DIGESTION

Part 3: Absorption and Nutrients

ABSORPTION AND NUTRIENT LEVELS

Outcomes:

-B11-2-06: Describe the processes of absorption that take place at various sites along the alimentary canal. (GLO: D1) Include: uptake of nutrients by villi in the small intestine and uptake of water in the large intestine

B11-2-07: Describe the homeostatic role of the liver with respect to the regulation of nutrient levels in the blood and nutrient storage. (GLOs: D1, E2, E3) Include: carbohydrate metabolism

ABSORPTION

- Absorption is the transfer of digested food (micromolecules) into the bloodstream (capillaries).
- Once in the bloodstream, micromolecules can be transported to cells around the body.
- The majority of absorption occurs in the duodenum and jejunum (small intestine)
- Diffusion and active transport are both involved in absorption

ABSORPTION

1. Stomach

- Not always seen as a major site of absorption
- Only absorbs a few substances like:
  - Water (especially if body is dehydrated)
  - Aspirin
  - Anti-inflammatory drugs
  - ethanol

ABSORPTION

2. Small Intestine (~ 6 meters of 20 feet long)

- Duodenum is ~ 20-25 cm (less than a foot)
  - It receives chyme from stomach, pancreatic enzymes, and bile from liver.
- Jejunum is ~ 2.5 m
  - Main absorption site for most nutrients
- Ileum is ~ 3 m
  - Absorbs any nutrients left, mainly B_{12} and bile acids

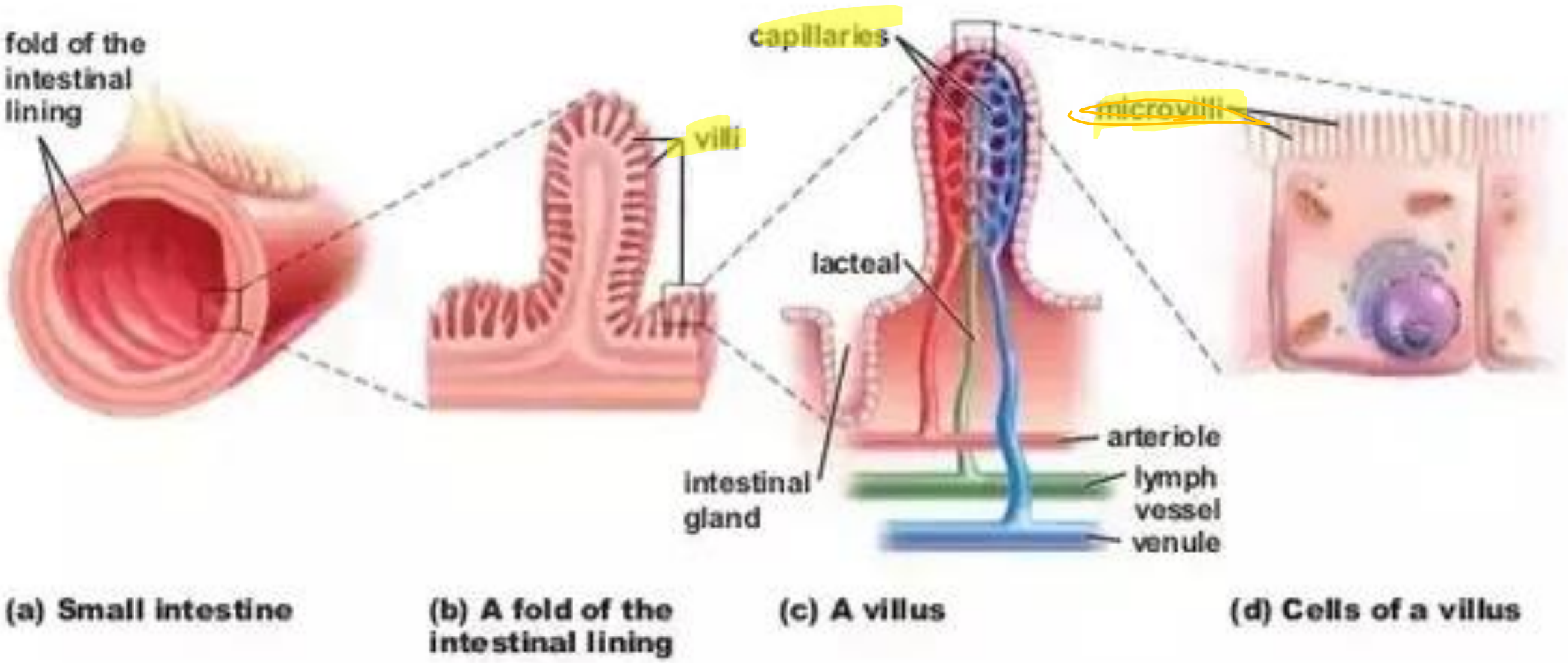
ABSORPTION

2. Small Intestine

- Releases its own digestive enzymes (peptidase, sucrase, maltase, lactase, intestinal lipase)

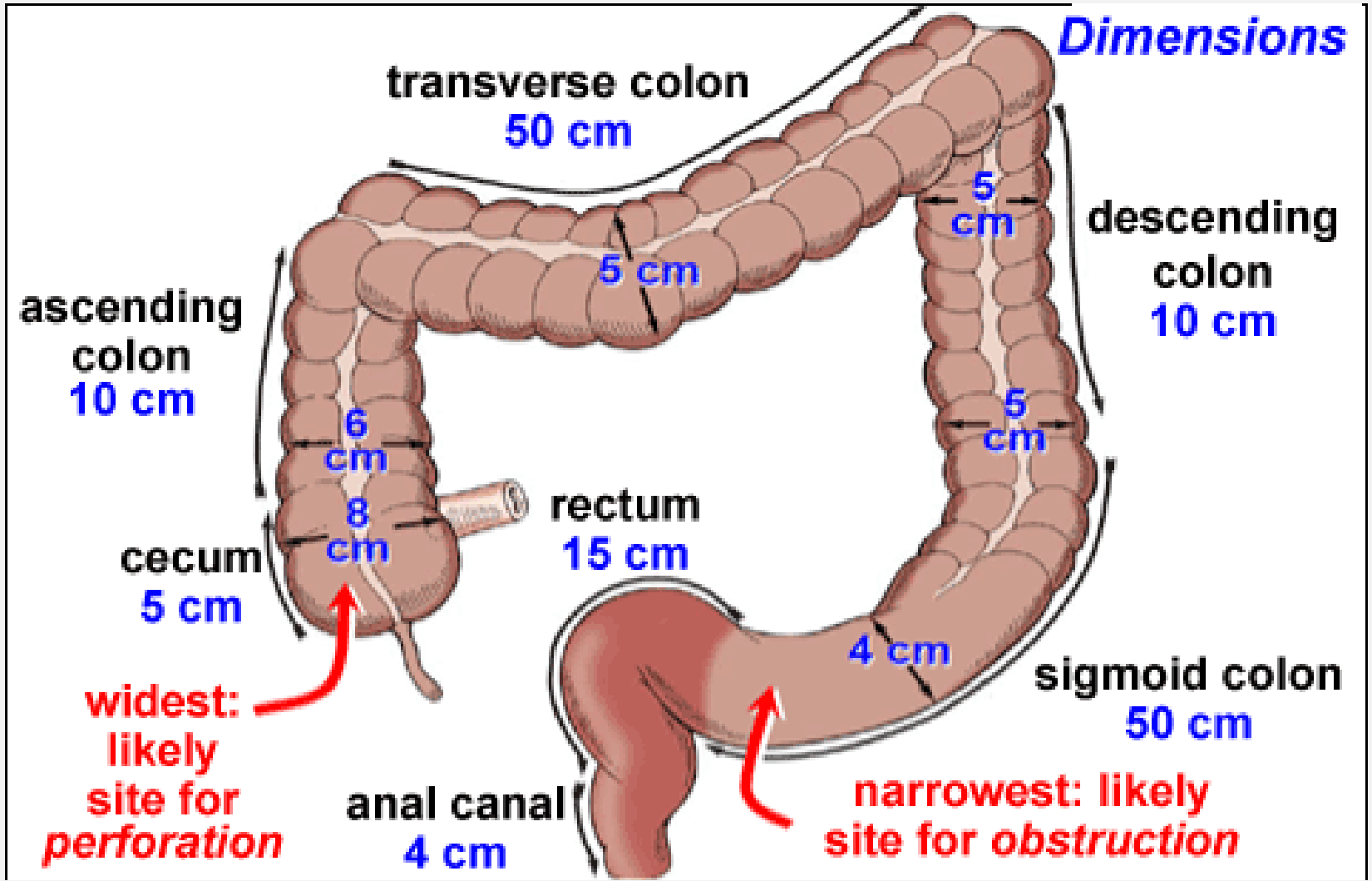
- There is a huge surface area due to villi and microvilli

- Capillaries go up each villi for the nutrients to absorb into the blood stream.


fold of the intestinal lining
villi
capillaries
microvilli
lacteal
arteriole
lymph vessel
venule
intestinal gland
(a) Small intestine
(b) A fold of the intestinal lining
(c) A villus
(d) Cells of a villus

ABSORPTION

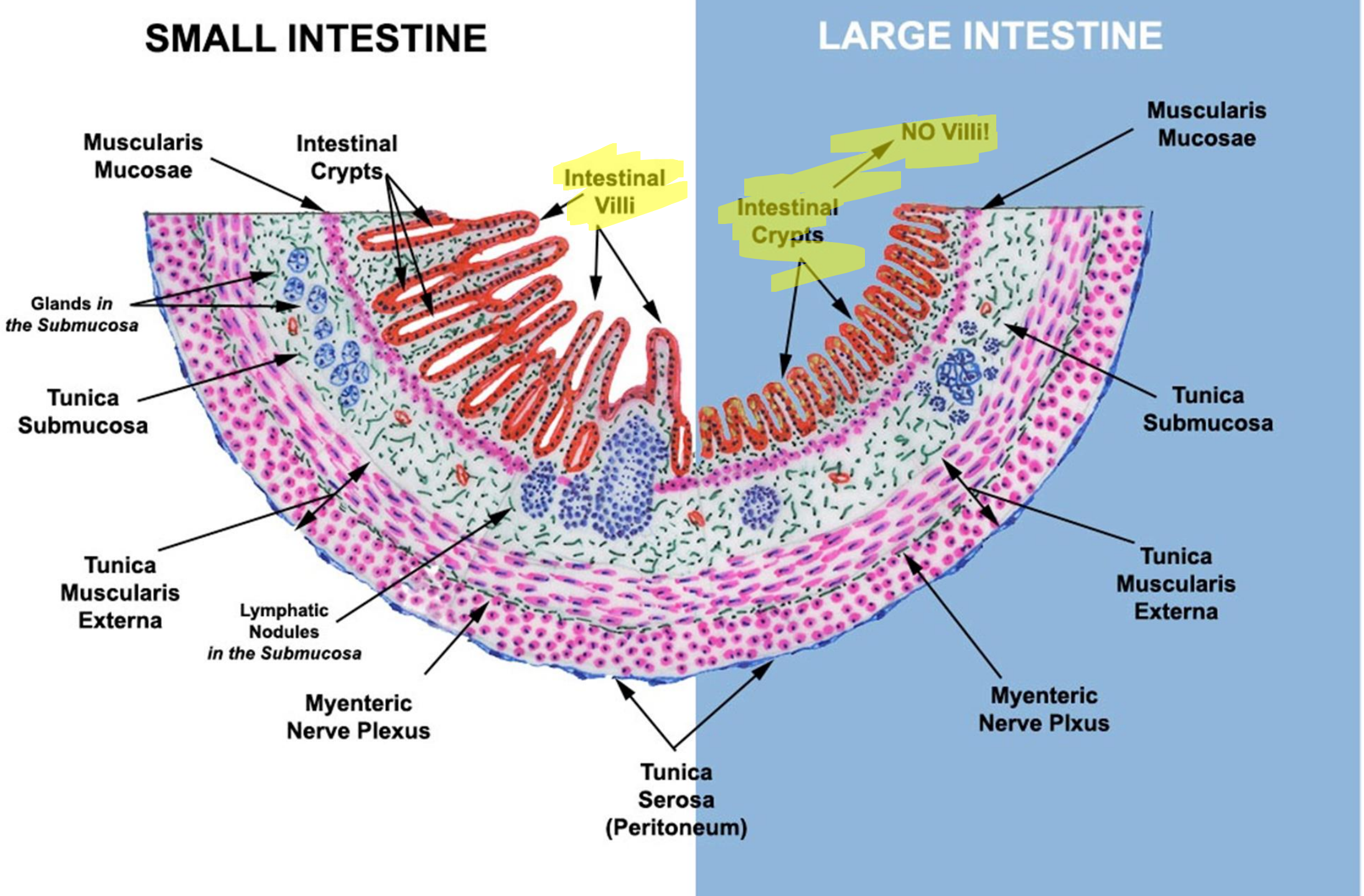
3. Large Intestine (~ 1.5 meters of 5 feet long)



ABSORPTION

3. Large Intestine (~ 1.5 meters of 5 feet long)

- Ileocecal valve separates the small intestine from the large intestine (makes sure nothing goes back)
- It is the main site for re-absorption of water, salts, and vitamins/minerals.
- Feces, the final product of the food eaten, is eliminated after passing through the anal sphincters.


SMALL INTESTINE
LARGE INTESTINE
Muscularis Mucosae
Intestinal Crypts
Intestinal Villi
NO Villi!
Intestinal Crypts
Muscularis Mucosae
Glands in the Submucosa
Tunica Submucosa
Tunica Submucosa
Tunica Muscularis Externa
Lymphatic Nodules in the Submucosa
Tunica Muscularis Externa
Myenteric Nerve Plexus
Myenteric Nerve Plxus
Tunica Serosa (Peritoneum)

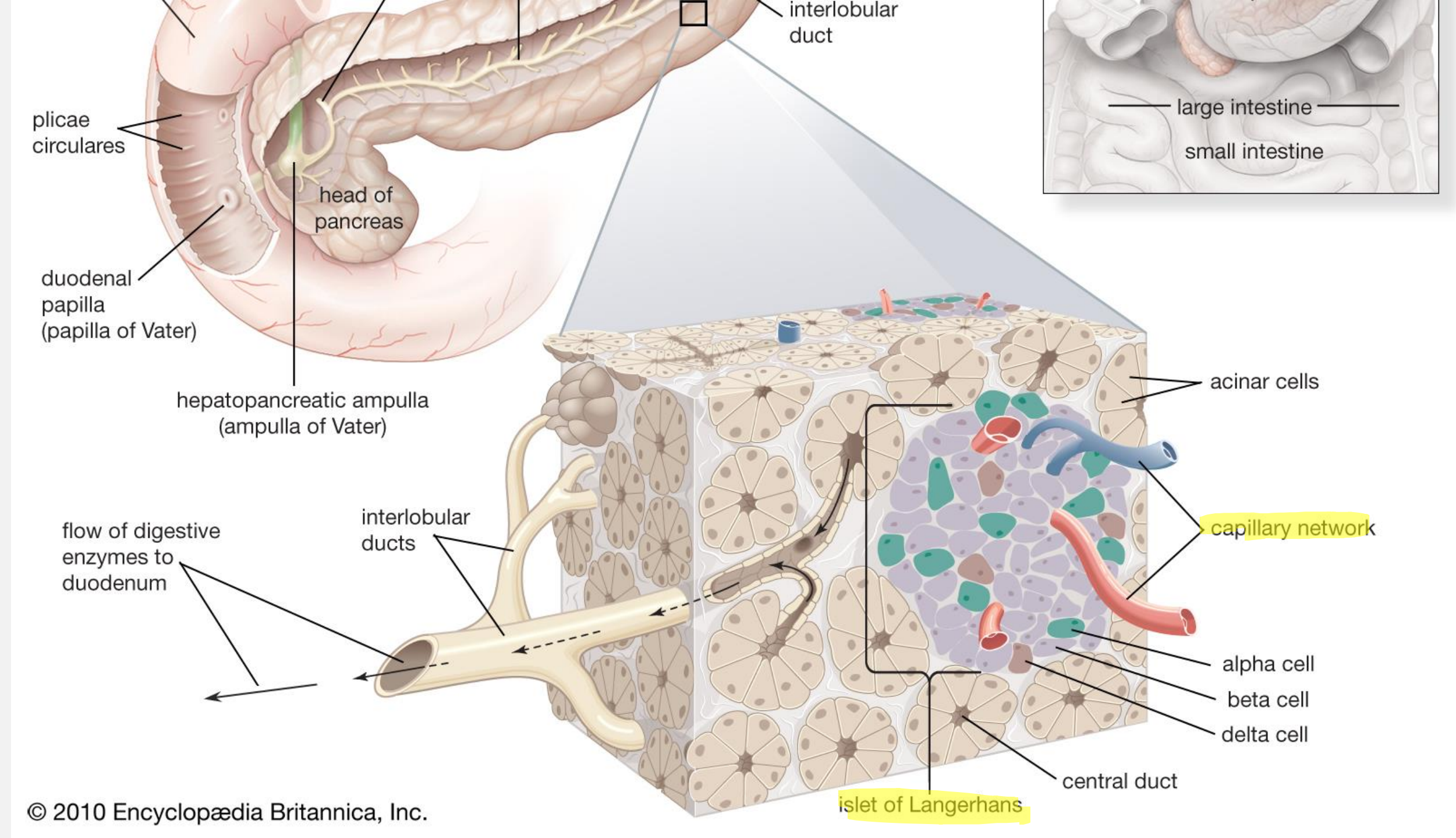
HOMEOSTASIS AND THE PANCREAS

- The pancreas is responsible for regulating blood sugar levels.
- Glucose is necessary to produce ATP (cell's energy molecule), which is needed in different amounts continuously.
- What happens?

- Blood sugar levels rise → receptors in Islets of Langerhans stimulate the production of insulin (converts glucose to glycogen)
- Blood sugar levels drops → receptors in Islets of Langerhans stimulate the production of glucagon (converts glycogen to glucose)

storage

use



HOMEOSTASIS AND THE LIVER

- Almost all blood (carry the nutrients) circulating from intestines passes through the liver to the heart.
- What does it do with the blood?

- It absorbs nutrients or breaks them down even more

- It transforms nutrients into proteins, lipids, and cholesterol

- It stores Vitamins (A, D, K, B_{12}), minerals and carbohydrates

- It filters out toxic substances (alcohol), transforming them into less harmful substances

NUTRIENTS

Outcomes:

- B11-2-08: Describe the functions of each of the six basic types of nutrients—carbohydrates, lipids, proteins, vitamins, minerals, and water. (GLOs: B3, D1) Include: ATP production, construction/repair, and regulating

- B11-2-09: Identify dietary sources for each of the six basic types of nutrients—carbohydrates, lipids, proteins, vitamins, minerals, and water. (GLOs: B3, D1)

- B11-2-10: Evaluate personal food intake and related food decisions. (GLOs: B3, C4, C8) Examples: percentage of daily values of nutrients, portion size, nutrient labels, balance between lifestyle and consumption...

NUTRIENTS

1. Carbohydrates

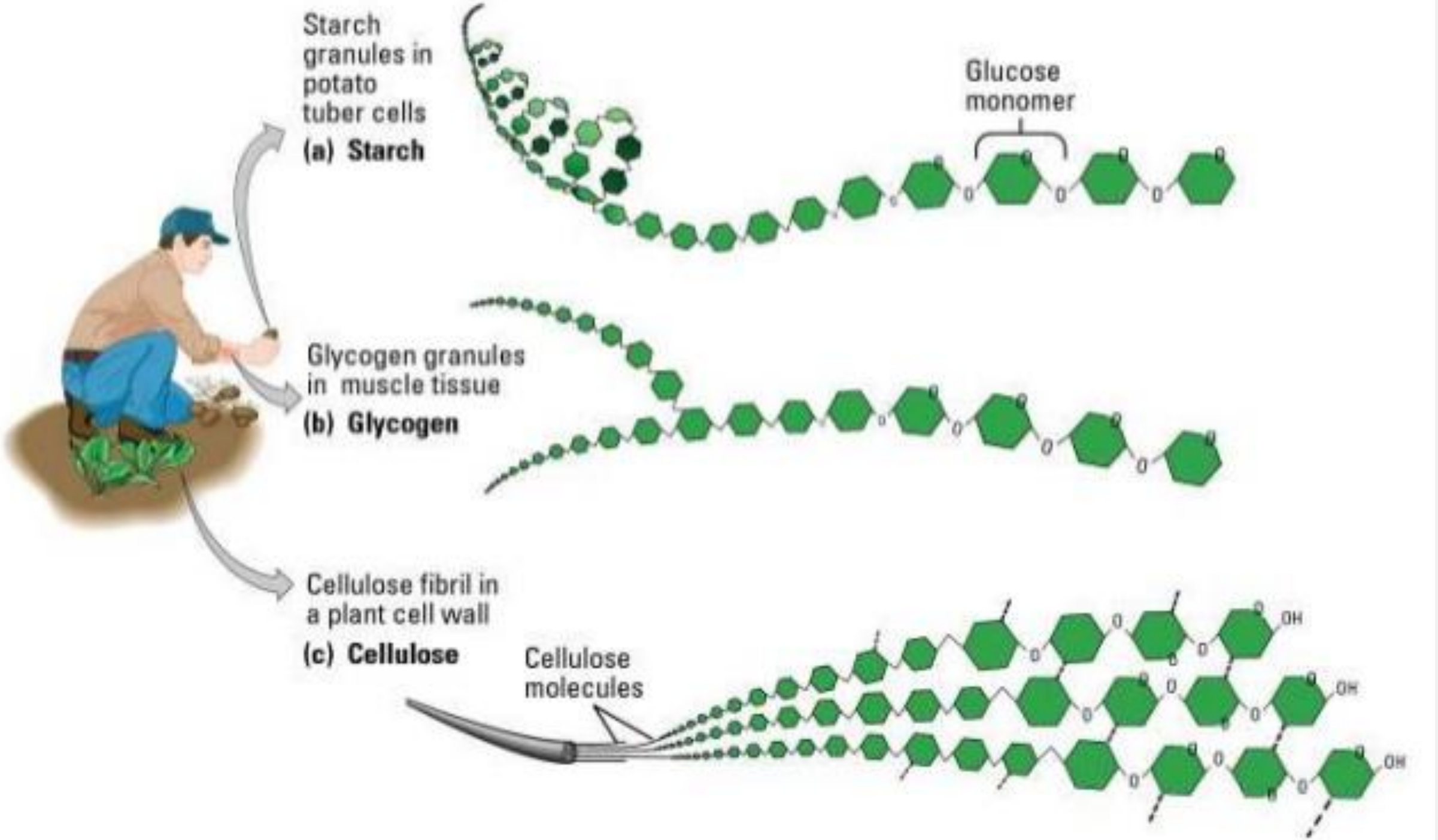
- Examples: disaccharide, or polysaccharide

- Foods include bread, pasta, rice, vegetables, fruit, candy, etc.

- Digested in the mouth and small intestine .

- Breaks down into simple sugars like glucose, fructose, galactose (monosaccharides).

- Function as the main source of energy in the body (glucose is used to produce ATP).


Starch granules in potato tuber cells
(a) Starch
Glucose monomer
Glycogen granules in muscle tissue
(b) Glycogen
Cellulose fibril in a plant cell wall
(c) Cellulose
Cellulose molecules
OH
OH
OH

NUTRIENTS

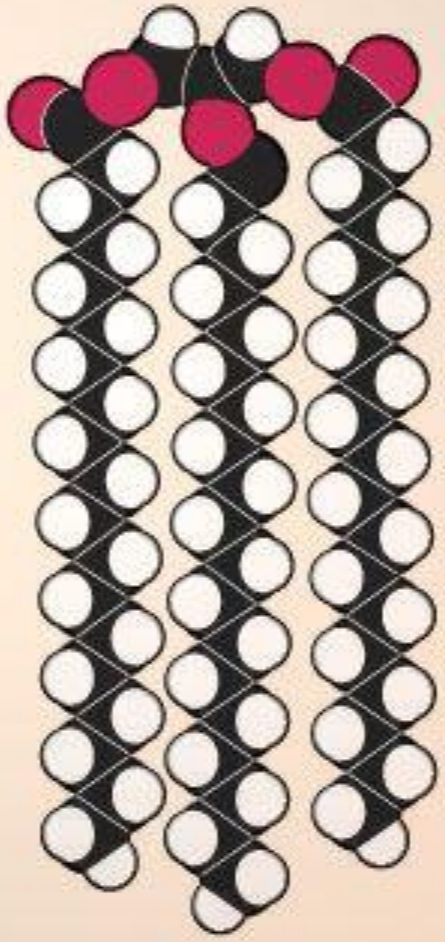
2. Lipids

- Examples: fats, oils, waxes
- Foods include oil, butter, bacon, other fatty foods.
- Digested in stomach and small intestine. lipase
- Breaks down into fatty acids and glycerol.
- Functions to store energy, insulation, vitamin storage, and protects organs.

Phospholipid

Phosphatidylcholine

Triglyceride



Triacylglycerol

Steroid

Cholesterol

Lipid

A single fatty acid

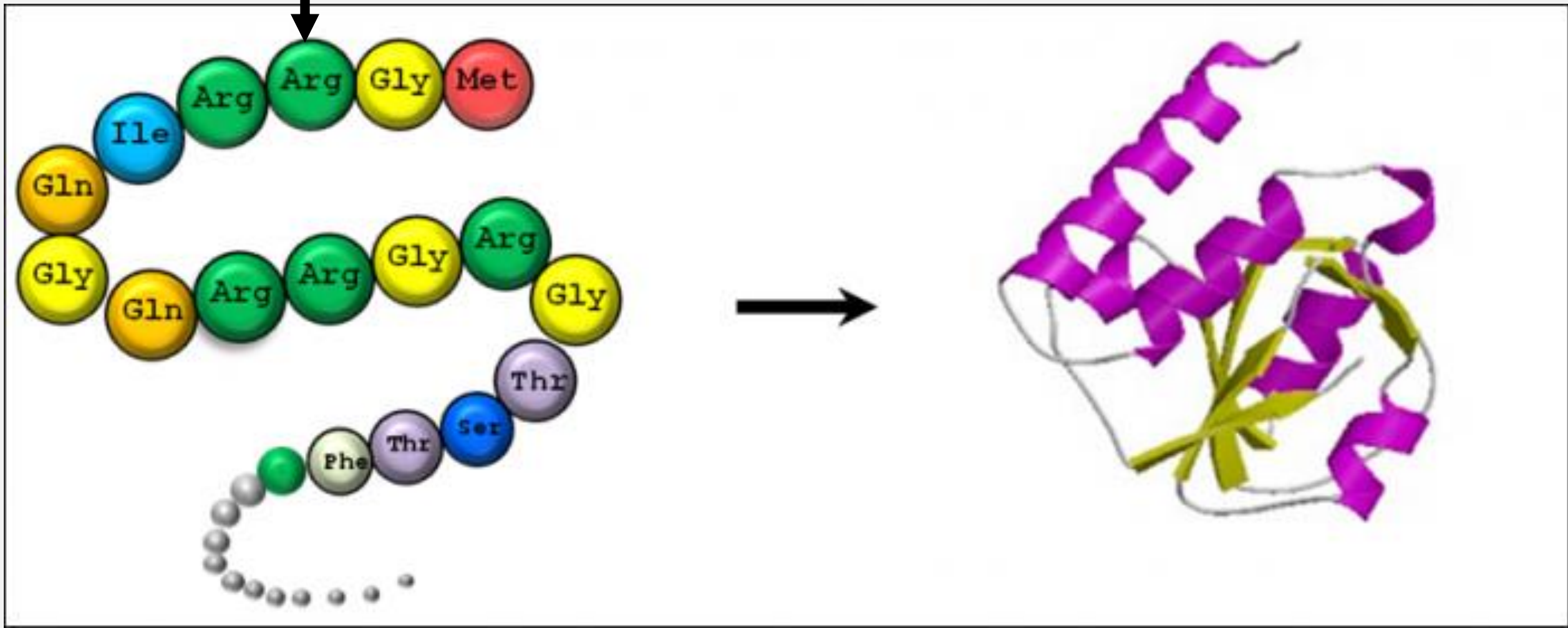
NUTRIENTS

3. Proteins

- Also known as “polypeptides”.
- Foods include meat, eggs, milk, fish, nuts, soy products
- Digested in stomach and small intestine.
- Breaks down into amino acids.
- Functions to aid in growth and maintenance of cells.

Amino Acid

Protein



NUTRIENTS

4. Vitamins

- These are nutrients your body needs to fight off disease.
- Your body cannot produce vitamins!
- 2 main types:
    - Fat-soluble – stored and absorbed in fat cells
    - Water-soluble – not stored in body, and need to be replenished daily.
- Each of the 13 vitamins are found in a variety of foods.

VITAMIN A

(FAT SOLUBLE)

for
Normal Growth and Development, Normal Night Vision & Healthy Epithelium, Anti-infective

Deficiency leads to Retarded Growth, Night Blindness, Diseased Epithelium, Dry Scaly Skin, Colds, Bronchitis, Diarrhoea, Xerophthalmia

VITAMIN B12

(WATER SOLUBLE)

for
Red Blood Cells, Nitrogen Metabolism, Healthy Nervous Tissue

Deficiency leads to Pernicious anaemia

VITAMIN B1

(Vitamin F)
(WATER SOLUBLE)

for
Growth, Appetite, Normal Intestinal Function, Nerve and Muscle Function

Deficiency leads to Beri-Beri,Loss in Weight, Loss of Appetite, Stenosis, Defective Carbohydrate Metabolism

VITAMIN C

(WATER SOLUBLE)

for
Healthy Growth, Good Gums & Teeth, Sound Blood-vessels, Rapid Healing, Resistance against Flu & Colds

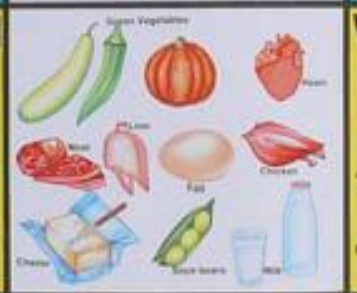
Deficiency leads to Scurvy, Swollen Gums, Bursting of Blood capillaries

VITAMIN B2

(Vitamin G)
(WATER SOLUBLE)

for
Growth, Healthy Skin, Mouth & Eyes

Deficiency leads to : Retarded Growth, Dim Vision, Photophobia, Keratitis, Blistered Tongue, Premature Senility



VITAMIN D

(FAT SOLUBLE)

for
Proper utilization of Calcium & Phosphorus, Formation of Bones and Teeth

Deficiency leads to Rickets, Poor Growth, Weak Teeth & Bones, Tooth Decay

VITAMIN B

(P.P. Factor)
(WATER SOLUBLE)

for
Proper Carbohydrate Metabolism, Nervous System

Deficiency leads to Pellagra, Glossitis, Dermatitis, Psychosis, Diarrhoea

VITAMIN E

(FAT SOLUBLE)

for
Normal Reproduction

Deficiency leads to Sterility, Muscular Paralysis

VITAMIN B6

(WATER SOLUBLE)

for
Proper Metabolism of Amino Acids, Disease - Resistance, Anti-Emetic

Deficiency leads to Anaemia, Atrophied Lymph Tissues, Poor Resistance against Diseases

VITAMIN K

(FAT SOLUBLE)

for
Normal Blood Coagulation and Liver functioning

Deficiency leads to Haemorrhage

NUTRIENTS

5. Minerals

- These are nutrients that are needed in small amounts to keep you healthy.

- Your body cannot produce minerals! There are 16 essential nutrients that your body cannot live without.

- They have a variety of functions at the cellular level

- Absorbed in the small intestine.

CALCIUM	· BONE & TOOTH HEALTH · MUSCLE CONTRACTION · NERVE SIGNALING · HEART RATE REGULATION	 yogurt · cheese · milk & soy milk fortified cereals
IODINE	· THYROID FUNCTION · CELL METABOLISM	 dried seaweed · cod · iodized salt baked potato with skin · milk
IRON	· RED BLOOD CELL FORMATION · OXYGEN TRANSPORT · IMMUNE FUNCTION · ENZYME & DNA FORMATION	 clams · liver · pumpkin seeds nuts · beef & lamb · beans dark leafy greens
POTASSIUM	· IMPORTANT ELECTROLYTE · MUSCLE CONTRACTION · NERVE SIGNALING · FLUID BALANCE & HYDRATION	 beans · dark leafy greens · baked potato with skin · dried apricots
SODIUM	· IMPORTANT ELECTROLYTE · MUSCLE CONTRACTION · NERVE SIGNALING · FLUID BALANCE & HYDRATION	 table salt · bouillon & soups soy sauce · deli meat · cheese processed snack foods pickled foods
ZINC	· IMMUNE FUNCTION · CELL DIVISION · WOUND HEALING · CARBOHYDRATE METABOLISM	 oysters · beef & lamb · wheat germ pumpkin seeds · cocoa

NUTRIENTS

6. Water

- An essential nutrient because we need more than our bodies can produce.

- Required to fill spaces in and between cells, lubrication of digested food, dissolving nutrients, thermoregulation, and other vital functions.

- 50-80% of body weight is water

RESEARCH PROJECT

Outcomes:

- 11-2-11: Investigate and describe conditions/disorders that affect the digestive process. (GLOs: B3, C6, D1)

- B11-2-12: Use the decision-making process to investigate an issue related to digestion and nutrition. (GLOs: B3, C4, C5, C8)