Overview of Nutrition

Food choices

Food choices can significantly affect our health and are influenced by multiple factors**, including:**

- Personal preference for flavors
- Habit
- Ethnic heritage or tradition
- Social interactions, such as special events, customs and holidays where food i**s involved**
- Availability, convenience and economy
- Positive and negative associations:
  - Eating for emotional comfort
  - Body weight and image
  - Values (religious beliefs, political views or environmental concerns)
  - The nutrition and health benefits of functional foods, such as whole, modified or fortified foods

Key nutrients

	Water	**Carbohydrates**	**Lipids (fats)**	**Proteins**	**Vitamins**	**minerals**
Weight	2/3 body weight					Tiny portion
Organic		√	√	√	√	
Energy 1kcal=4.2kJ		√ 17kJ/gram	√ 37kJ/gram	√ 17kJ/gram (role is limited)		
Macro	√	√	√	√	micronutrient	micronutrient
Functions	Metabolic reaction, transport vital materials to cell and carry waste away			Muscle tissues, skin, enzymes, hormones, antibodies	Allow the body to obtain energy from energy yielding nutrients	Found in bones, teeth and body fluid

Micronutrients: vitamins and minerals, don't provide energy, needs them in smaller quantities

Essential nutrient: need from outside the body

Metabolism: The process by which nutrients are broken down to yield energy or are rearranged into body structures (catabolism and anabolism)

Energy in the body

During catabolic metabolism. macronutrient molecules are broken down and the broken bonds release their energy.

- Heat
- BMR
- Exercise and metabolism
- Fat storage (excess)

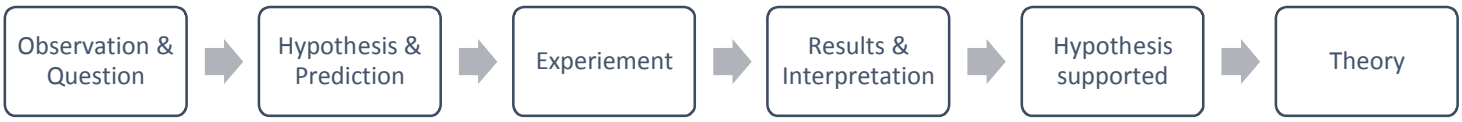
Science of nutrition

Epidemiological studies:

- Cross sectional: researchers observe how much and what kinds of foods a group of people eat and how healthy those people are
- Case-control: researchers compare people who do and do not have a given condition such as a disease, closely matching them in age, gender and other key variables so that differences in other factors will stand out.
- Cohort: researchers analyze data collected from a selected group of people at intervals over a certain period of time.

Laboratory studies: Animals studies. Researchers feed animals special diets that provide or omit specific nutrients and then observe any changes in health

Clinical trials: human intervention trials, scientists ask people to adopt a new behaviour.
Control: large sample sizes, placebos and blind treatments, double blind
The scientific method:



If hypothesis not supported→ new observation & questions

Correlation and Causality

- A correlation occurs when the results of studies show a relationship between two factors ie; vitamin C and colds.
- This is not necessarily cause and effect! But an indication as to a possible association that needs to be investigated by lab experiments

Evaluate the reliability of research

- the journal (impact factor in its class), has it been peer-reviewed
- study funding source
- authors (relevant discipline training, society membership, track record etc),
- The study methodology and discussion of results (eg do the conclusions match the results ??)

Replication should be used to confirm or disprove findings.

Nutrient reference value (NRV)
a set of standards that define the amounts of energy, nutrients, other dietary components and physical activity that best support health.

- Nutrient reference values apply to healthy people.
- Recommendations are not minimum requirements and can be adjusted for individuals by dietitians.
- Are achieved by consuming a variety of foods.
- Apply to average daily intakes.
- Each NRV category serves a unique purpose, either nutritional assessment of individuals or populations.
- EARs for groups/populations.
- RDI / AIs for individuals.

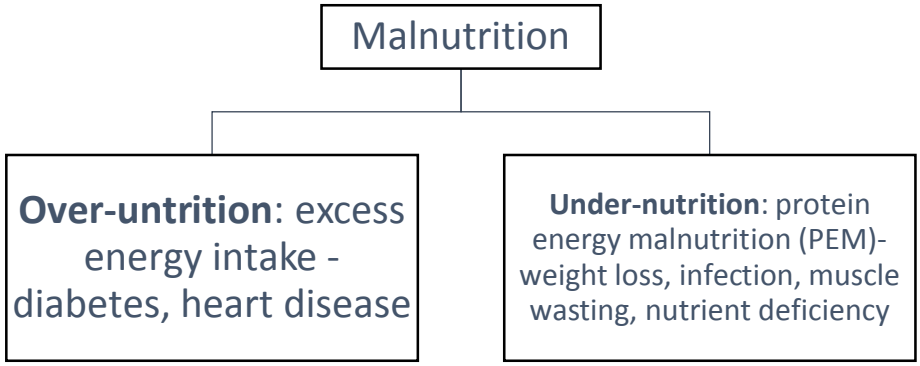
- **Estimated Average Requirements (EAR)**
  A daily nutrient level estimated to meet the requirements of **half** the healthy individuals.
- **Recommended Dietary Intake (RDI)**
  The average daily dietary intake level sufficient to meet the nutrient requirements of nearly **all healthy individuals** in a particular life stage and gender group. (based on EAR)
  - Don't need to meet RDI everyday, dependent on the body's use and the storage of that nutrient.
- **Adequate Intakes (AI)**
  Used when an RDI cannot be determined. The average daily intake level based on observed or experimentally determined approximates of nutrient intake by a group that are assumed to be adequate.
- **Upper Level of Intake (UL)**
  The highest average daily nutrient intake level likely to pose no adverse health effects to almost all individuals in the general population. As intake increases above the UL the risk of adverse effects increase.

- **Estimated energy requirement (EER)**

the average dietary energy intake that will maintain energy balance in a person with a healthy body weight and level of activity

- **Acceptable Macronutrient Distribution Ranges (AMDR)**
  45-65% kJ from Carbohydrate
  20-35 % kJ from fat
  15-25% kJ from protein

Nutrient Assessment



Nutrition assessment of individuals:

- Evaluates the many factors that influence or reflect nutritional health.
- Historical information regarding diet, health status, drug use and socioeconomic status is gathered.
  - health status, socio economic status, diet, medications, drug/ alcohol use
- Anthropometric data measure physical characteristics including height and weight.
  - weight, height, BMI, waist:hip ratio, %body fat
- Physical examinations require skill and reveal possible nutrition imbalances.
  - hair, skin, eyes, fingernails, tongue
- Laboratory tests detect early signs of malnutrition.
  - Blood, urine

Primary deficiency caused by inadequate diet; secondary deficiency caused by problem inside the body.

National nutrition surveys:

- survey research to collect data on foods people eat and people's health status.
- Data collected is used for nutrition policy, food assistance programs and food supply regulation.

National trends show an increased intake of fast food, increased portion sizes and an increased consumption of energy-dense foods and drinks.

- increased risk for overweight and obesity and other chronic conditions.

Diet and Health

Risk factor

Definition: A condition or behaviour associated with an elevated frequency of a disease – but not definitively known to cause the disease status.

Clusters: Risk factors tend to cluster, which indicates a degree of interaction. For example obesity, physical inactivity, high BP and high blood cholesterol are often seen together and all impact heart disease.

Types of risk factors:

- Modifiable risk factors contributing to deaths - smoking, diet, physical inactivity, alcohol, overweight etc.
- Non modifiable risk factors - genetics, age, sex
- Measurable risk factors (biomarkers) - Blood pressure, plasma lipids, BMI, insulin **resistance etc.**

Carbohydrates: sugars, starches and dietary fibre

Carbohydrates

- Glucose
- Glycogen (storage form)

→provide half of our body energy
→provide energy for body cells
→ 45%-65% of daily energy
All plant foods, whole grains, vegetables, legumes and fruits (milk) provide carbohydrate
Carbohydrate: Carbon (C), Hydrogen (H), Oxygen (O)

Dietary carbohydrate

Simple carbohydrates (the sugars)

- **Monosaccharides** ($C_6H_{12}O_6$) ->different sweetness
  →glucose: essential energy source for all the body's activities.
  →fructose: sweetest of the sugars, occurs naturally in fruits and honey; and is added to many foods in the form of high-fructose corn syrup.
  →galactose: occurs naturally as a single sugar in only a few foods.

- **Disaccharides** (pairs of monosaccharides)

Condensation: links two monosaccharides together, water expelled
Hydrolysis: break disaccharide in two, add water. Occur during digestion
→maltose (glucose + glucose): produced whenever starch breaks down, during fermentation process
→sucrose (glucose + fructose): Refined from sugar cane and sugar beets, tastes sweet and is readily available.
→lactose (glucose + galactose): principle carbohydrate of milk

Complex carbohydrates (starches and fibre)

- **Oligosaccharides**
- **Polysaccharides**

→Glycogen: storage form of glucose in the body; provides a rapid release of glucose (energy) when needed.
→Starch: storage form of glucose in plants; found in grains, tubers and legumes. *Major source of energy for body.
→Fibre: the structural parts of plants. Bonds between their monosaccharides cannot be broken down by digestion in the body. Contribute no monosaccharides- little or no energy.

Digestion and Absorption of carbohydrates

Digestion

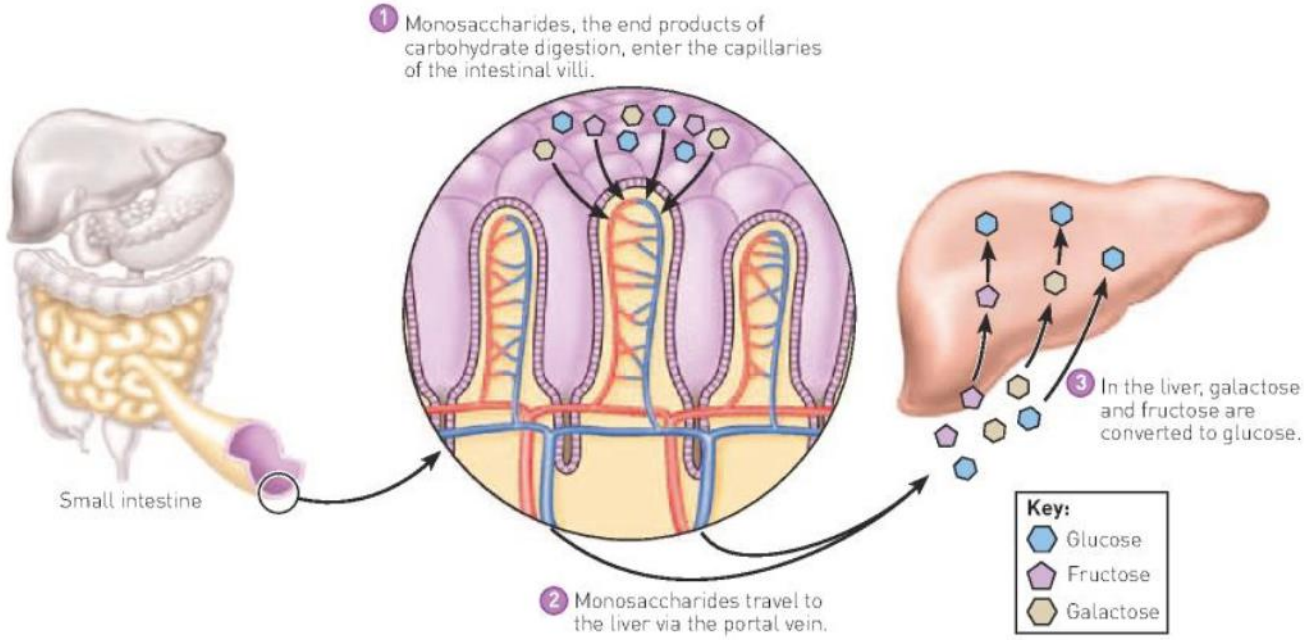
1. In the **mouth**: salivary enzyme amylase, hydrolysing starch to shorter polysaccharides and to the disaccharide maltose.
2. In the **stomach**: bolus mixes with the stomach's acid and protein-digesting enzyme -> inactivate salivary amylase. Still hydrolyse starch but very limited.
   Dietary fibre delays gastric emptying and provides a feeling of fullness (satiety).
3. In the **small intestine**: most of the work of carbohydrate digestion. Pancreatic amylase, enters the intestine via the pancreatic duct and continues breaking down the polysaccharides to shorter glucose chains and maltose.
   Dietary fibre helps to regulate the passage of food through the GI system and slows the absorption of glucose.

Outer membrane of the intestinal cells, <u>specific enzymes</u> break down specific disaccharides
Maltase → maltose into two glucose
Sucrose → sucrose into one glucose and on fructose
Lactase → lactose into one glucose and one galactose
Intestinal cells absorb these monosaccharides.

4. In the **large intestine**: only dietary fibre remains in the digestive tract after 4 hours. Bacterial enzymes digest dietary fibres into short-chain fatty acids and gas. Dietary fibre holds water, regulates bowel activity and binds substances such as bile, cholesterol and some minerals, carrying them out of the body.

Absorption

Nutrient absorption mostly take part in the <u>small intestine</u>
Glucose & Galactose → active transport
Fructose →facilitated diffusion →small rise in blood glucose (unbranched chains of starch also)
Fructose and galactose → liver → convert into glucose



Lactose intolerance- insufficient lactase to digest the disaccharide lactose found in milk and milk products.
Symptoms: bloating, abdominal discomfort and diarrhoea.

- Undigested lactose are transported to colon where fermentation by colonic bacteria occurs

Causes: lactase deficiency, damaged intestinal villi, aging
Management:

- Increase the intake of milk gradually
- Take them with other foods in meals to reduce lactose concentration
- Spread their intake throughout the day
- Use of acidophilus milk, yoghurt to aid lactose fermentation. (bacteria digest lactose for their own use)
- Use enzyme lactase to breakdown lactose

Fructose intolerance

- Increasingly being used as a sweetener, either alone or as part of high fructose corn syrup
- Absorbed more slowly than glucose increasing the chances that it will pass into the large intestine
- People who are lactose intolerance often fructose intolerance, symptoms similar including GI stress

Glucose homeostasis: blood glucose must be constantly maintained at ~5mM to nourish cells

- Low blood glucose → dizziness and weakness
- High blood glucose → fatigue

- Extreme fluctuation → fatal

Regulating hormones

- Insulin (from pancreas): moves glucose from the blood into the cells (muscle, liver) and helps to lower blood sugar levels
- Glucagon (from pancreas): brings glucose out of storage when necessary; raises blood sugar levels

After a meal → blood glucose rises → pancreas secret insulin into the blood (correspond to the rise of glucose)

- Adrenaline/epinephrine (fight-or-flight) → acts quickly to bring glucose out of storage during times of stress

Balance glucose by eating meals regularly with adequate complex carbohydrates.
Blood glucose fall outside the normal range:
→diabetes(hyperglycaemia): the cells fail to respond to insulin (obesity)

- Type I- pancreas is faulty and insulin is not produced. Usually childhood onset.
- Type II- large amounts of insulin secreted but the cellular receptor function is faulty and cells fail to respond to the insulin and take up glucose as they should. Generally adult onset with fat gain/genetic component

→hypoglycaemia: too much insulin, strenuous physical activity, inadequate food intake or illness

- weakness, rapid heartbeat, sweating, anxiety, hunger and trembling

Glycaemic response: how quickly glucose rises and returns to normal
→ Glycaemic Index (GI) classifies foods according to their potential for raising blood glucose
→ Glycaemic load refers to a food's glycaemic index and the amount of carbohydrate the food contains

- High GI- cause large and rapid rise in blood glucose. E.g., white bread, potatoes, rice
- Low GI- cause a slower and more gradual rise in blood glucose. E.g., wholegrain, fibre

Digestion, Absorption and Transport

Digestion

the mechanical and chemical breakdown of food, extraction of nutrients, and breakdown of macronutrients

Gastrointestinal (GI) tract

- The GI tract is the flexible muscular tube from mouth to anus.
- The mouth is the beginning of the digestive system.
- Digestion in the mouth involves mastication (chewing), the stimulation of taste buds and swallowing.

- After swallowing, the food is called a bolus.
- The oesophagus is the tube that leads the bolus to the stomach.
- The stomach adds juices and grinds the bolus into chyme (semi liquid).
- The pyloric sphincter regulates the flow of chyme into the small intestine.
- The small intestine receives digestive juices from the gallbladder and the pancreas
- The three segments of the small intestine are the duodenum, the jejunum and the ileum.
- The large intestine (colon) begins at the ileocaecal valve and ends at the rectum and anus.

Functions

Mouth: Chews and mixes food with saliva

Oesophagus: Passes food from the mouth to the stomach

Liver: Manufactures bile salts to break down fats to help later digestion

Stomach: Adds acid, enzymes and fluid. Churns and mixes to a liquid mass

Pancreas: manufactures enzyme to digest all energy-yielding nutrients **and releases bicarbonate to neutralize acid chime** that enters the small intestine

Small intestine: Secretes enzymes that digest all energy-yielding nutrients to smaller molecules. **Cells of wall** absorb nutrients into the blood and lymph

Large intestine: Reabsorbs water and minerals. Passes waste (Fibre, bacteria and unabsorbed nutrients) along with water to the rectum

Rectum: Stores waste prior to elimination

Anus: Holds rectum closed and opens to allow elimination

Muscular Actions (mechanical)

- Chewing
- Peristalsis: when the rings muscle tighten and the long muscle relax, the tube is constricted. When the rings of muscle relax and the long muscles tighten, the tube bulges
- Stomach action: force the chime downward and pass through the pyloric sphincter
- Segmentation: the circular muscles of the intestines rhythmically contract and squeeze the contents
- Sphincter contractions: periodically open and close allowing the contents of the GI tract to move along at a controlled pace

Digestion secretions: chemical breakdown of food following mechanical breakdown

Digestive enzymes act as catalyst in hydrolysis reaction

Organ or Gland	Target Organ	Secretion	Action
Salivary glands	Mouth	Saliva	Fluid eases swallowing; salivary enzyme breaks down carbohydrate
Gastric glands	Stomach	Gastric juice	Fluid mixes with bolus; hydrochloric acid uncoils proteins; enzymes break down proteins; mucus protects stomach cells
Pancreas	Small intestine	Pancreatic juice	Bicarbonate neutralize acidic gastric juices; pancreatic enzymes break down carbohydrates,

			fats and proteins.
Liver	Gall bladder	Bile	Bile stored until needed
Gall bladder	Small intestine	Bile	Bile emulsifies fat so enzyme can attack
Intestinal glands	Small intestine	Intestinal juice	Intestinal enzymes break down carbohydrate, fat and protein fragments, mucus protects the intestinal wall.

Carbohydrate digestion:

1. Begins in the mouth
2. No digestion in the stomach
3. Duodenum- pancreatic amylases continue to breakdown the molecules into disaccharides
4. The walls of the small intestine- enzymes break down the disaccharides into monosaccharides

Fibre: at least 30g/day

- Insoluble fibre- prevent constipation: not digested and passes through the GI tract unchanged
- Soluble fibre- oat, barley and legumes: partially fermented in the large intestine producing gases and short chain fatty acids
- Resistant starch: completely digested by the body's normal digestive system. Some doesn't get digested ends up as food for bacteria

Lipids digestion:

1. Breakdown of hard fats begins in the mouth- warmed to body temperature
2. The small intestine- action of pancreatic and intestinal lipase enzymes.
3. lipid substances must be reduced in size by the <u>emulsification</u> action of bile secreted from the gall bladder before enzymatic breakdown

Proteins digestion

1. Begins in the stomach, acidic conditions uncoil protein strands and the enzyme pepsin can break it down to smaller peptide chains.
2. In the duodenum, pancreatic and intestinal protease enzymes reduce chains to dipeptides
3. Dipeptidase enzymes from the intestinal lining complete the breakdown, producing amino acids ready for absorption.

Final stage of Digestion

- Energy-yielding nutrients are disassembled for absorption.
- Vitamins, minerals and water do not need disassembling
- Undigested residues, including some fibres, continue through the digestive tract and form stool.
- The enormous surface area of the 3-4 metre small intestine facilitates nutrient absorption.
- Meal digestion = 3 to 4 hours.

Absorption

the transfer of nutrients from the lumen of the **small intestine** to **blood** or **lymphatic capillaries** surrounding the digestive tract

- The small molecules are taken up by the **villi** projections of the mucosal cells of the **small intestine**.
- Most nutrients enter blood vessels which collect into the **portal vein** which connects to the **liver**.
- The liver then controls regulated transport of nutrients to the body.
- <u>Glucose and amino acids are absorbed</u> into mucosal cells (epithelium) of the villi and pass into <u>blood vessels.</u>
- <u>Lipids and fat soluble vitamins</u> are **insoluble** in an aqueous environment and must be packaged into **lipoprotein particles called chylomicrons**.
- These lipid rich particles enter the **lymph vessels** in the villi, bypass the liver and meet the circulatory system at the subclavion vein through the right lymphatic duct and thoracic duct in the chest region.

Small intestine structure

- Approximately 3-4 metres long with a diameter of 2-3 cm.
- Inner surface contains hundreds of folds, each fold is contoured into thousands of finger like projections called villi.
- Each villi has a layer of mucosal cells, each of which is covered in many **microvilli**.
- The microvilli provide the large absorptive surface that allow nutrients to enter mucosal cells and pass into the blood stream or lymphatic vessels.
- Internal surface of the small intestine is equivalent to a tennis court in area

Villi structure and function

- Each villi moves constantly, trapping any nutrient small enough to be absorbed, amongst its microvilli.
- The small nutrient molecules are then absorbed into the mucosal cells of the villi then through into blood capillaries or lymphatic vessel.
- Absorption process varies depending on the nutrient, and can be of three types:
  - *Simple diffusion*
    Some nutrients (such as water and small lipids) are absorbed by simple diffusion. They cross into intestinal cells freely.
  - *Facilitated diffusion*
    Some nutrients (such as water-soluble vitamins) are absorbed by facilitated diffusion. They need a specific carrier to transport them from one side of the cell membrane to the other.
  - *Active transport*
    Some nutrients (glucose and amino acids) must be absorbed actively. These nutrients move against a concentration gradient, which requires energy.

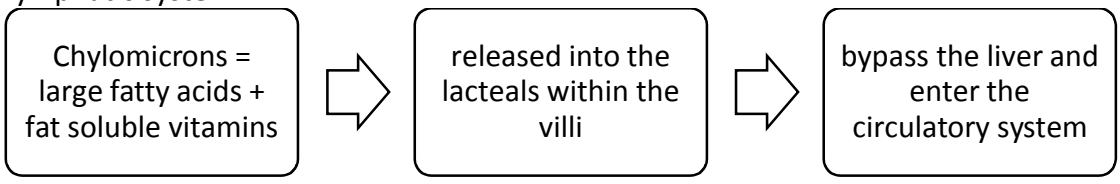
Absorption of nutrients

- The cells are specialised to absorb different nutrients.
- 'Food combining', which emphasises separating food for digestive purposes, is a myth.
- Water-soluble nutrients and small products of fat digestion are released to the bloodstream.
- Fat-soluble vitamins and larger fats form chylomicrons and are released to the lymphatic system.

Nutrient Transport and Circulatory system

- Once inside mucosal cells, nutrients are released into the circulatory system and distributed to body cells
- Amino acids, monosaccharides, glycerol and small fatty acids pass into the blood stream via capillaries in the villi
- These nutrients are then **transported via the portal vein to the liver** and around the body
  All blood collected from the digestive system travels via the portal vein to the liver.
- Larger lipid molecules are incorporated into chylomicrons which travel via the lymph system and bypass the liver to enter the blood stream later

Lymphatic system



Large Intestine function

- Approximately one metre in length and consists of ascending colon, transverse colon, descending colon, rectum and anus.

- Primary function is for the absorption of water, sodium and potassium.

GI Tract and Health

- Many factors influence health and regulation of GI tract.
- Age, diseases and malnutrition can affect functioning.
- Estimated 10 trillion bacteria live in GI tract.
- Flora or microflora assist digesting some fibre and protein.
- Probiotics are bacteria found in the foods such as yoghurt, that can be beneficial to health.
- Prebiotics are foods not absorbed but used as food by intestinal bacteria.

Probiotics Benefits

- Helping to alleviate diarrhoea or constipation, inflammatory bowel disease, ulcers, allergies and lactose intolerance.
- Enhancing immune function and protecting against colon cancer.
- Bacteria in the gut also produce small amounts of Vitamin K.

Regulation of the GI tract

- Hormonal (or endocrine) system and the nervous system coordinate all digestive and absorptive processes.
- Stimulates or inhibits secretions with hormones and nerve pathway **'feedback mechanisms'**.
- Pancreatic secretions change based on the content of the diet.
- Rapid change in typical diet can often result in 'upset stomach' due to lag in pancreatic secretion change.

Hormone	**Responds to**	**Secreted from**	**Stimulates**	**Response**
Gastrin	Food in the stomach	Stomach wall	Stomach glands	HCL secreted into the stomach
Secretin	Acidic chime in the small intestine	Duodenal wall	Pancreas	Bicarbonate-rich juices secreted into the small intestine
Cholecystokinin	Fat or protein in the small intestine	Intestinal wall	Gall bladder Pancreas	Bile secreted into the duodenum Bicarbonate and enzyme-rich juices secreted into the small intestine

A healthy GI tract

- Healthy diet promotes healthy GI tract and optimal nutrient absorption; too much can be harmful.
- Good sleep assists with maintenance and repair of GI tract.
- Physical activity promotes good GI muscle tone.
- Relaxed mealtimes promotes good regulatory hormonal control.
- In summary: balance, moderation, variety and adequacy should feature in everyday eating.