**Digestive system** (Chapters 18 and 19) **Page 1**

Nutrients

The molecules in foods that are needed for health and proper growth

• The macromolecule monomers:

√ Amino acids are the monomers of proteins

√ Monosaccharides are the monomers of carbohydrates

√ Fatty acids and glycerol are the monomers of lipids

• Vitamins

• Minerals (Atomic ions such as Ca2+, Mg2+, Fe3+, etc. )

Fig 18.1; table 19.3

Chyme

Food after it has been swallowed

Digestion

Breaking down the macromolecules in chyme into smaller molecules

• The digestive system breaks macromolecules in chyme down into

their monomer molecules

• The digestive system won’t allow macromolecules in chyme to pass

directly into the body (The macromolecules must first be digested

into their monomers to be absorbed into the body)

Fig 18.1

**Digestive system Page 2**

Digestive system

The organ system responsible for (a) food intake, (b) digesting the macromolecules in chyme down into their monomer molecules, (c) absorbing nutrients (monomers, vitamins, minerals) and water into the body, and (d) eliminating the undigested wastes from the body

• Food is broken down by mechanical digestion (physically tearing)

and chemical digestion (digestive enzymes, acids, and other

chemicals)

√ Digestive enzymes = Proteins that break macromolecules into

smaller molecules (usually monomers)

• Most digestive system organs are in abdominal cavity

• Gastrointestinal (GI) tract (also called the alimentary canal) = The

continuous tube, from mouth to anus, that the chyme passes through

√ Major GI tract organs = Stomach, small and large intestines

• Accessory organs = Digestive system organs that are not part of the

GI tract, but which supply digestive juices to the GI tract

√ Major accessory organs = Pancreas, gall bladder, liver

Fig 18.2

**Digestive system Page 3**

General structure of the GI tract organs

• Lumen (hollow interior) surrounded by a four-tissue wall

• Mucosa = innermost tissue layer: simple columnar epithelial cells

√ Cells secrete digestive juices and protective mucus; cells also

absorb nutrients and water into the blood

√ Often arranged in pits or folds

• Submucosa = connective tissue layer outside mucosa

√ Loose connective and irregular dense connective tissue

√ Physically supports mucosa; contains blood vessels and

neurons

• Muscularis externa = two layers of smooth muscle tissue

√ Circular muscle layer = inner muscle layer, cells point around

canal

√ Longitudinal muscle layer = outer muscle layer; cells point up

and down canal

√ Muscles layers are used for peristalsis (slow involuntary

waves of contraction that propel chyme through the GI tract)

√ Muscles layers also used for segmentation contractions

(churn and break apart the chyme into smaller pieces)

• Peritoneum = a fluid filled double membrane (serosa) that surrounds

and cushions the GI tract organs

√ Visceral peritoneum = inner membrane; attached to muscle

layer

√ Parietal peritoneum = outer membrane; attached

to abdominal cavity wall

Figs 18.3, 18.4, 18.13

**Digestive system Page 4**

Oral cavity (mouth)

• Food is taken in and masticated (chewed)

√ This is the first mechanical digestion of the food

• Salivary glands add a digestive enzyme

√ This is the first chemical digestion of the food

Fig 18.2

Pharynx

The upper region of the throat, behind the nasal cavity and the oral cavity.

• Conducts air, food, and water downward from oral cavity

Fig 18.2

Esophagus (gullet)

Tube that conducts chyme (swallowed food and water) from pharynx

to stomach

Fig 18.2

**Digestive system Page 5**

Stomach

GI tract organ specializing in digestion of chyme (but

essentially no absorption)

• Rugae = Large folds of the stomach’s mucosa layer

• Gastric pits = Microscopic crevices in the stomach’s mucosa layer

√ At the bottom of each gastric pit is a gastric gland (a

stomach gland that secretes digestive juices)

√ Parietal cells = Gastric gland cells that secrete hydrochloric

acid

√ Chief cells = Gastric gland cells that secrete digestive enzyme

• The stomach’s muscularis externa has three muscle layers

√ The extra third layer is for better mechanical digestion

Figs 18.5, 18.6

The esophageal and pyloric sphincters

Rings of smooth muscle that control passage of chyme into and out of

the stomach

**Digestive system Page 6**

Small intestine

The GI tract organ where most chyme digestion and most nutrient

(and water) absorption occur

• Subdivided into three sections:

√ Duodenum = region where chyme enters from stomach and

digestive juices enter from accessory organs

√ Jejunum = region of most digestion and absorption

√ Ileum = final section of small intestine

• Inner surface is highly folded to increase absorption surface area

√ Villi = finger-shaped outward folds of the small intestine’s

mucosa

√ Microvilli = Microscopic finger-shaped outward folds of the

cell membranes of the small intestine’s epithelial

cells

• Nutrients and water are absorbed into blood vessels inside the villi

√ Blood vessels in villi transport nutrients to liver

• Ileocecal valve = sphincter at end of small intestine

Figs 18.9, 18.10, 18.11

**Digestive system Page 7**

Large intestine (colon)

The GI tract organ for final water and ion (mineral) absorption from

feces (the undigested chyme)

• Intestinal crypts = Microscopic inward folds of the large intestine’s

mucosa

• The large intestine is subdivided into four major regions (colons):

√ The ascending colon, transverse colon, descending colon, and

sigmoid colon

• Bacteria in large intestine feed on undigested chyme

• Appendix = A fingerlike pouch at the start of the colon

√ Plays minor role in fighting infection

• Rectum = Feces storage area until expulsion

• Anus = sphincter where feces exits body

Fig 18.16

**Digestive system Page 8**

Accessory organs

Digestive system organs that are not part of the GI tract, but which

supply digestive juices to the GI tract

• The pancreas, gall bladder, and liver

• All three organs secrete their digestive juices into the duodenum

• Their secretions are controlled by hormones from alimentary canal

and nervous system

Fig 18.2

Pancreas

An accessory organ that produces digestive juices and secretes them

into duodenum

• Secretes many digestive enzymes and a buffer (to neutralize stomach

acid)

Figs 18.25 and 18.28

Gall bladder

A small accessory organ near the liver that stores bile and secretes it

into duodenum

• Bile = A detergent-like substance that helps digestion of fat by

breaking down large fat globules into smaller ones

Figs 18.25, 18.26

Liver

A large accessory organ with several functions

• Manufactures bile and stores it in gall bladder

• Receives nutrients directly from the GI tract via the

hepatic portal vein

• The liver stores carbohydrates and regulates their distribution

Fig18.21

**Digestive system Page 9**

Metabolism

All the chemical reactions that take place in the body

• All metabolic reactions (including digestion of chyme in GI tract)

are carried out by enzyme proteins

Digestive enzymes

Enzymes made by the digestive system to break down macromolecules in chyme into smaller molecules.

• Only the monomers from the foods are allowed to pass into the bloodstream. The lining of the GI tract does not allow intact macromolecules to pass through.

• Enzymatic digestion of macromolecules is usually a two-step

process: Large polymers are first digested into smaller polymers, then the smaller polymers are digested into monomers

Protein -> peptides -> amino acids

Polysaccharide -> disaccharides -> monosaccharides

Fat globules -> triglycerides -> glycerol and

fatty acids

• Most of the digestive enzymes are made by the pancreas and the

small intestine; a few are made by the stomach and the salivary

glands

Figs 18.1, 18.32, 18.34; table 18.7

**Digestive system Page 10**

Carbohydrate metabolism:

• Carbohydrate polymers (such as starch) are digested to glucose

monomers in the GI tract.

√ Cellulose (bran/fiber) = An indigestible plant polysaccharide

• Glucose is the major monosaccharide found in blood (“blood sugar”)

√ This is because cells use glucose as their major energy source

• The liver is the organ responsible for maintaining blood sugar

homeostasis:

√ The liver stores excess glucose as the polysaccharide

glycogen when blood sugar is high (hyperglycemia)

√ The liver secretes glucose by glycogenolysis (breaking down

its stored glycogen into glucose monomers) when blood

sugar is low (hypoglycemia)

Figs 2.14, 19.7

### Digestive system Page 11

Control of blood sugar levels

The pancreas contains small endocrine glands called pancreatic islets (the islets of Langerhans). The islets secrete the hormones insulin (which decreases blood sugar) and glucagon (which increases blood sugar)

• High blood glucose (hyperglycemia) causes insulin secretion from

the pancreas

√ Insulin lowers blood sugar by causing cells to take in

glucose

√ Most cells use the glucose for energy and growth; the liver

stores glucose as glycogen

• Low blood sugar (hypoglycemia) causes glucagon secretion from

the pancreas

√ Glucagon causes glycogenolysis (breaking down stored

glycogen into glucose) in the liver; the liver secretes the

glucose into the blood for use by other cells

Figs 19.7, 19.8, 19.9, 19.10; table 19.4

Diabetes mellitus

A disorder caused by the insulin system not functioning

• The body’s cells can’t take in glucose

√ The cells use fatty acids, ketone bodies, and amino acids as

fuel sources

• Major symptom = Hyperglycemia (especially after a carbohydrate-

rich meal)

• The urine’s glucose and water content increase

**•** Glucose imbalance affects brain function and can lead to coma or

death

Fig 19.11; table 19.5

**Digestive system Page 12**

Triglyceride (fats and oils) metabolism

• Triglyceride molecules are digested into fatty acids and glycerol molecules in GI tract then absorbed into bloodstream

√ Animal lipids tend to have more saturated fatty acids and

cholesterol (unhealthy)

√ Plant lipids tend to have more unsaturated fatty acids and

don’t have cholesterol (healthy)

• Cells use fatty acids for energy through aerobic respiration

• Fatty acids also are used as the building blocks for the cell’s fats and

phospholipids

• The liver uses fatty acids to make cholesterol

• Low density lipoprotein (LDL) = a protein + lipid globule that the

liver secretes into the bloodstream to transport cholesterol and fats to

other tissues

√ High LDL levels are associated with atherosclerosis

• High density lipoprotein (HDL) = a protein + lipid globule that

cells secrete into the bloodstream to transport cholesterol to the liver

for disposal (as bile)

√ High HDL levels are associated with lower cholesterol and

healthy arteries

**Digestive system Page 13**

Metabolic rate

The amount of calories our body uses per hour

• Basal metabolic rate (BMR) = calories per hour when resting

√ Thyroxine = hormone from thyroid that sets BMR

√ BMR is also affected by size, gender, age

• Total metabolic rate (TMR) = calories used per hour when doing

activities

√ Always above BMR

√ TMR depends on activities

Table 19.1

Energy balance

When total calories (energy) gained from food exactly equals calories

expended by body

• Energy balance results in no significant change in weight

• If more calories are taken in than are used, body weight increases

• If more calories are used than are taken in, body weight decreases

Fig 19.5