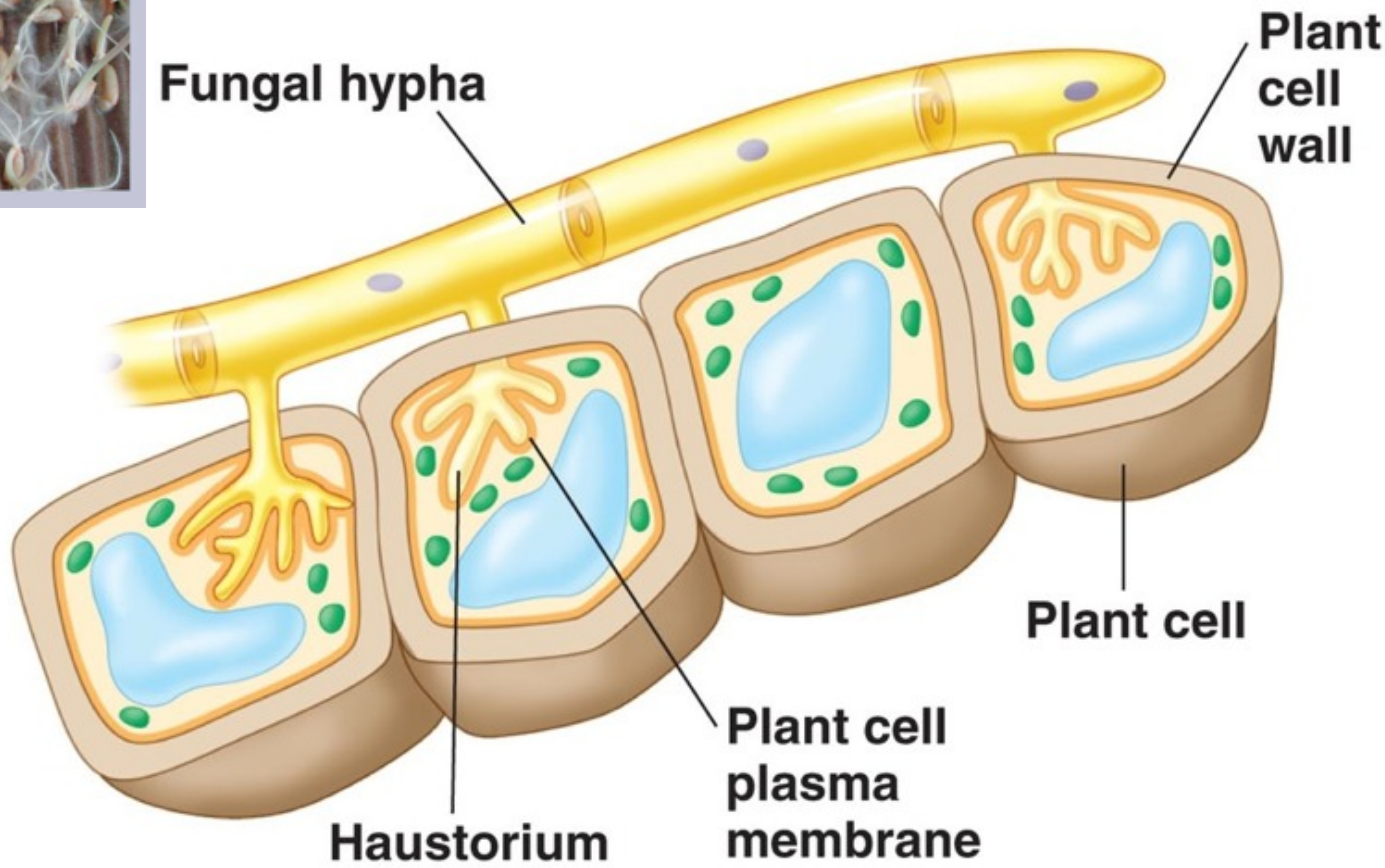
protist (algae) or

bacteria

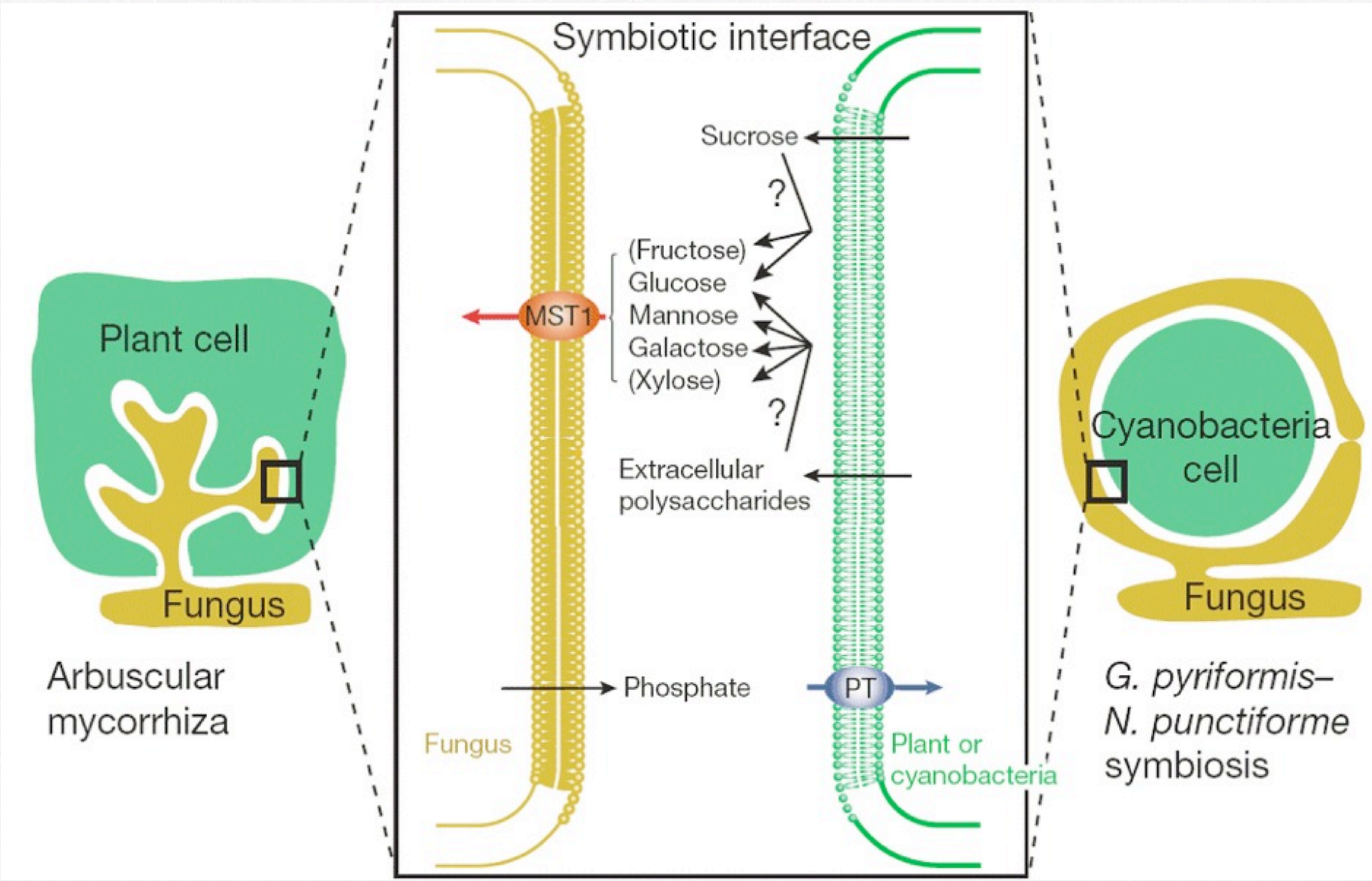
(cyanobacteria)



Mycorrhizae



(b) Haustoria



Symbiotic interface
Sucrose
?
(Fructose)
Glucose
Mannose
Galactose
(Xylose)
?
MST1
Extracellular
polysaccharides
Phosphate
PT
Fungus
Plant or
cyanobacteria
Plant cell
Fungus
Arbuscular
mycorrhiza
Cyanobacteria
cell
Fungus
G. pyriformis–
N. punctiforme
symbiosis

Fungi as Pathogens

- About 30% of fungi feed from living organisms as parasites or pathogens.
- Mostly affects plants but can also attack animals including humans.

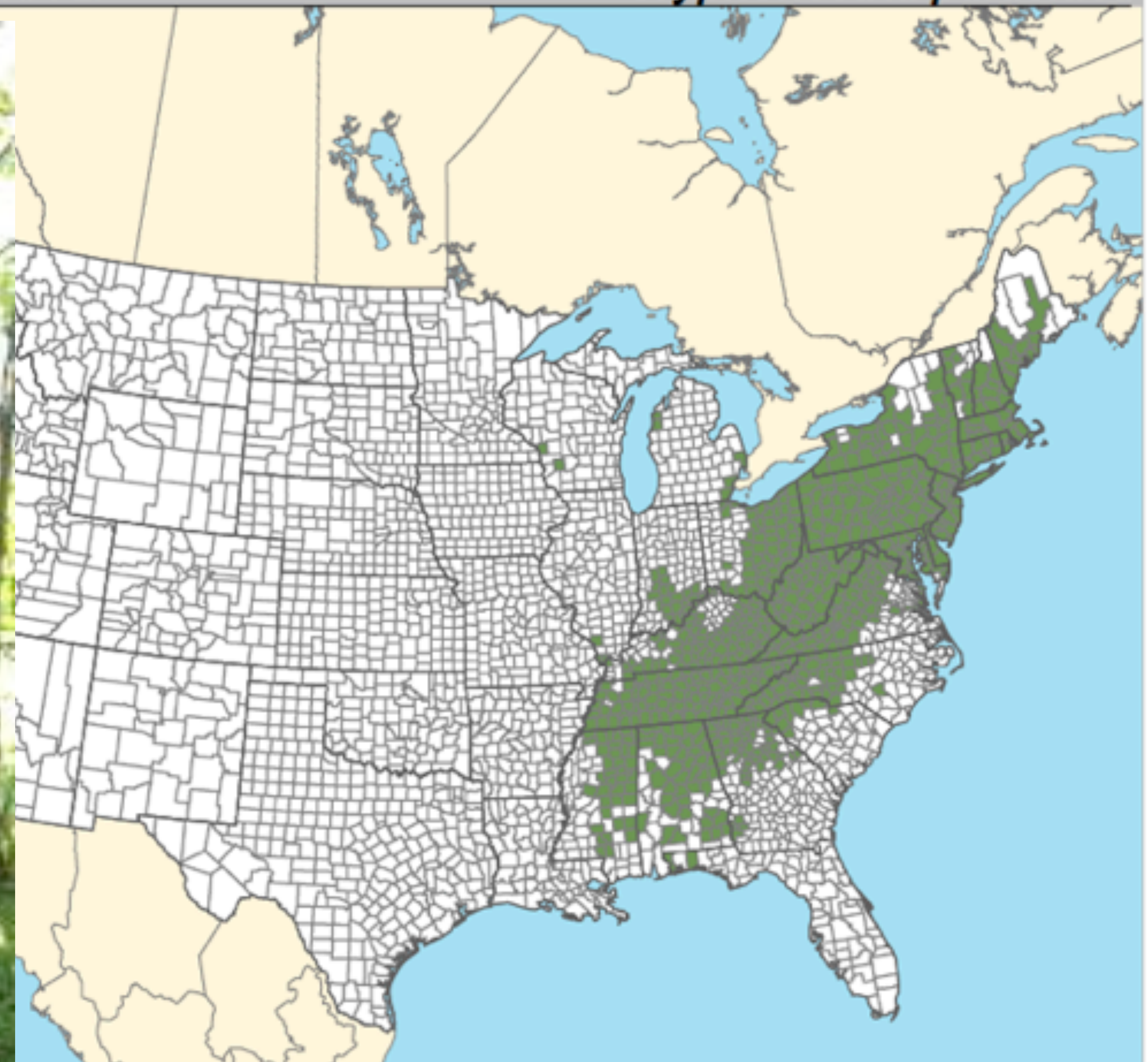
Alien Forest Pest Explorer

www.fs.fed.us/ne/morgantown/4557/AFPE/

Pest Distribution Map

Chestnut Blight

Cryphonectria parasitica



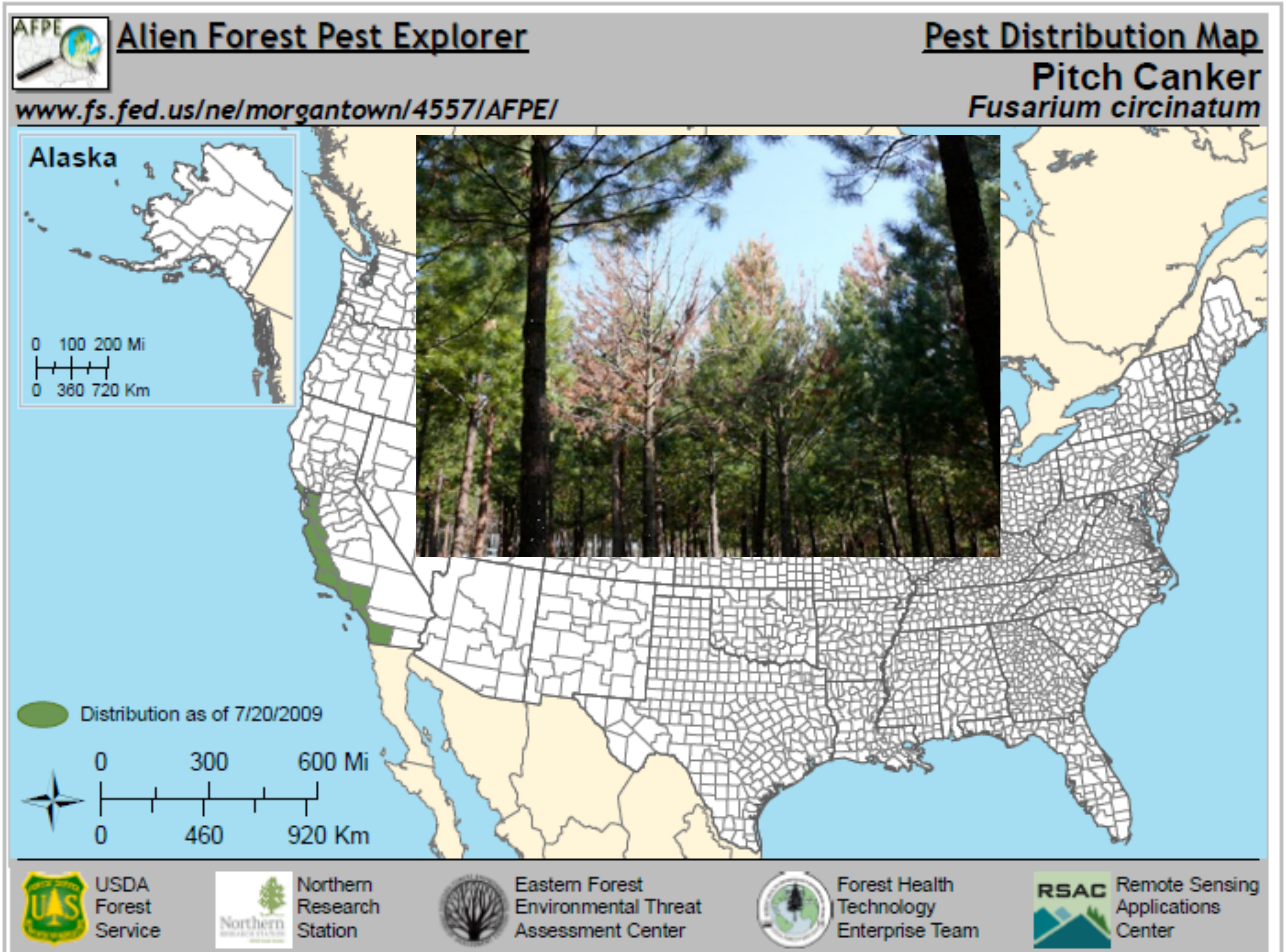
USDA Forest Service

Northern Research Station

Eastern Forest Environmental Threat Assessment Center

Forest Health Technology Enterprise Team

RSAC Remote Sensing Applications Center



Alien Forest Pest Explorer
Pest Distribution Map
Pitch Canker
Fusarium circinatum
www.fs.fed.us/ne/morgantown/4557/AFPE/
Alaska
0 100 200 Mi
0 360 720 Km
Distribution as of 7/20/2009
0 300 600 Mi
0 460 920 Km
USDA Forest Service
Northern Research Station
Eastern Forest Environmental Threat Assessment Center
Forest Health Technology Enterprise Team
Remote Sensing Applications Center

(a) Corn smut on corn (b) Tar spot fungus on maple leaves (c) Ergots on rye

Rye
Ergots

Yeast Infections

Athletes Foot

Ringworm

Protista

Nutritional Requirements

Nutritional Diversity

- Like all life protists must acquire the 17 essential elements
- How they acquire these essential elements as a group is very diverse…
- Some are **HETEROTROPHS**, some are **AUTOTROPHS** and yet others are **MIXOTROPHS** as they obtain their nutrition or produce it from photosynthesis

Nutritional Needs

- Protists must acquire sugars (organic molecules) that provide **energy** and **building blocks**.
- These macromolecules provide the energy for cellular respiration and provide the raw materials for biosynthesis
  - In addition protists require certain specific **essential nutrients** usually needed in much smaller amounts

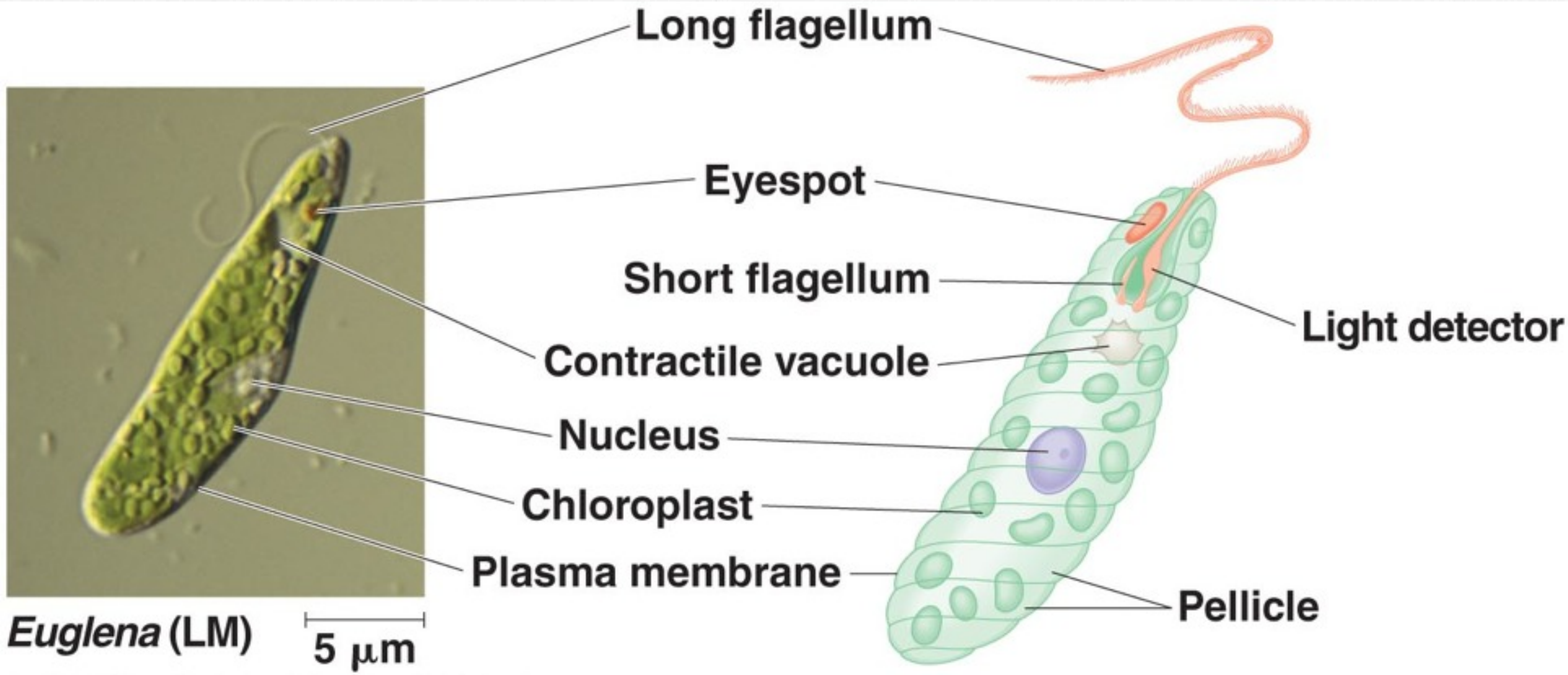
Protista

Nutritional Processing

Essential Nutrients

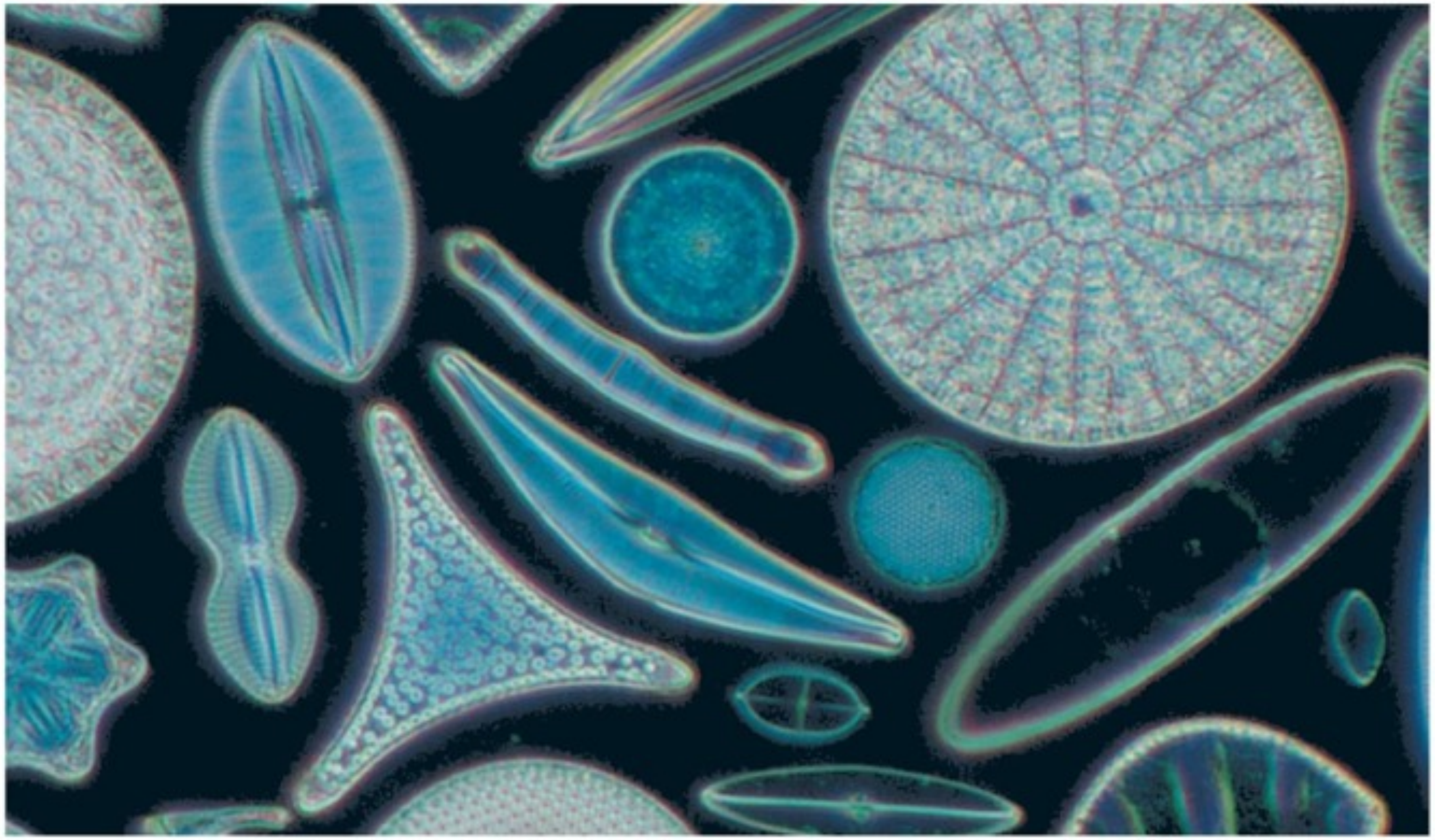
- Protista acquire "food" in one of three ways
  - Absorption
  - Ingestion
  - Engulfing
- Unless of course, they make their own "food"

Excavata



MIXOTROPHIC

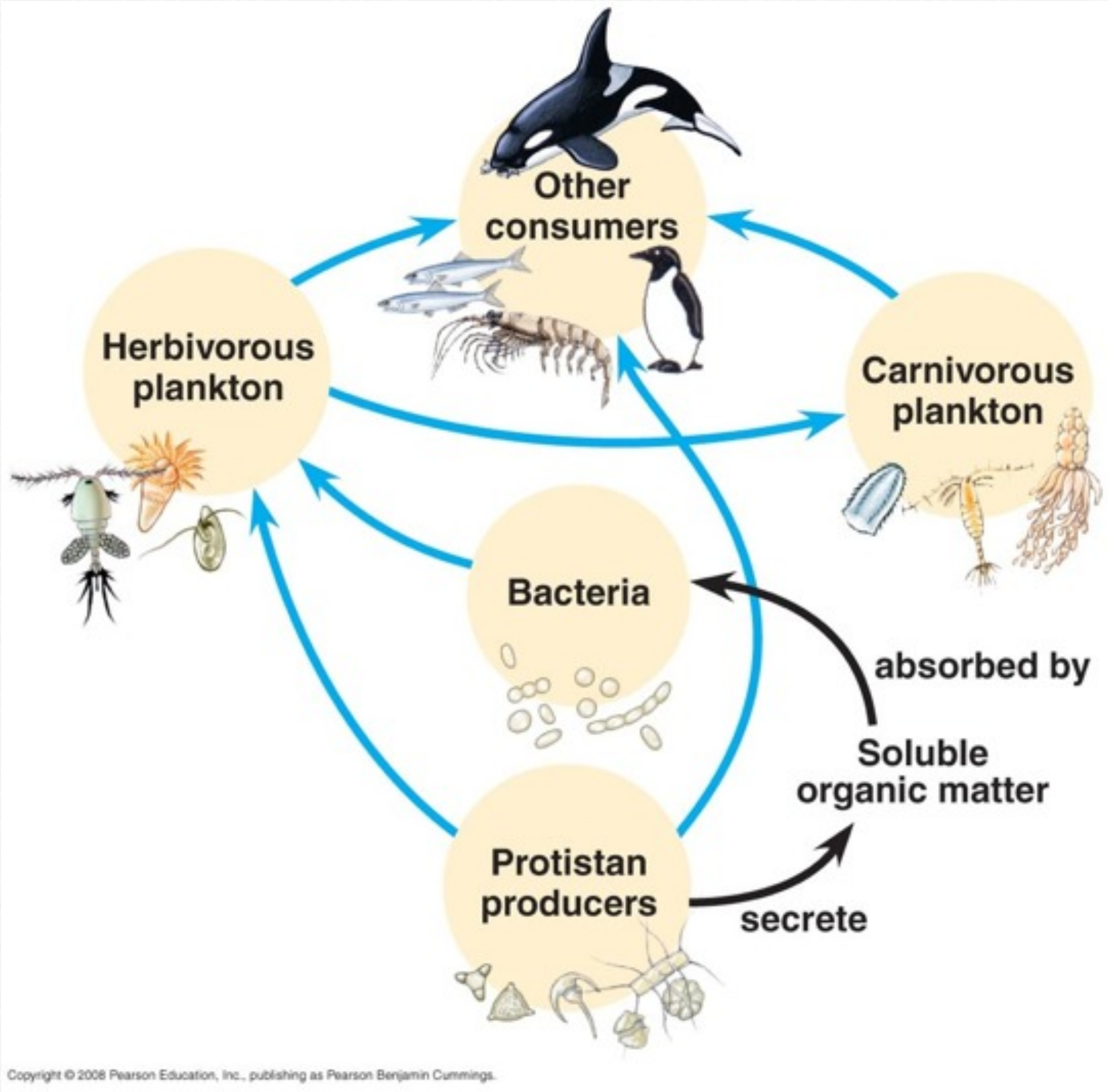
Chromalveolata



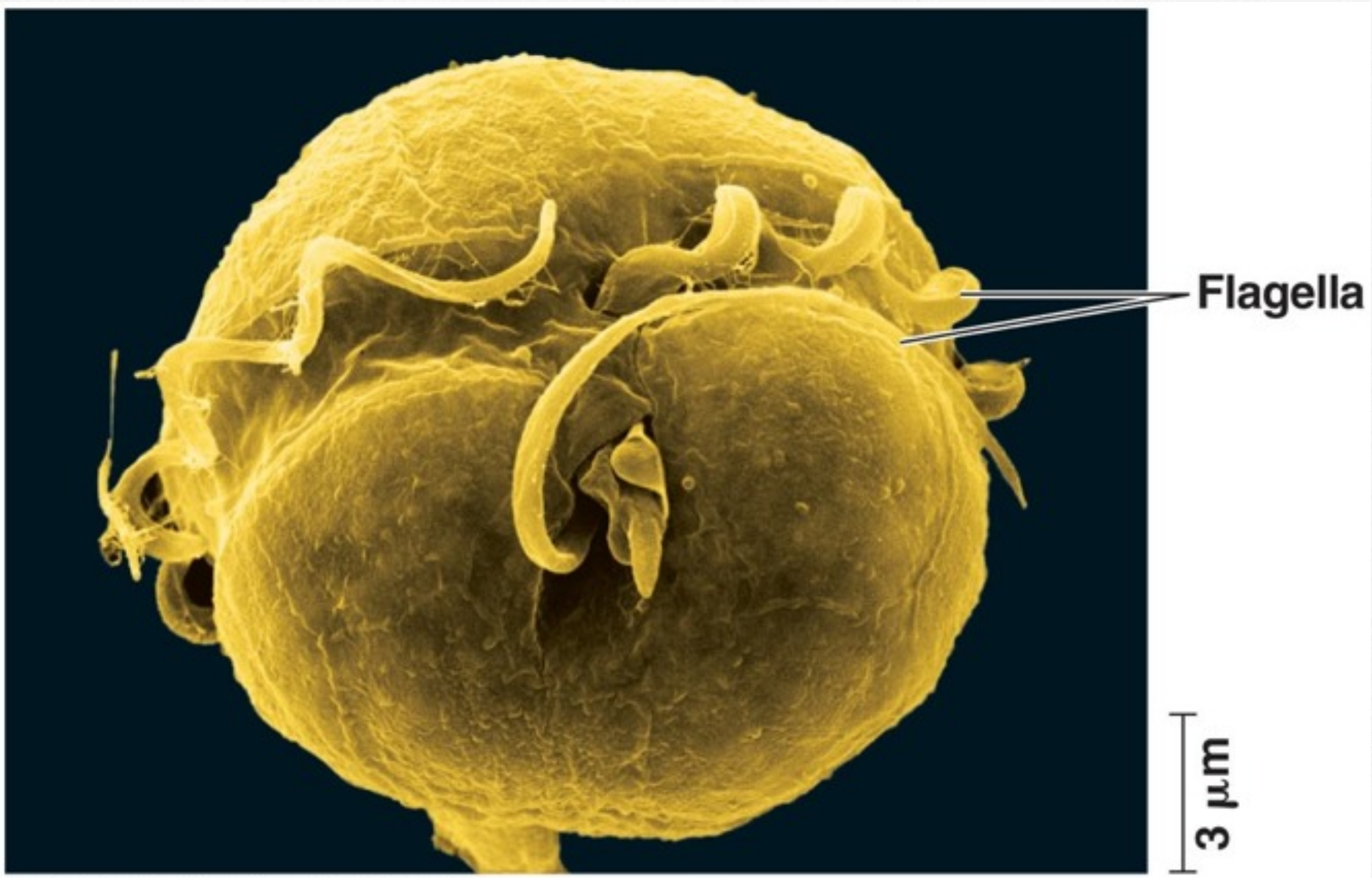
Some of the most important photosynthetic organisms on earth!

Chromalveolata

Scientists estimate that 30% of the world's photosynthesis is performed by diatoms, dinoflagellates, multicellular algae and other aquatic protists



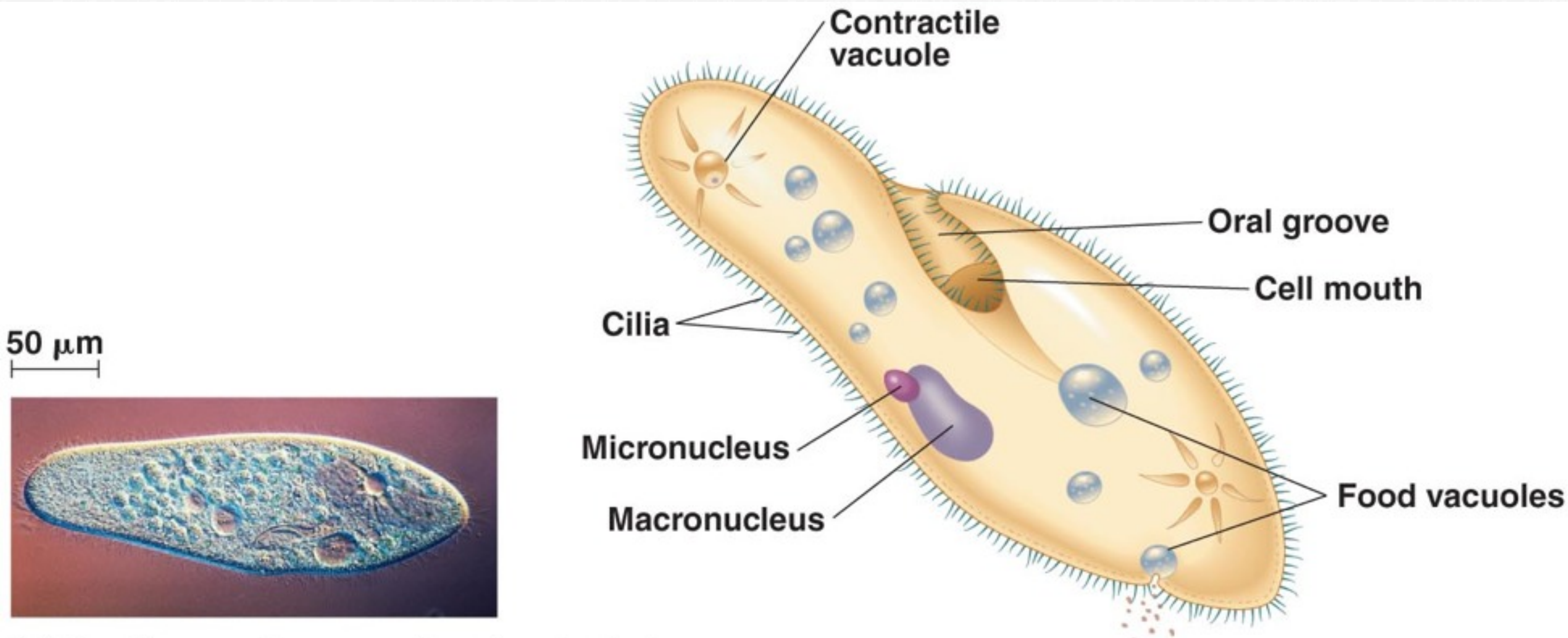
Chromalveolata: *Dinoflagellates*



Important component of phytoplankton, abundant producers of aquatic ecosystems

MIXOTROPHIC

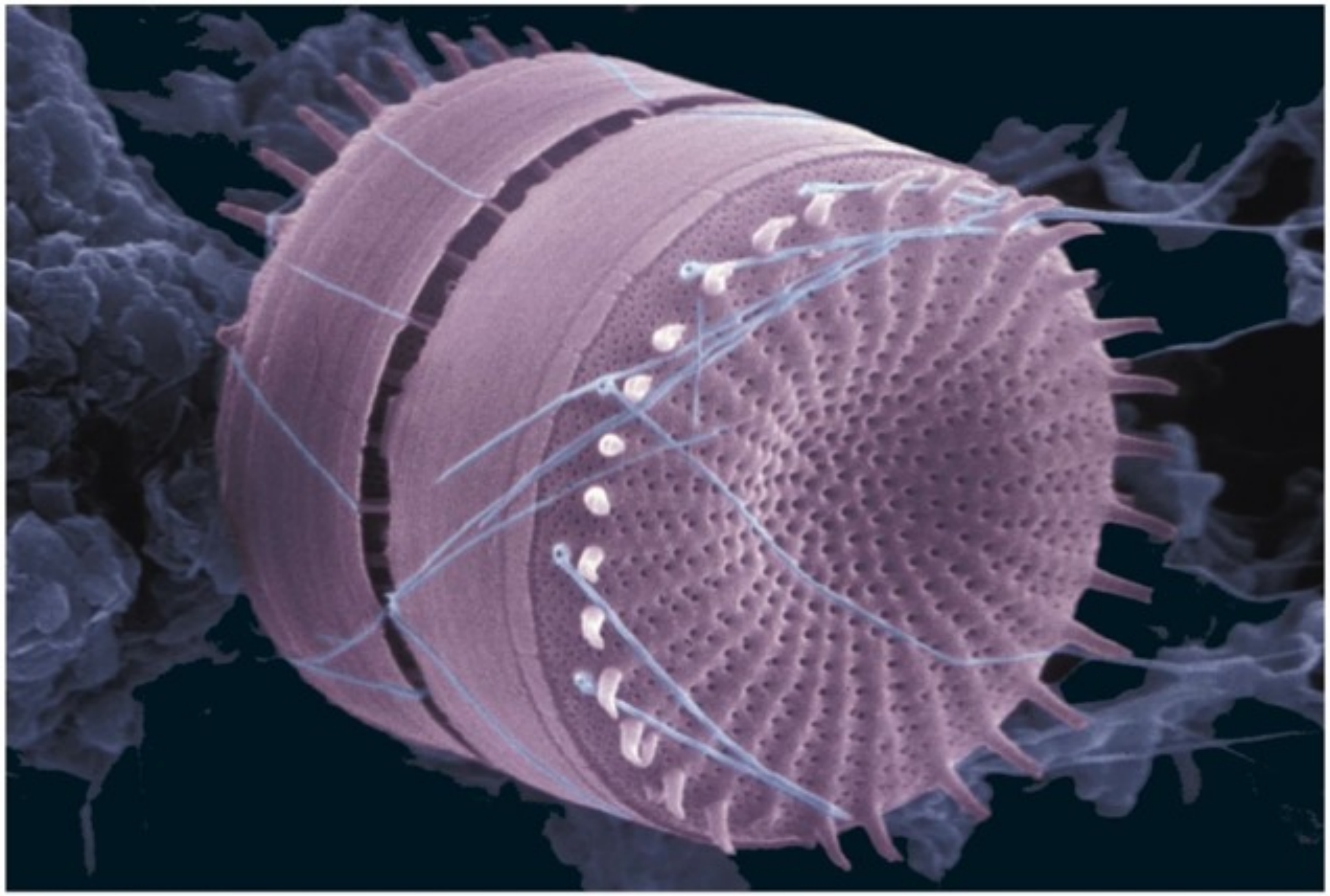
Chromalveolata: *Paramecium*



(a) Feeding, waste removal, and water balance

HETEROTROPHIC

Chromalveolata: *Diatoms*



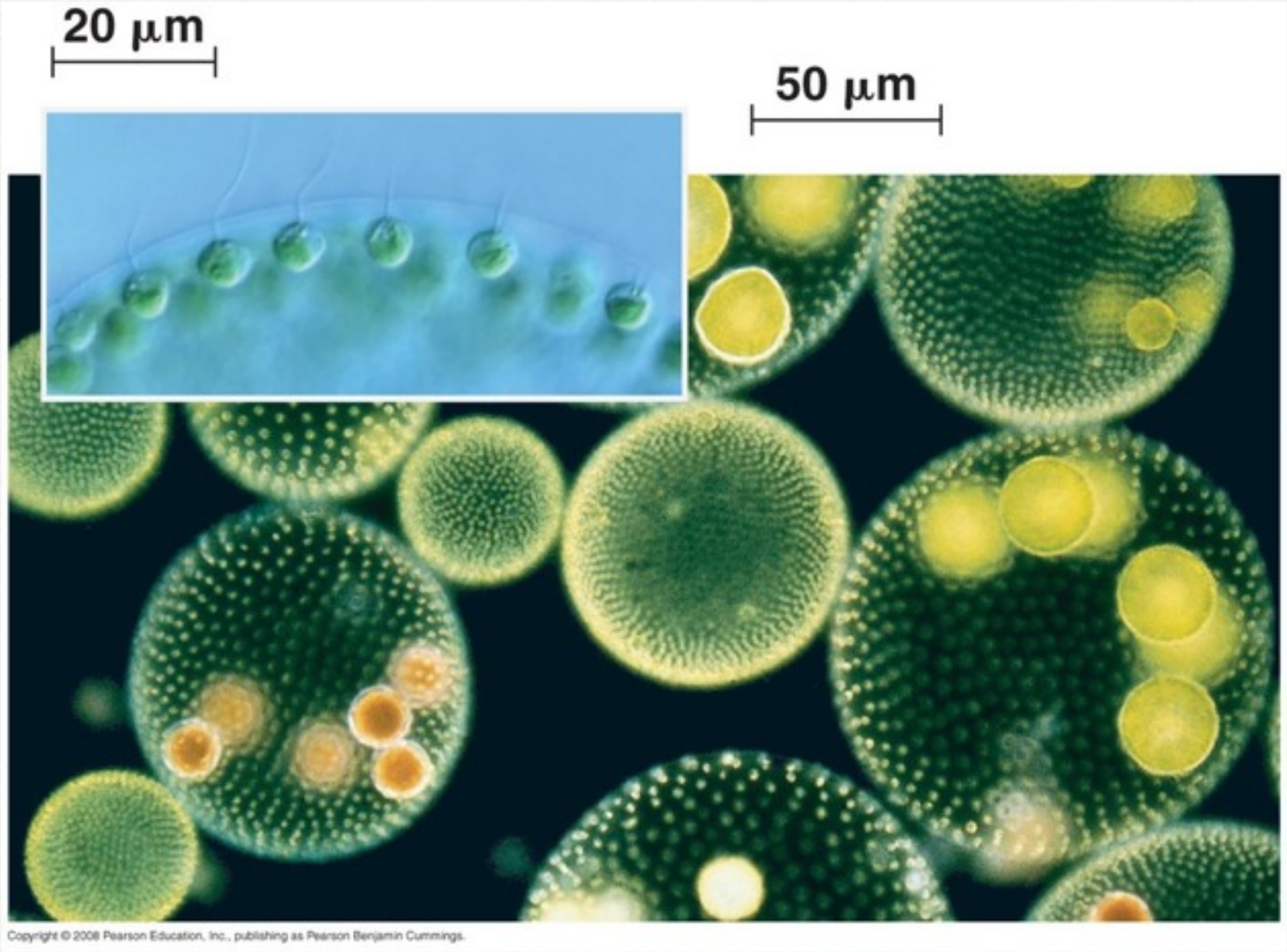
Unicellular algae, that have a unique glass-like wall made of silicon dioxide embedded in an organic matrix

AUTOTROPHIC

Important component of phytoplankton, one bucket of sea water may contain millions of diatoms

Archaeplastida

Unicellular,
Multicellular,
or colonial



Very important
photosynthetic
organisms

Volvox, a colonial freshwater green alga

Red Algae

Archaeplastida

AUTOTROPHIC

Photosynthetic pigment, phycoerythrin gives it the red color and masks chlorophyll

In shallow water appear greenish but as you get deeper more red and eventually become almost black

▶ ***Bonnemaisonia hamifera***

8 mm

Archaeplastida

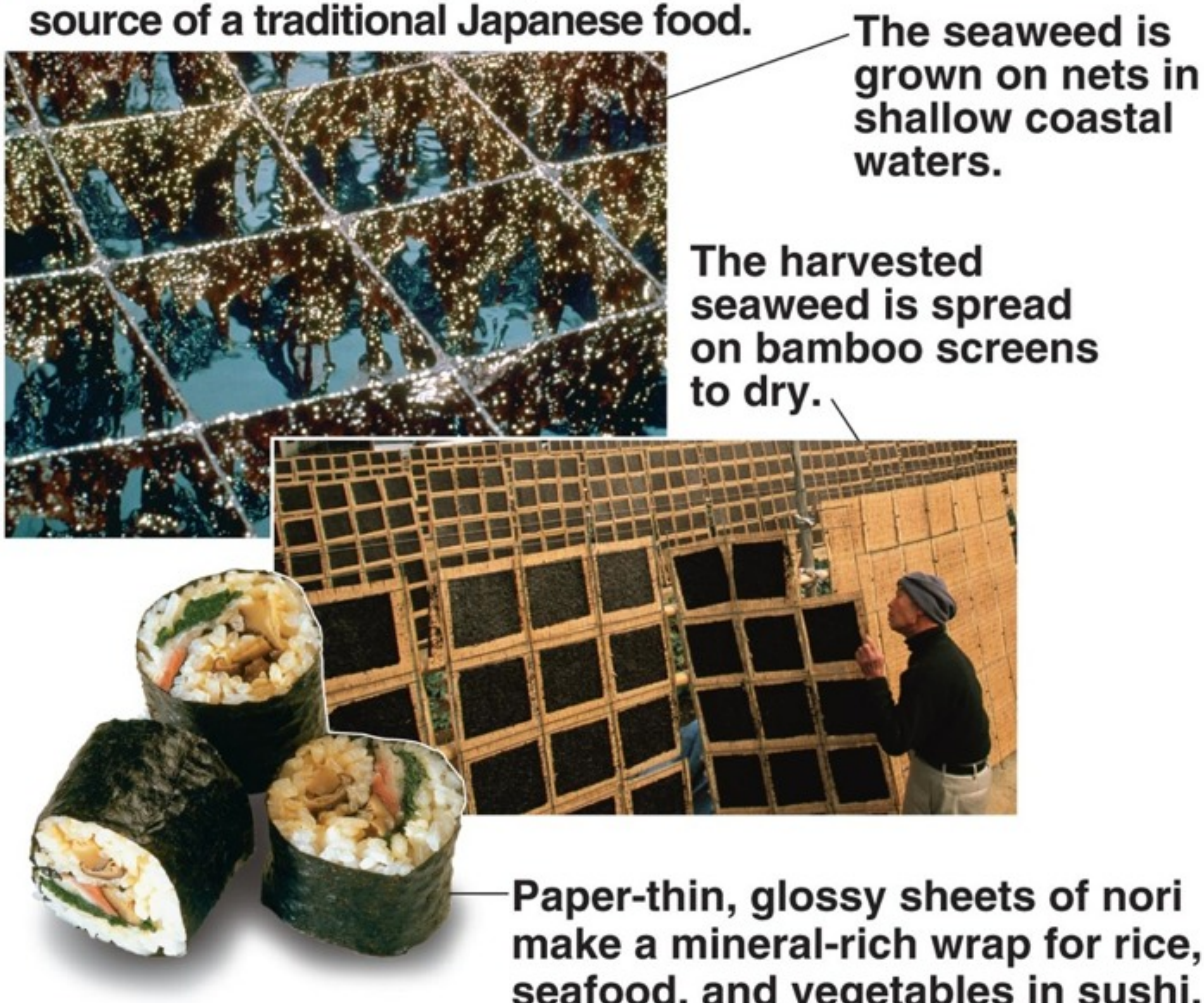
Red Algae

AUTOTROPHIC

Accessory Photosynthetic pigments, like phycoerythrin allows them use blue and green light that penetrate relatively far into the water

◀ **Dulse (*Palmaria palmata*)**

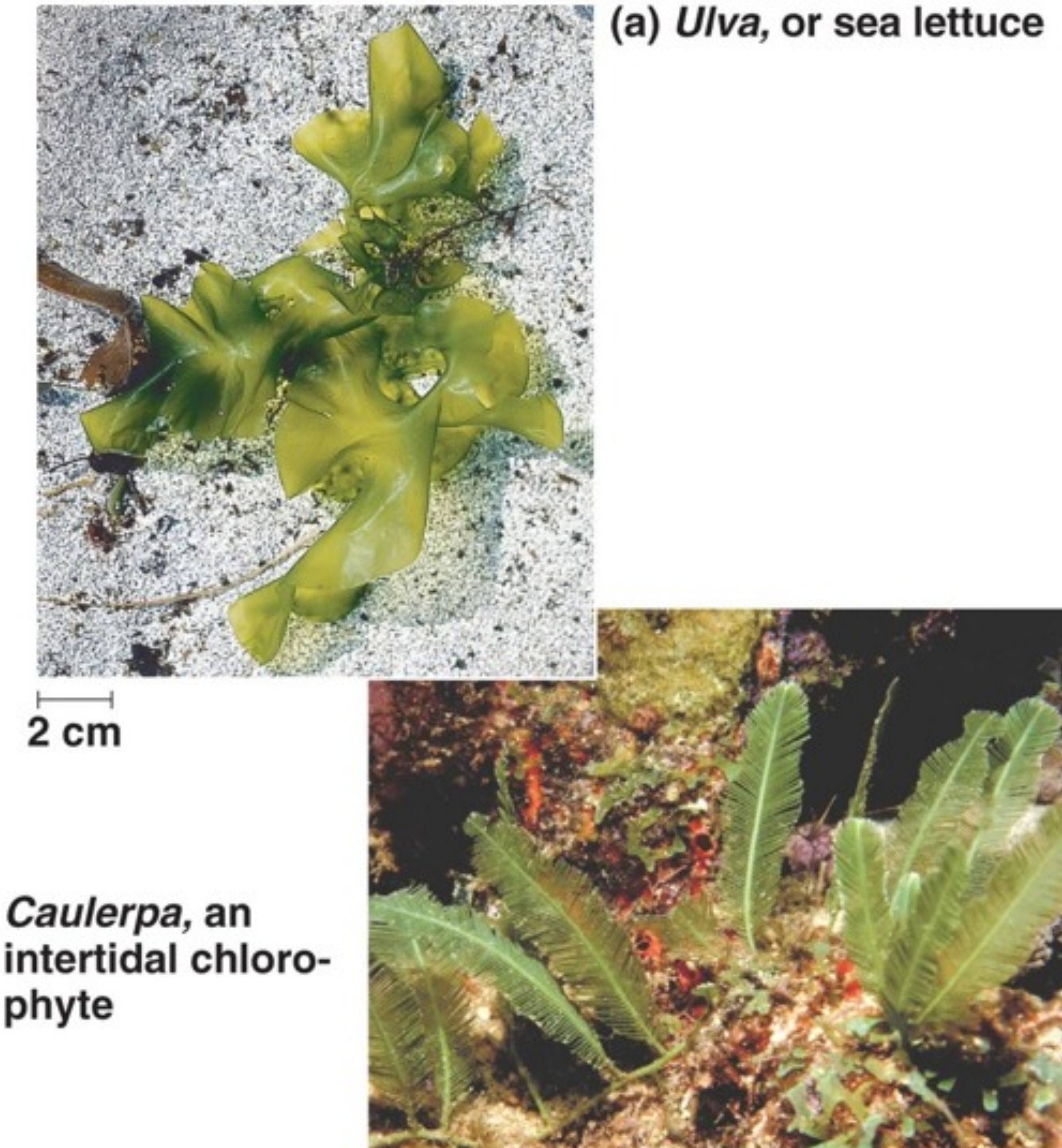
▼ Nori. The red alga *Porphyra* is the source of a traditional Japanese food.



Archaeplastida

Green Algae

AUTOTROPHIC



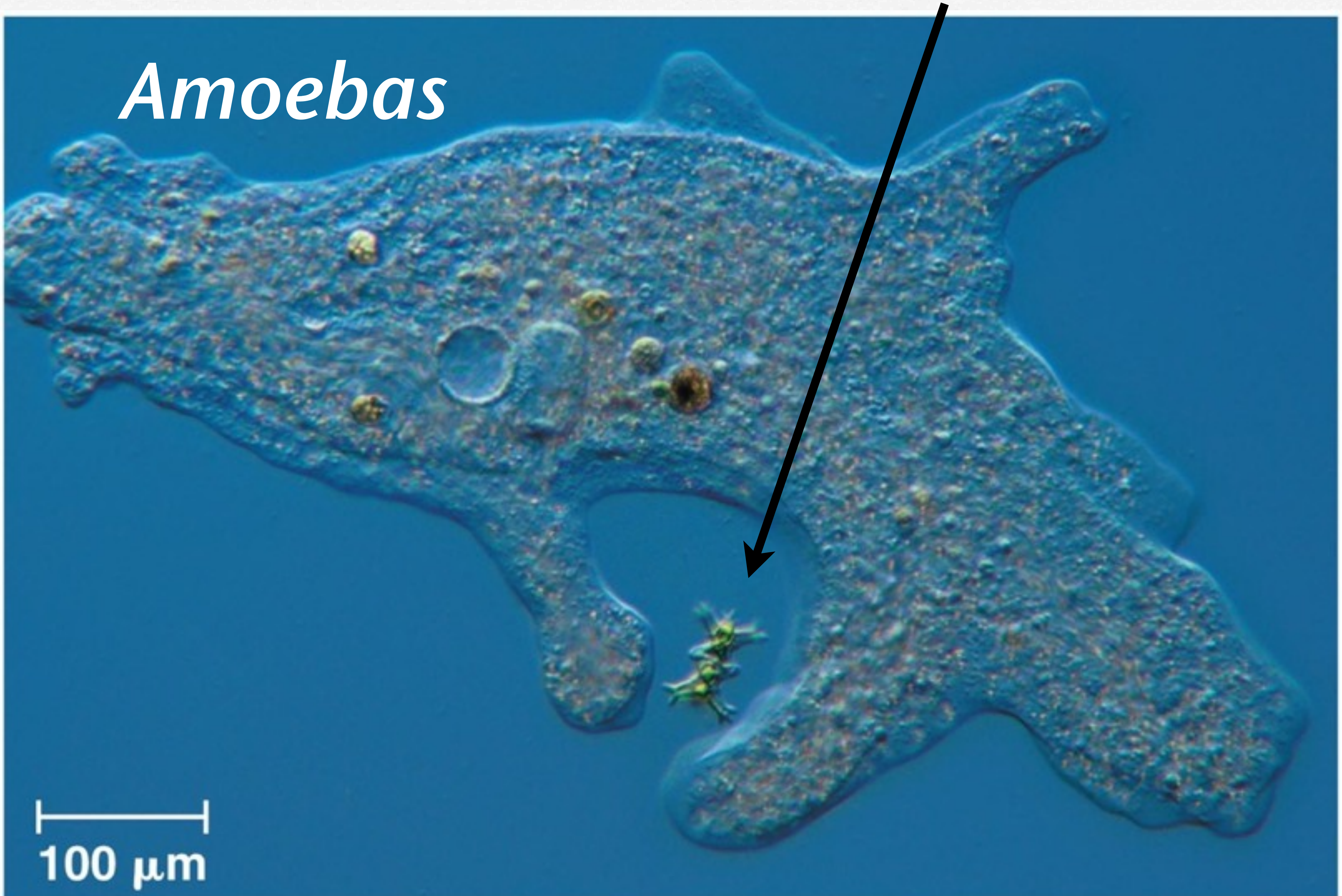
(a) *Ulva,* or sea lettuce

2 cm

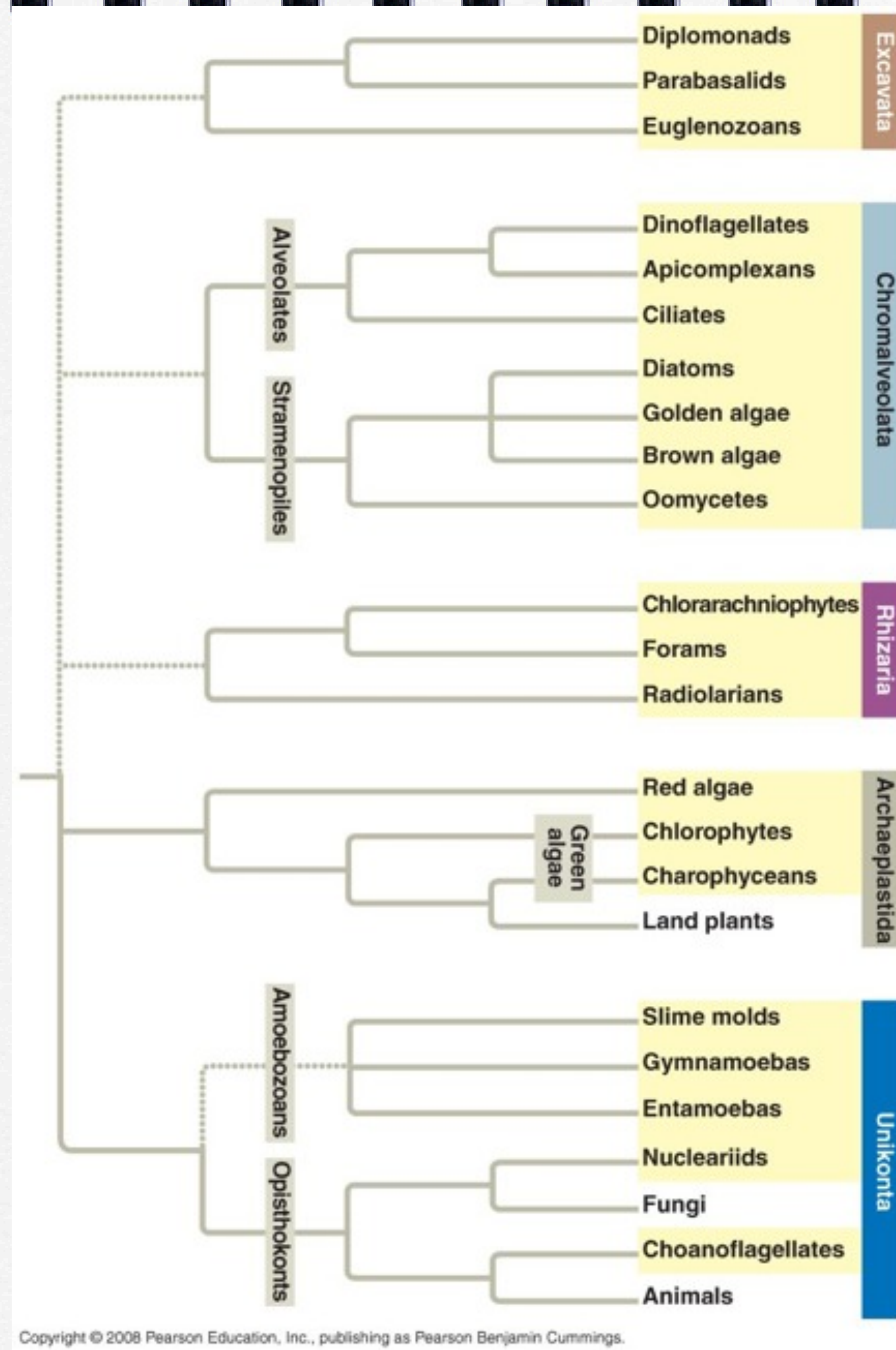
(b) *Caulerpa,* an intertidal chlorophyte

Unikonta:

HETEROTROPHIC



You can use this as a reference guide to the different groups of protists



Bacteria

Nutritional Requirements

Nutritional Diversity

- Like all life bacteria must acquire the 17 essential elements
- How they acquire these essential elements as a group is very diverse...
- Some are **HETEROTROPHS**, some are **AUTOTROPHS**
- Some use light as an energy source and others use chemicals

Nutritional Needs

- Bacteria must acquire sugars (organic molecules) that provide **energy** and **building blocks**.
- These macromolecules provide the energy for cellular respiration and provide the raw materials for biosynthesis
  - In addition bacteria require certain specific **essential nutrients** usually needed in much smaller amounts

Bacteria

Nutritional Processing

Alpha Proteobacteria

Rhizobium

MUTUALISTS

These bacteria fix nitrogen for plants and in return they given sugars

Rhizobium **(arrows) inside a root cell of a legume (TEM)**

Beta Proteobacteria

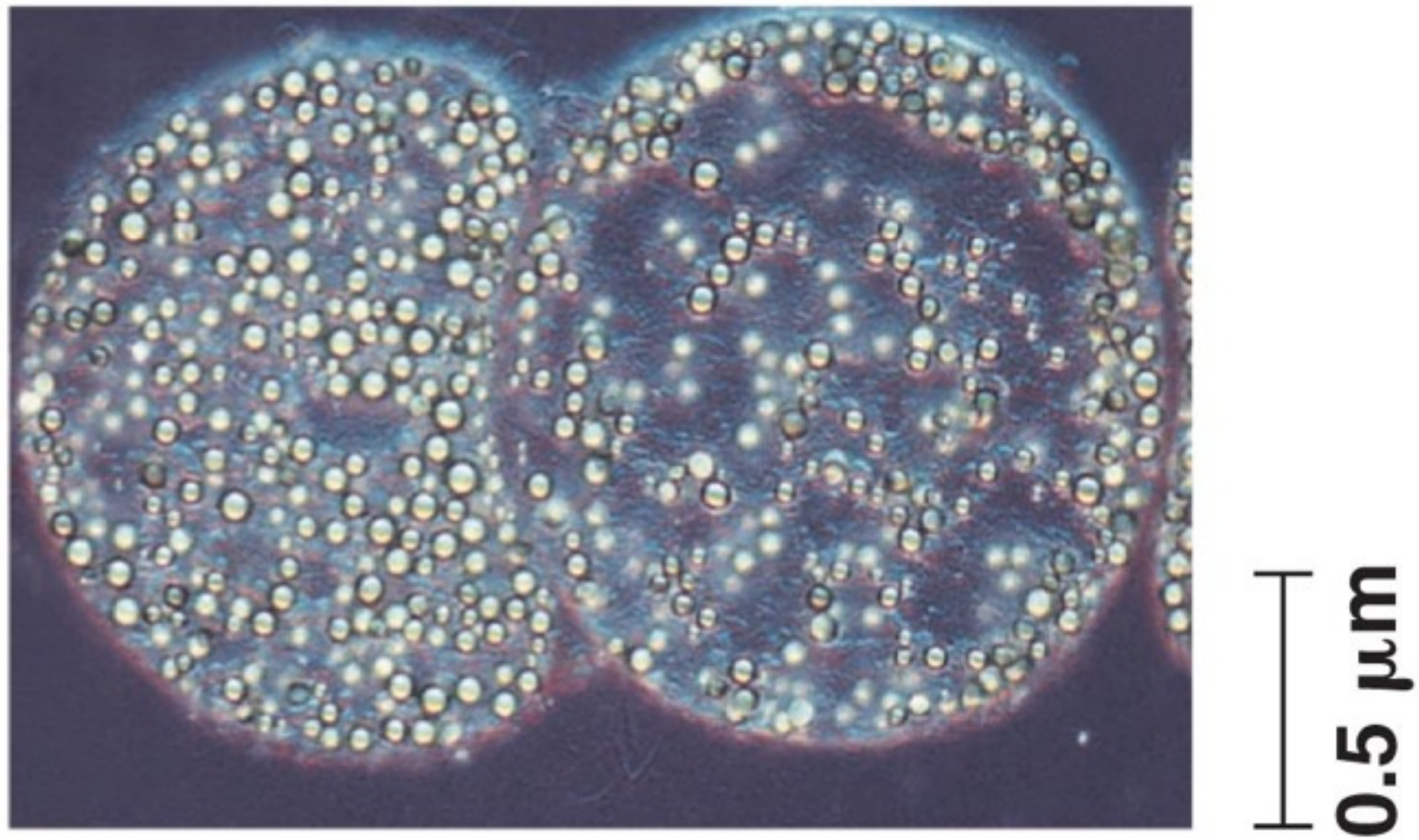
These bacteria acquire energy through nitrogen compounds, they play a key role in the nitrogen cycle.

Nitrosomonas (colorized TEM)

Gamma Proteobacteria

CHEMO-AUTOTROPHS

These bacteria acquire energy through hydrogen sulfide



Thiomargarita namibiensis containing sulfur wastes (LM)

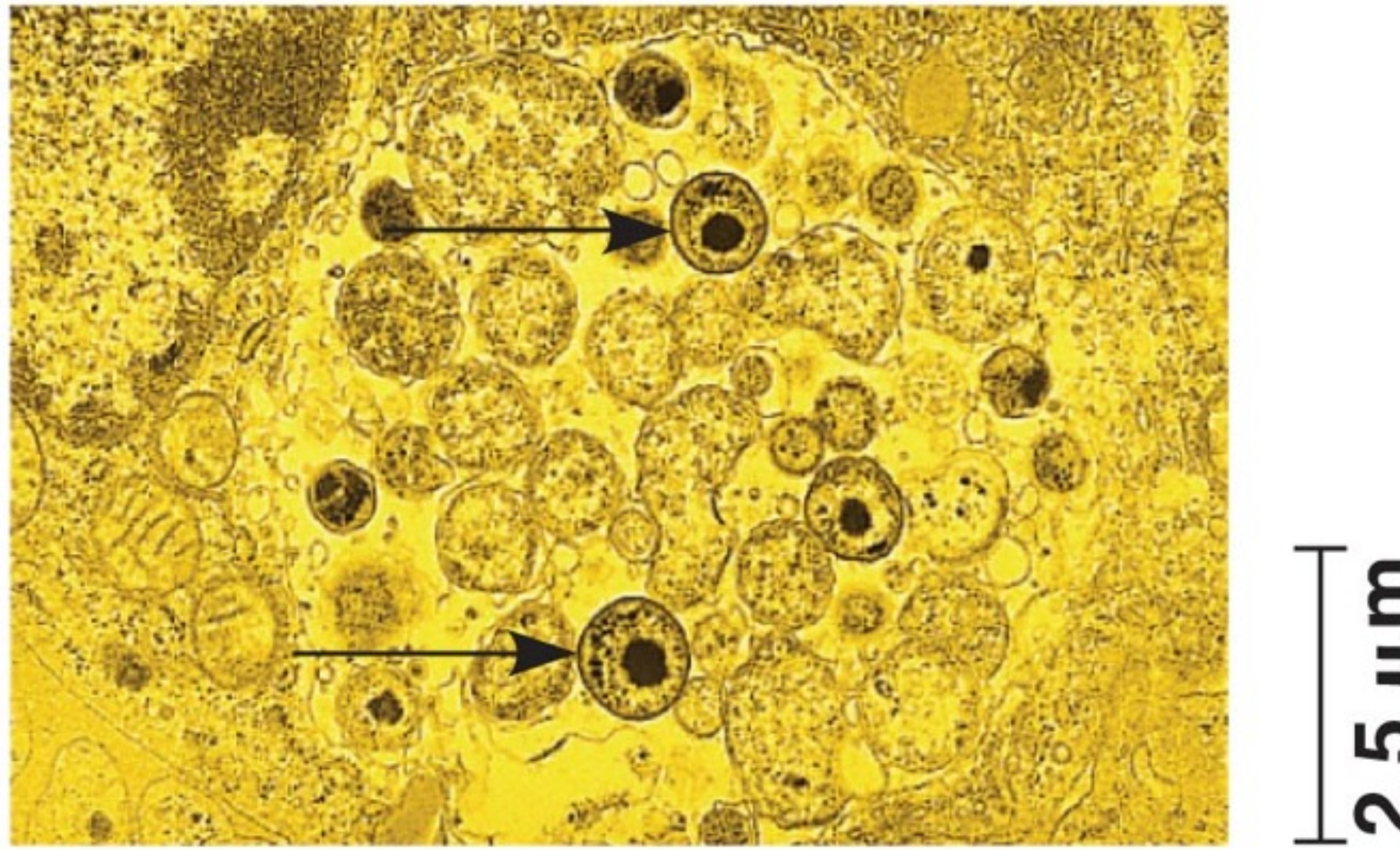
This group is responsible for food poisoning...salmonella, cholera and e-coli

Chlamydias

HETEROTROPHS

Parasites

Most common cause of blindness worldwide



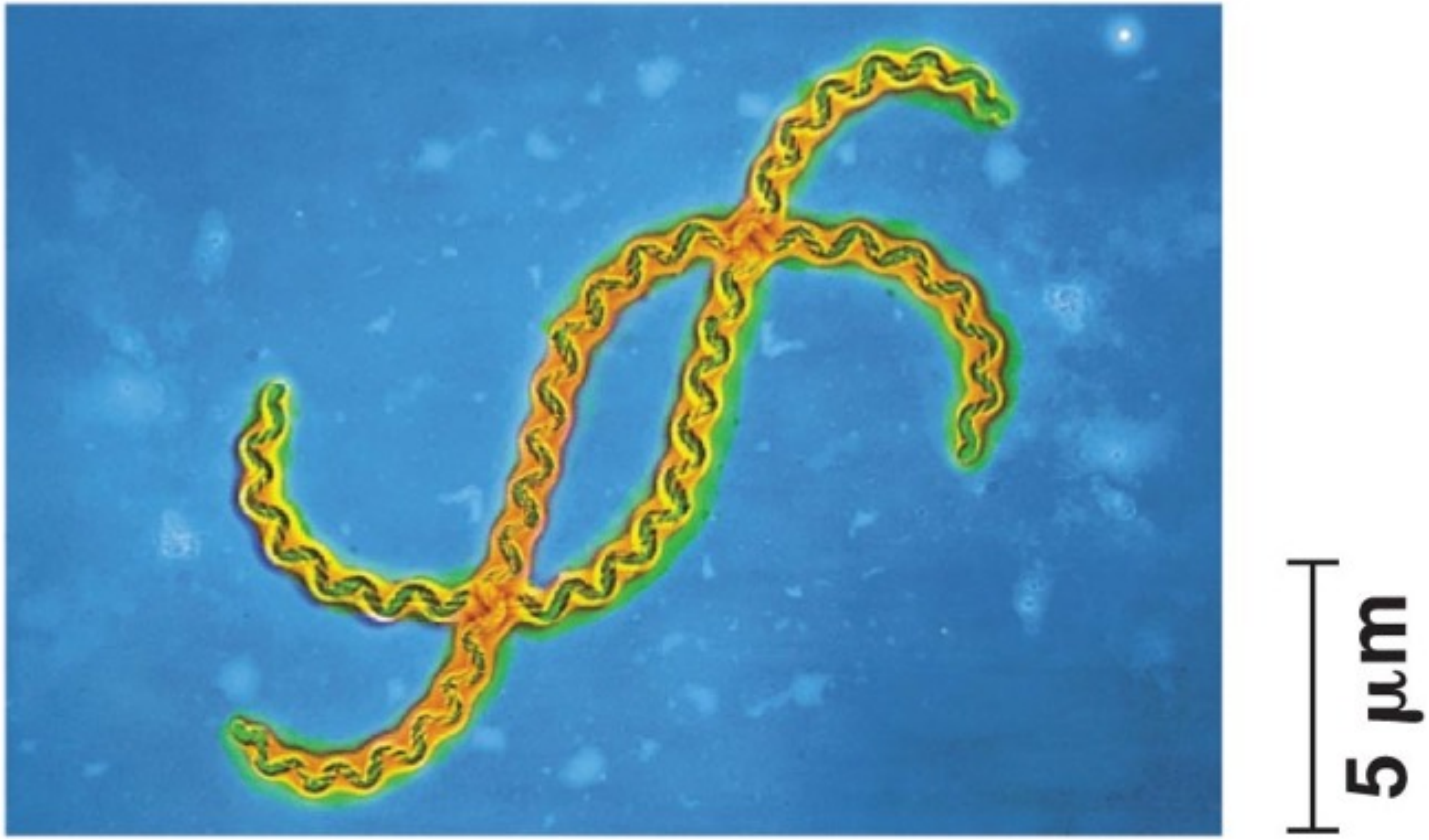
Chlamydia (arrows) inside an animal cell (colorized TEM)

Spirochetes

HETEROTROPHS

Pathogens

Cause Lyme Disease & Syphilis



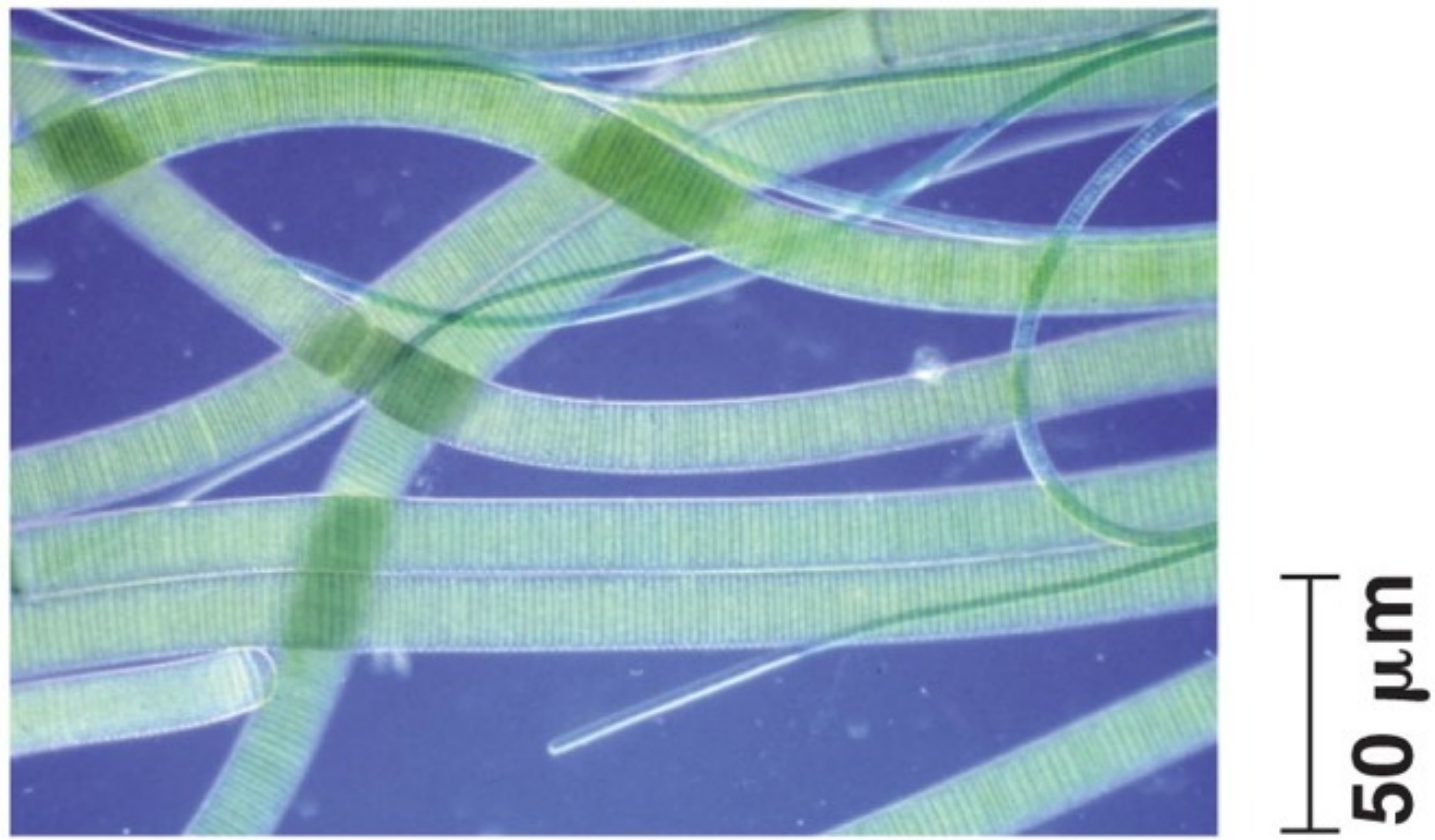
Leptospira, a spirochete (colorized TEM)

Cyanobacteria

PHOTOAUTOTROPHS

Important component of phytoplankton

Some also fix nitrogen



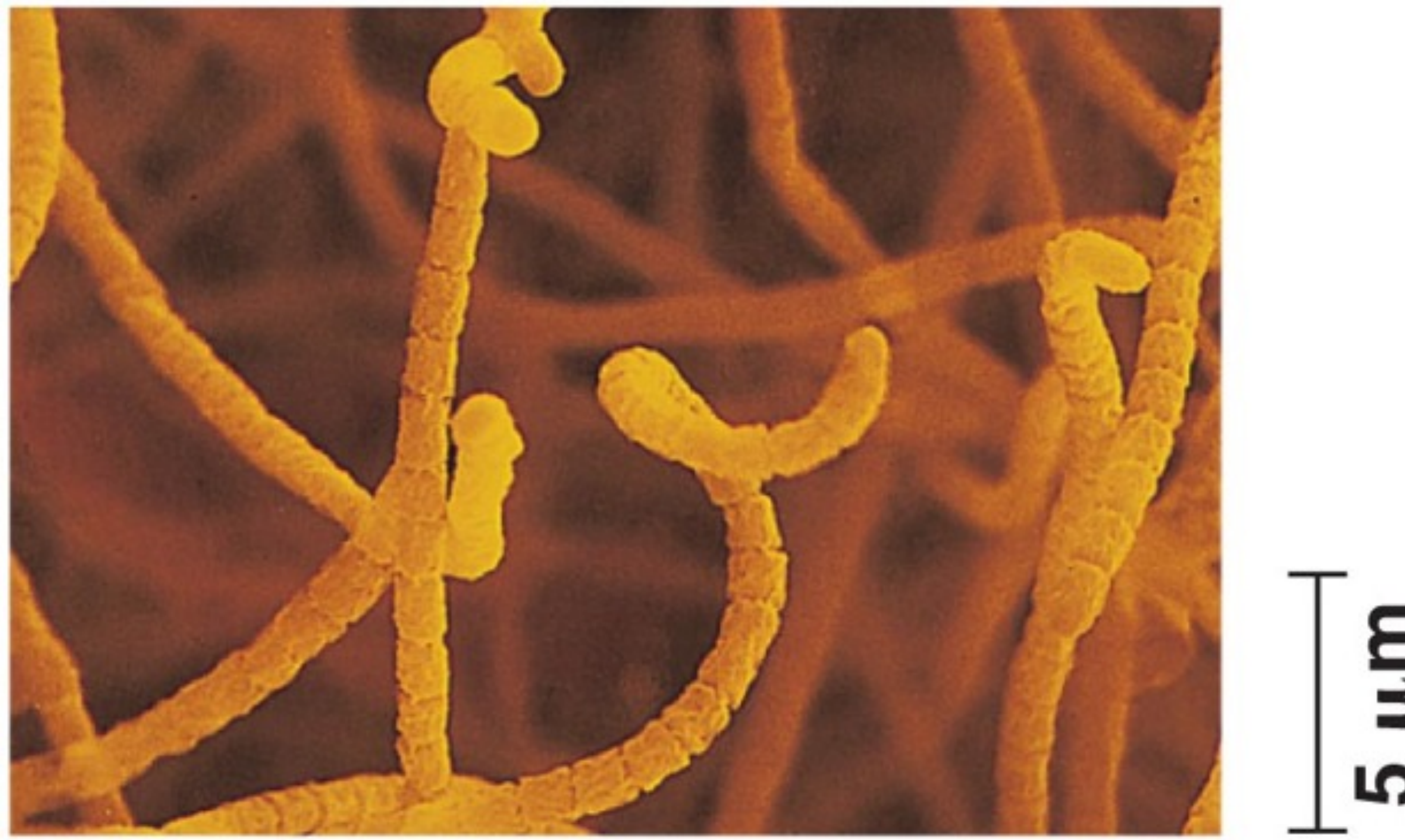
Two species of *Oscillatoria*, filamentous cyanobacteria (LM)

Actinomycetes

Decomposers

CHEMOHETEROTROPHS

This particular species produces very useful antibiotics



Streptomyces, **the source of many antibiotics (colorized SEM)**