MEGA LECTURE

Nutrition Chap 12 &13

Nutrition in Plants

CLASSIFICATION ON THE BASIS OF MODE OF NUTRITION

Plants can be divided into two groups on the basis of their mode of nutrition.

1. AUTOTROPHIC
2. HETEROTROPHIC

1. AUTOTROPHIC NUTRITION

DEFINITION

"Autotrophic nutrition is the type of nutrition in which organic compounds are manufactured from available inorganic raw material taking from surroundings". In autotrophic nutrition, the nutrients do not require to be pretreated or digested before taking them into their cells.

TWO METHODS OF AUTOTROPHIC NUTRITION

On the basis of source of energy, autotrophic nutrition can be sub-divided into following sub-types.

(I) Phototrophic nutrition
(II) Chemotrophic nutrition

I. PHOTOTROPHIC NUTRITION

DEFINITION

"The type of autotrophic nutrition is which organic molecules are manufactured from simple inorganic molecules by using light energy as a source is called Phototrophic Nutrition".

EXAMPLE

a. Green Plants
b. Photosynthetic Bacteria

(I-A) PHOTOTROPHIC NUTRITION IN GREEN PLANTS

Green plants are very prominent example of phototrophic nutrition. They prepare the food by the process of photosynthesis.

RAW MATERIAL

The raw material needed by these organisms are

(1) CO2 AND H20

They provide carbon, hydrogen and oxygen for the synthesis of organic molecules.

(2) MINERALS

The minerals like Nitrogen, Phosphorus and Sulphur and Magnesium are also required.

(3) GREEN PIGMENTS

The green pigments i.e. Chlorophyll a, b, or others are also required to absorb the energy from universal source of light.

(4) LIGHT

In the presence of sun light nutrients are used to synthesis the energy rich compounded (CHO) This process is called "PHOTOSYNTHESIS".

This process can be represented by equation as follows.

$6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$

(I-B) PHOTOTROPHIC NUTRITION IN PHOTOSYNTHETIC BACTERIA

Photosynthetic bacteria are unique because they are the only organisms which are capable of synthesizing the carbohydrate food without chlorophyll "a".

DIFFERENCES BETWEEN PHOTOSYNTHETIC BACTERIA AND GREEN PLANTS

Photosynthesis in bacteria is different from green plants. Some differences are

- Photosynthetic bacteria usually grow in sulphide spring where H_2S is normally present.
- Hydrogen is provided by H_2S instead of H_2O.
- Free oxygen is not released as a by product in bacterial photosynthesis.
- The process takes place at low expenditure of energy.

MEGA LECTURE

TWO TYPES OF PHOTOSYNTHETIC BACTERIA

There are two types of photosynthetic bacteria.

(1) THOSE IN WHICH "S" IS RELEASED AS BY PRODUCT

These bacteria use H2S as donor of hydrogen. Light splits hydrogen sulphide. Hydrogen combines with CO2 to form H2O.

$2H_2S + CO_2 \rightarrow (CH_2O)_n + H_2O + 2S$

EXAMPLES

Purple Sulphur Bacteria ® which use BACTERIO CHLOROPHIL & CARETENOID as photosynthetic pigments.

(2) THOSE IN WHICH "S" IS NOT RELEASED AS BY PRODUCT

These bacteria use H2S as Hydrogen donor where as sulphur is not the by product in their case.

EXAMPLES

PURPLE NON-SULPHUR BACTERIA

BROWN NON-SULPHUR BACTERIA

Both of these contain "BACTERIO CHLORPHYLL" as photosynthetic pigments.

(II) CHEMOTROPHIC NUTRITION

DEFINITION

*"The mode of autotrophic nutrition in which organic molecules are manufactured from simple inorganic molecules by using energy produced by the oxidation of certain inorganic substances such as ammonia, nitrates, nitrites, ferrous ions, H2S and etc. This type of nutrition is called CHEMOTROPHIC NUTRITION and process of manufacturing food is called CHEMOSYNTHESIS."*Mainly Bacteria are

AMMONIA USING BACTERIA

They derive their energy by oxidation of Ammonia.

$NH_4^+ + O_2 \rightarrow 2NO_2 + 2H_2O + 4H^+ + \text{energy}$

BACTERIA CONVERTING NITRITES TO NITRATES

$2NO_2 + O_2 \rightarrow 2NO_3^- + \text{energy}$

IMPORTANCE OF CHEMOSYNTHETIC BACTERIA

The chemosynthetic bacteria that act on nitrogen compounds do play an important role in the maintenance of nitrogen balance in the life system.

2. HETEROTROPHIC NUTRITION IN PLANTS

DEFINITION

"Plants which are not capable of manufacturing their own organic molecules entirely or partially depend for these organic molecular are called "HETEROTROPHIC PLANTS"

CLASSIFICATION OF HETEROTROPHIC PLANTS

On the basis of type of organisms on which heterotrophic plants depend, they can be classified into following two classes.

1. PARASITC PLANTS OR PARASITES
2. SAPROPHYTIC PLANTS OR SAPROPHYTES

1. PARASITES

DEFINITION

"Those heterotrophic plants which depend on living plants and animals for their nutritional requirements are known as PARASITES."

TYPES OF PARASITES

Parasitic plants can be divided into following types.

A. Obligate or total parasites.
B. Facultative or partial parasites.

1.A TOTAL PARASITES

DEFINITION

Those parasites which depend for their nutrition entirely on other living organisms

CLASSIFICATION OF TOTAL PARASITIC ANGIOSPERMS

Total or obligate parasitic angiosperms are broadly classified into

1. Total stem parasite
2. Total root parasite

1. TOTAL STEM PARASITES

DEFINITION

"Those parasitic plants which depend entirely on the stems of other plants are called "Total stem Parasites"

EXPLANATION

These plants send HAUSTORIA (specialized structures for absorbing nutrients in parasitic plants) inside the tissue of host. The xylem of parasite comes in contact with xylem of host and phloem of parasite to phloem of host. Through xylem it sucks the water and nutrients, through phloem prepared organic material. The host plant eventually dies off due to exhaustion.

EXAMPLE

CUSCUTA (AMER-BAIL)

2. TOTAL ROOT PARASITES

DEFINITION

"Those parasitic plants which suck their nutritional requirements from the roots of host are called "Total root parasites".

EXAMPLES

OROBANCHE -> attacks the roots of the plants belonging to families Cruciferae and Solanaceae

CISTANCHE -> Parasitizes on the roots of Calatropis.

STRIGA -> Found as parasite on the roots of sugar cane

(1.B)PARTIAL PARASITES

DEFINITION

"Those parasite plants which depend for their nutritional requirements partially on other living organisms are called Falcultave or partial parasites."

CLASSIFICATION OF PARTIAL PARASITIC ANGIOSPERMS

Partial parasitic angiosperms can be broadly classified into

1. PARTIAL STEM PARASITE
2. PARTIAL ROOT PARASITE

1. PARTIAL STEM PARASITES

DEFINITION

Those partial parasites whose haustoria penetrate in the stem of the host and suck their nutrition from vascular tissues of stem are called PARTIAL STEM PARASITE

EXPLANATION

LORANTHUS, is a partial stem parasite. It has thick green leaves, a woody stem and elaborated haustorial system. It can manufacture some of its food with the help of nutrients and water absorbed from host plants. The seeds get stuck upto the stem of host plant and germinates sending its haustoria in the tissues of the host.

EXAMPLES

LORANTHUS -> found on shrubs, roseaceous tree, Bauhinia and mango

VISCUM -> produce haustorial branches for an internal suckling system.

CASSYTHA FILLIFORMIS -> found in tropics

2. PARTIAL ROOT PARASITES

EXAMPLE

The examples of this category are rare.

One important example is

SANDLE WOOD TREE

SAPROPHYTES

DEFINITION

"Those plants which depend for their nutrition on dead or rotten organic remains of plants or animals are called as SAPROPHYTES"

or

"Plants which break up complex dead food material into simple compounds and use them for their growth and development are called as SAPROPHYTES."

TYPES OF SAPROPHYTES

Saprophytes can be divided into two types:

1. Total Saprophytes
2. Partial Saprophytes

1. TOTAL SAPROPHYTES

DEFINITION

"Those plants which depend entirely for their nutrition on dead organic matter are called Total Saprophytes.

2. PARTIAL SAPROPHYTES

DEFINITION

"Those plants which depend partially on dead organic matter are called Partial Saprophytes."

EXAMPLES OF SAPROPHYTES

There are some examples of Saprophytes among flowering plants.

1. Neothia (bird's net or orchid)
2. Monotrapa (Indian Pipe)

In both of these cases, the roots of plant form a Mycorhizzal Association with fungal mycelium to help in absorption process.

SPECIAL MODE OF NUTRITION

CARNIVOROUS OR INSECTIVOROUS PLANTS

DEFINITION

"The plants which have as their prey, insects and small birds are called Carnivorous plants. It is a special mode of nutrition in partially autotrophic and partially heterotrophic plants."

EXPLANATION

Partially autotrophic and partially heterotrophic plants are carnivorous, which possess the green pigments and can manufacture CHO but are not capable of synthesizing nitrogenous compounds and proteins. For their nitrogen requirement, carnivorous plants have to depend on insects, which they catch and digest by specific devices developed in them. J.D. Hooker suggested that the digestion of carnivorous plants is like that of animals.

COMMON AREAS WHERE THESE PLANTS GROW

These plants commonly grow in areas where nitrogen is

deficient due to unfavourable atmosphere for nitrifying bacteria but favourable atmosphere for denitrifying bacteria.

SOME COMMON EXAMPLES

1. PITCHER PLANT

In Pitcher plant leaf is modified into pitcher like structure which is insect trapping organ.

EXAMPLES

Common examples are :

Nepenthes
Sarracenia
Cephalotus
Neliamphora
Darling tonia

2. DORSERA INTERMEDIA OR SUNDEW

This plant has half a dozen prostrate radiating leaves, which bear hair like tentacles each with gland at its tip. The insects attracted by plant odour are digested.

3. DIONAEA MUSCIPULA OR VENOUS FLY TRAP

Most well known of all carnivorous plants. It has a resette of prostrate radiating leaves with inflorescence in the centre. The petiole of leaf is winged and lamina has two halves, with mid-rib in the centre. Each half has 12-20 teeth. In the centre of dorsal surface of lamina are numerous secretory glands, three hairs projecting out, which are sensitive to touch.

4.ALDROVANDA (WATER FLY TRAP)

It is a root less aquatic plant with floating stem. It has ressettes of modified leaves, which have two lobed mobile lamina having teeth at the margin and sensitive jointed hairs and glands on the surface.

5. UTRICULARIA OR BLADDER WORT

It is a root less plant having branched slender stem. Leaves are also much divided and some leaflets are modified into bladder like traps of about 1/16 to 1/8 inches in diameter.

Human Digestive System

DIGESTION

"It is the process by which large complex insoluble organic food substances are broken down into smaller simpler soluble molecules by the help of enzymes".

Digestion in man is mechanical (break down) as well as chemical (enzymatic hydrolysis)

NUTRITION

HETEROTROPHIC, i.e. man is dependent upon ready made food.

TYPE OF DIGESTION

EXTRACELLULAR, i.e. digestion takes place outside the cells but within GIT.

TYPE OF DIGESTIVE SYSTEM

TUBE LIKE DIGESTIVE SYSTEM, i.e.

Digestive cavity is separated from body cavity.

It has both openings, mouth and anus.

"Complete" digestive sytem

This one way tube is known as GASTRO-INTESTINAL TRACT (GIT)

ORGANS OF GASTRO-INTESTINAL SYSTEM

The adult digestive system is a tube approximately 4.5m (15ft) long and comprises of

(A) G I T

1. MOUTH
2. ORAL CAVITY -> TEETH, TONGUE
3. PHARYNX
4. OESOPHAGUS
5. STOMACH
6. SMALL INTESTINE -> DUODENUM, JEJUNUM, ILEUM
7. LARGE INTESTINE -> CAECUM, RECTUM, COLON
8. ANUS -> PAROTID

(B) ASSOCIATED GLANDS

1. SALIVARY GLANDS -> SUBLINGUAL,

SUBMANDIBULAR
2. LIVER
3. PANCREAS

(1) MOUTH

The anterior or proximal opening of gut, which is bounded anteriorly by lips. It opens into oral cavity.

FUNCTION

1. Lips close the mouth.
2. Lips also help in ingestion.

(2) ORAL CAVITY

It is a wide cavity supported by bones of skull

BOUNDARIES

- Cheeks form side walls.
- Tongue forms floor
- Palate forms roof
- Jaws form roof boundary of mouth.

+ JAWS

Upper jaw is fixed while lower jaw is moveable. Both jaws bear teeth.

CONTENT OF CAVITY

Teeth and Tongue

+ TEETH

"The hard calcified structures, meant for mastication (chewing)"

NUMBER OF SETS

Humans have 2 sets of teeth ® DIPHYODONT

(1) DECIDUOUS

The 20 teeth of first dentition, which are shed and replaced by permanent teeth.

(2) PERMEMANT

The 32 teeth of second dentition, which begin to appear in human at about 6 year of age. It consisting of 8 incisors, 4 canines, 8 premolars and 12 molars.

+ Molars are absent in deciduous set.

HETERDONT They are embedded in gums -> THECODONT

STRUCTURE OF A TOOTH

Each tooth consist of 3 parts

1. CROWN
2. NECK
3. ROOT

FUNCTIONS

1. Incisors are cutting and biting teeth. Their flat sharp edges cut food into smaller pieces.
2. Canines are pointed teeth and poorly developed in humans. They are used in tearing, killing and piercing the prey.
3. Premolars and Molars are grinders and used for crushing the food.
4. Mastication increases surface area of food for action of enzymes.
5. If one attempt to swallow a food particle too large to enter ocsophagus, it may block the trachea and may stop ventilation.

"DENTAL DISEASES"

PLAQUE

"A mixture of bacteria and salivary materials"

OR

"A soft thin film of food debris, mucin and dead epithelial cells deposited on teeth, providing medium for growth of bacterias"

Plague plays an important role in development of dental caries, periodontal and gingival disease. Calcified plaque forms dental calculus.

PERIODONTAL DISEASES

Accumulation of plaque causes inflammation of gums. Continuous inflammation may spread to the root of tooth and destroy peridental layer. Eventually tooth becomes loose and falls off or may have to be extracted.

DENTAL CALCULUS

Plaque combine with certain chemicals in saliva which become harden and calcified forming deposits of calculus which cannot be removed by brushing.

DENTAL CARIES

When bacteria of plaque converts sugar of food into acid, the enamel (hardest substance of body, covers dentin of crown of teeth) is dissolved slowly. When dentine and pulp are attached, produce toothache and loss of teeth.

FACTOR CAUSING DENTAL CARIES

- Prolonged exposure to sugary food stuff.
- Disturbance of saliva composition
- Lack of oral hygiene
- Low levels of fluoride in drinking H2O

PREVENTION

- Add 'flouride' in drinking H2O or milk
- Take 'flouride' tablet
- Use 'flouride' tooth paste.

TONGUE

Tongue is a muscular fleshy structure forming floor of oral cavity. Tongue has

- a root
- a tip and
- a body

It is attached posteriorly and free anteriorly

TASTE BUDS

- Taste buds respond to sweet, salt, acid and bitter taste, only when these substances are dissolved in H2O of saliva.
- Taste buds are most numerous on sides of vallate papillae. They are absent on mid dorsal region of oral part of tongue.

TONGUE PAPILLAE

Papillae are projections of mucous membrane which gives characteristic roughness to the tongue. These are of 3 types

- VALLATE PAPILLAE
- FUNGIFORM PAPILLAE
- FILLIFORM PAPILLAE

FUNCTIONS

1. Its function is 'Spoon-like'.
2. It mixes the masticated food with saliva
3. It helps in swalloing
4. It helps in sucking and testing food.

SALIVARY GLANDS

3 pairs of salivary glands.

(1) PAROTID

Lies at base of pinnae.
It is supplied by IX cranial nerve.

(2) SUB LINGUAL

Lies at base of tongue.
Supplied by VII cranial nerve.

(3) SUB MANDIBULAR

Lies at base of lower jaw.
Supplied by VII cranial nerve

FUNCTION

These three pairs produce about 1.5dm3 of saliva each day. These glands are supplied by Parasympathetic Nervous System. Fibers of parasympathic N.S lie in Cranial nerves. These nerves increase their secretion.

SALIVA

It is a watery secretion containing 95% H2O, some mucous, amylase and Lysozyme enzyme.

- Salivation is brought about by "Parasympathetic Nervous System."
- Saliva is secreted in response to the sight, thought, taste or smell of food.

FUNCTIONS

1. Mucous of Saliva moistens and lubricates the food particles prior to swallowing.
2. Salivary Amylase or Ptylin begins digestion of starch, first

to dextrins and then to maltose (dissacharide).
3. Lysozyme destroys the oral cavity pathogen bacteria. It has a cleansing action.
4. Water in Saliva, dissolve some of the molecules in food particle then they react with chemo receptors in taste buds, giving sensation of taste, hence, the H2O enables taste buds to respond.
5. Saliva is fully saturated with calcium and this prevents decalcification of teeth.
6. Saliva makes speech possible by moistening the mouth; it is not possible to talk if the mouth is dry.
7. It acts as a lubricant and enables a bolus (a rounded mass of semi-solid, partially digested food particles stick together by mucus) to be formed. The tongue pushes bolus into pharynx.

3. PHARYNX

The musculo-membranous passage between mouth and posterior nares and the larynx and oesophagus.

OPENINGS

It contains opening of oesophagus, glottis, Eustachian tube and internal nostrils.

PARTS OF PHARYNX

NASOPHARYNNX

The part above the level of soft palate is NASOPHARYNX, which communicates with auditory tube.

OROPHARYNX

It lies between soft palate and upper edge of the epiglottis.

HYPOPHARYNX

It lies below the upper edge of epiglottis and opens into larynx and oesophagus.

FUNCTION -> SWALLOWING

Swallowing in its initial stages is voluntary but involuntary afterwards.

MECHANISM

1. As the bolus of food moves into the pharynx, the soft

palate is elevated and lodges against the back wall of pharynx sealing the nasal cavity and preventing food from entering it.

2. The swallowing center inhibit respiration, raises the larynx and closes the glottis (opening between vocal cords), keeping food from getting into trachea.

3. As the tongue forces the food further back into the pharynx, the bolus tilts the epiglottis backward to cover the closed glottis.

4. This pharyngeal act of swallowing lasts about 1 second.

4. OESOPHAGUS

This is a narrow muscular tube of about 25cm long. It connects pharynx to stomach. It passes through the thoracic cavity and penetrates the diaphragm, then it joins the stomach a few cms below the diaphragm.

MUSCLES OF OESOPHAGUS

Upper-one third is surrounded by skeletal muscles.

Lower two-third is surrounded by smooth muscles.

SPHINCTERS (MUSCULAR VALVES)

1. Skeletal muscles, just below pharynx surrounding oesophagus form Upper Oesophageal Sphincter.

2. Smooth muscles, last 4 cm of oesophagus forms Lower Oesophageal Sphincter. It seals the exit of food.

FUNCTION

It conveys the food or fluid by Peristalsis.

PERISTALSIS

Alternate rhythmic contraction and relaxation waves in the muscle layers surrounding a tube are called Peristaltic Waves.

It is the basic propulsive movement of GIT.

STIMULUS

Distention of oesophagus.

TIMING

An oesophageal peristaltic wave takes about '9 sec' to reach stomach. Bolus is moved toward stomach by progressive

peristaltic wave which compresses the lumen and forces the bolus ahead of it.

ANTI-PERISTALSIS

Peristalsis in opposite direction, i.e. from stomach towards pharynx.

STIMULUS

- Early stages of GIT irritation.
- Over distention.

VOMITING

Anti peristalsis begins to occur, some minute before vomiting appears. The initial events of anti peristalsis may occur repeatedly without vomiting, called RETCHING. 1. Vomiting begins with a deep inspiration, closure of glottis and elevation of soft palate.

2. Abdominal and thoracic muscles contract, raising intradominal pressure.

3. Stomach is squeezed, lower oesophageal sphincter relaxes allowing expulsion of stomach content into oesophagus in form of VOMITUS.

5 OESOPHAGUS

Stomach is a hollow, muscular, distensible bag like organ.

LOCATION

Lying below the diaphragm on the left side of abdominal cavity.

STRUCTURE

It has 3 regions.

1 CARDIAC REGION

This is the anterior region which joins the oesophagus through a cardiac sphincter. It has muscous glands which helps in lubrication of food.

2 BODY

The middle portion is body of stomach. The part to the left and above the entrance of oesophagus is called FUNDUS of stomach. Body of stomach contain gastric glands. Gastric glands contain 3 types of cells.

MUCOUS CELLS

- These cells are present at opening of gastric glands and secrete mucous.
- It lubricates the food and passage.
- It also protects the epithelium from self digestion by pepsin.

OXYNTIC / PARIETAL CELLS

- They lie deeper within the glands and secrete dilute HCl having a pH of 1.5 – 2.5.
- Kills microbes
- Solublization of food particles.
- Activate the inactive enzyme pepsinogen into Pepsin.

CHIEF CELL / ZYMOGEN CELLS

- Deeper in the glands and secrete enzyme precursor Pepsinogen.
- After converting into Pepsin, it acts upon proteins and convert them into short chain polypeptides, Peptones.

The collective secretion of the above mentioned 3 cells is called as GASTRIC JUICE

PYLORIC REGION

The posterior region is the terminal narrow pyloric region or Antrum. It opens into duodenum through pyloric sphincter / pylorus.

ITS SECRETION -> GASTRIN

This region does not secrete acid. It secretes mucous, pepsinogen and a hormone GASTRIN. Endocrine cells which secrete GASTRIN are scattered throughout epithelium of antrum.

STIMULUS

Partially digested proteins.

ACTION

Activate gastric glands to produce gastric juices.

"RENIN"-ADDITIONAL ENZYME IN INFANT

In infants, RENIN is secreted which curdles the milk.

FUNCTION OF STOMACH

(1) STORAGE OF FOOD

Pylorus acts as a valve and retain food in the stomach for about 4 hours. Periodic relaxation of pylorus releases small quantities of chyme into duodenum.

(2) MECHANICAL DIGESTION

The weak peristaltic waves also called mixing waves move along the stomach wall once every 20 seconds. These waves not only mix the food with secretions but also move mixed contents forward.

(3) CHEMICAL DIGESTION

Gastric juice converts food to a creamy paste called CHYME.

6. SMALL INTESTINE

The small intestine is a coiled tube approximately 6 meters long and 2.5 cm wide, leading from stomach to large intestine. It fills most of the abdominal cavity.

DIVISIONS

There are 3 divisions.

A. DUODENUM

It begins after pyloric stomach and ends at jejunum. Its length is about 30cm.

SECRETION

Pancreatic juice from pancreas by pancreatic duet and bile from gall bladder by common bile duct act on chyme from stomach. Both ducts open via a common opening in duodenum.

BILE

SYNTHESIS, STORAGE AND SECRETION

Bile is made in liver and enters the duodenum via the bile duct. It stores in gall bladder.

COLOUR

Bile is yellow in colour but changes to green due to exposure to air.

CONSTITUENT

- Water.

- Bile Salts

+ *BILE SALTS*

These are sodium salts of compounds of cholestrol. NaHCO3 is also present which neutralizes the acidity of gastric juice and make the chyme alkaline.
The main bile salts are for emulsification of fats.
EMULSIFICATION Break down of large fat particles into small droplets so that they can mix well with H2O to form emulsions.

+ *BILE PIGMENTS*

BILIRUBIN and BILIVERDIN are excretory products formed by breakdown of haemaglobin of worn out RBCs in the liver.

ACTION OF 'CHOLECYSTOKININ (CCK)'

CCK is a hormone and produced by cells of small intestine.

STIMULI FOR HORMONE RELEASE

Fatty food in duodenum.

ACTION

CCK is released in blood and reaches to gall bladder and causes it to contract. Due to contraction of gall bladder, bile enters the duodenum.

'PANCREATIC JUICE'

Pancreatic juice is produced in pancreas by its exocrine function and secreted via pancreatic duct. It is a colourless fluid.

ACTION OF SECRETIN

Secretion is also a hormone and produced by cells of small intestine.

STIMULI

Acid (HCl) carried with chyme in small intestine.

ACTION

It increases the secretion of pancreatic juice and also increases bicarbonate secretion in bile.

CONSTITUENTS

(1) TRYPSIN (PROTEASE)

It is secreted in an inactive form called Trypsinogen which is

activated by action of an enzyme produced by duodenum called enterokinase.

ACTION

Break proteins and long chain polypeptides into small peptide fragments.

(2) CHYMOTRYPSIN (PROTEASE)

It is also secreted in inactive form, Chymotrypsinogen which is converted into chymotrypsin by action of Trypsin.

ACTION

Converts casein (milk proteins) into short chain peptide.

(3) AMYLASE

It is similar to salivary amylase. It acts on polysaccharides (Glycogen and Starch) and convert them into maltose (a disaccharide).

(4) LIPASE

It acts on emulsified fat droplets. It splits off lipid into fatty acid and glycerol, hance the digestion of fat is completed in duodenum.

(B) JEJUNUM

It extends from duodenum to illeum. It is 2.4 meters long. Here the digestion of food is completed.

COLLECTION OF PEPTIDASES, EREPSIN

Peptidases complete the breakdown of polypeptide into amino acids.

NUCLEOTIDASE

It converts nucleotides into nucleoside. End products of digestion, i.e, monosaccharide and A.As are liberated in lumen of small intestine for absorption in ileum.

(C) ILEUM

It is the last and longest part of small intestine. Its length is about 3.6 meters long. It contains digested food in true solution form.

STRUCTURE

The inner wall (Mucosa and Submucosa) of small intestine is

thrown into various folds. These folds have finger-like microscopic projections called villi.

VILLI

Each villus is lined with epithelial cells having microvilli on their free surfaces.

Their walls are richly supplied with blood vessels and lymph vessels called Lacteals. Some smooth muscles are also present in villi.

MECHANISM OF ABSORPTION

Major function of ileum is absorption of digested food, which is facilitated by highly folded inner wall of intestine with villi on their surfaces.

This increases the absorptive area. Villi are able to move back and forth due to muscle fibers in them.

- The monosaccharide and A.As are absorbed into blood capillaries by Diffusion or Active Transport.
- Fatty acid and glycerol enter epithelial cells of villi, covert into triglycerols and enters Lacteals and pass into blood stream.

BLOOD DRAINAGE OF INTESTINE

All capillaries converge to form hepatic portal vein, which delivers absorbed nutrients to liver.

7. LARGE INTESTINE

Small intestine opens into large intestine, which is a large diameter tube about 6.5 cm. It is not coiled by relatively has 3 straight segments.

+ Caecum
+ Colon
+ Rectum

+ CAECUM

Caecum is a blind ended pouch placed in the lower right side of abdominal cavity. It gives a 10cm long finger like projection, Appendix. Appendix is a vestigial organ, i.e. an organ present in rudimentary form and has no function but has well developed function in ancestors.

FUNCTION

Symbiotic bacteria, present in caecum, help in digestion of cellulose, which is not digested by man, as enzyme for digestion is absent.

+ COLON

Colon is longest part and has 3 regions :

+ Ascending colon
+ Transverse Colon
+ Descending Colon

-> SIGMOID COLON is terminal part of Descending Colon.

FUNCTION

Inorganic salts, water and mineral absorbed in colon. Some metabolic waste products and excess calcium of body as salts are excreted into large intestine. Each day 500 ml of intestinal content enter the colon and during its passage the amount reduced to 150 ml due to absorption of H2O.

+ RECTUM

Rectum is last portion, it stores faeces for some time. When the faeces enter into rectum, it brings about a desire for defecation. The process by which faeces passes out is called Egestion.

SYMBIOTIC BACTERIA

Many symbiotic bacteria in large intestine provide the body with a source of vitamin and A.As, especially vitamin B complex and K, which are absorbed in blood stream. Administration of Broad-spectrum antibiotics destroys these bacteria and a vitamin deficiency results, which is then make up by vitamin intakes.

8. ANUS

External opening of digestive system is ANUS.

SPHINCTERS

Two sphincters surround the anus:

+ Internal Sphinter -> made up of smooth muscle and under Autonomic control (involuntary control).

+ Outer Sphincter -> made up of skeletal muscle and under Somatic Control (voluntary control).

FAECUS

Faecus consists of:

Dead bacteria, cellulose, Plant fibers, dead mucosal cells, mucous, cholesterol, bile pigment derivatives and H2O.

(DIAGRAM "DIGESTIVE SYSTEM" FROM BOOK XI)

9. LIVER

Liver is the largest organ and gland of body. It weighs about 1.5 kg . It is also called 'HEPAR'.

COLOUR

It is reddish brown in colour.

LOCATION

It lies below the diaphragm on right side.

LOBES OF LIVER

Liver has 2 lobes, i.e. Right and Left. Left is further divided into two lobes.

FUNCTIONS OF LIVER

'AS A METABOLIC FACTORY'

It maintains the appropriate level of nutrients in blood and body. It is performed in 3 ways.

A. GLUCOSE METABOLISM

1. Additional (Surplus) Glucose is converted into Glycogen by action of INSULIN after every meal. This is called Glycogenesis.
2. Glycogen is splitted into Glucose for body needs. This is called Glycogenolysis.
3. New glucose for body requirement is formed by non-carbohydrate compounds. This is called Gluconeogenesis.

B. A.AS METABOLISM

A.As are also stored after deamination (removal of NH2 group), which forms Urea.

C. FATTY ACID METABOLISM

It also processes F.As and stores the products as Ketone Bodies, which are released as nutrients for active muscles.

'AS A DETOXIFICATION CENTER'

Poisons and toxic substances, which can harm the body, are degraded into harmless compounds. It excrete out bile pigments and waste products.

'AS A STORAGE ORGAN'

It stores vitamins and also produces proteins and coagulating factors of blood.

GALL BLADER

It lies on undersurface of liver, a pear shaped organ.

FUNCTION

It concentrates and stores the bile secreted by liver.

BILIARY TRACFT

Two hepatic ducts from liver bring bile and join the cystic duct from gall bladder. This form common bile duct, which joins Pancreatic duct coming from pancreas bringing pancreatic juice. These 2 ducts open into duodenum at same opening.

10.PANCREAS

A large elongated gland situated transversely behind the stomach, between spleen and duodenum.

PARTS OF PANCREAS

HEAD

It is the right extremity and directed downwards.

TAIL

Left extremity is transverse and terminates close to spleen.

BODY

The main portion in middle.

DUCT

Pancreatic duct opens into duodenum with common bile duct and delivers pancreatic juices.

WORKING AS A GLAND

It works both as an endocrine and exocrine gland.

ENDOCRINE PANCREAS

Endocrine part consists of ISLETS OF LANGERHANS.
The islets contain.

α cell (ALPHA)
Produce GLUCAGON which increases blood glucose level.
β cell (BETA)
Produce INSULIN which reduces blood glucose level.
Δ cell (DELTA)
Produce Somatostatin (SS) which inhibit the release of many harmones.
P P cells
Secrete pancreatic polypeptide.
EXOCRINE PANCREASE
The exocrine part consists of pancreatic acini. Acini are secretory unit that produce and secrete pancreatic juice into duodenum which contain enzymes essential to digestion.
DISORDERS OF 'GIT'
(1) DIARRHOEA
Abnormal frequency and liquidity of fecal discharges. It is the rapid movement of fecal matter through large intestine.
CAUSES
ENTRITIS
It may be caused by infection of intestinal wall (mucosa) by a virus or bacteria. Due to infection, mucosa becomes irritated and motility of intestinal wall increases.
CHOLERA
Cholera is a bacterial disease caused by VIBRIO CHOLERA. It can cause diarrhoea. It causes extreme amount of HCO_3^- (bicarbonates ion) and Na and H_2O to be secreted in faeces. It may causes death.
PSYCOGENIC DIARRHOEA
It is caused by nervous tension. In the young and elderly, diarrhoea may lead to a serious depletion of H_2O and inorganic salts.
(2) DYSENTARY
Acute inflammation of intestines especially of the colon.
SYMPTOMS

Pain in abdomen, tenesmus (straining), frequent stool containing blood and mucus.

CAUSES

PROTOZOA. (like amoebic dysentery)

- PARASITIC WORMS.
- BACTERIA. (like bacillary dysentery)
- CHEMICAL IRRITANTS.

(3) CONSTIPATION

Infrequent or difficult evacuation of faeces. OR Slow movement of faeces through large intestine.

Faeces becomes hard due to long time available for H_2O absorption.

CAUSE

Irregular bowel habits that have developed through a life time of inhibition of normal defection reflaxes.

TREATMENT

- Laxatives are used
- Substance which hold H_2O with them

(4) PILES

Also called HAEMORRHOIDS Varicose dialatation of veins occurring in relation to anus, resulting from a persistence increase in pressure.

EXTERNAL PILES

Venous dialatation covered with modified anal skin.

INTERNAL PILES

Dilatation of veins covered by mucous membrane.

CAUSE

CONSTIPATION

The pressure exerted to defecate stretches skin with vein and causes dilation.

PREVENTION

Can be avoided by regular habit of defecation and by use of fiber diet.

(5) DYSPEPSIA

Impairment of the power or function of digestion, usually applied to epigastria discomfort following meals.

CAUSE

May be due to peptic ulcer.

SYMPTOMS

- Heart burn.
- Flatulence (distended with gas)
- Anorexia, nausea, vomiting with or without abdominal pair.

FUNCTIONAL / NON-ULCER DYSPEPSIA

Dyspepsia in which symptoms resemble those of peptic ulcer, although no ulcer is detectable. It is caused by disturbance in moter function of alimentary tract.

(6) PEPTIC ULCER

Since pepsin, is a protein digesting enzyme, it may digest the stomach wall, the first part of duodenum or rarely lower part of oesophagus where stomach juices frequently refluxes. This condition is called Peptic Ulcers.

- GASTRIC ULCERS
- DUODENAL ULCERS

CAUSES

- Excessive secretion of acid and pepsin.
- It may be hereditary.
- Psychogenic factors.

COMPLICATIONS

Complications of peptic ulcers are perforation, haemorrhage and obstruction. INVESTIGATIONS

1. Acid output of stomach is studied.
2. Ulcers cavity may be shown up on X-rays after ingestion of insoluble barium sulphate (Barium meal).
3. It may be seen using optical instrument passed down through oesophagus (endoscopy)

(7) FOOD POISONING

Also called GASTRO-ENTRITIS

CAUSES

INFECTION

By bacteria, virus, protozoa. 'Salmonella' species are very common.

NON-INFECTIOUS

Allergy, irritating food or drink.

SYMPTOMS

Vomiting and diarrhoea within 48 hours.

(8) MAL NUTRITION

Any disorder of nutrition due to unbalanced diet or due to defective assimilation or utilization of foods.

An organism may be deficient or may receives excess of one or more nutrients for a long period of time.

UNDER NUTRITION

Deficiency is known as under-nutrition. It is most common problem of under developed countries.

OVER NUTRITION

Excess is known as over-nutrition. Obesity with heart problems and reduced life expactency are its symptoms and are more common in developed countries.

(9) OBESITY AND OVER WEIGHT

Increase in body weight beyond the limitation of skeletal and physical need as the result of accumulation (excessive) of fat in the body.

It is the most common nutritional disorder. It is most prevalent in middle age. It may be hereditary or family tendency over weight results in rate of mortality.

(10) ANOREXIA NERVOSA

Loss or lack of appetite for food is called Anorexia.

ANOREXIA NERVOSA

An eating disorder affecting young females, characterized by refusal to maintain a normal minimal body weight, intence fear of gaining body weight, intense fear of gaining weight or becoming obese. Sometimes accompanied by spontaneous or induced vomiting.

(11) BULIMIA NERVOSA

Exclusively found in women and the age of onset is slightly older than for anorexia.
Recurrent episodes (bouts) of binge (uncontrolled) eating.
Lack of self control over eating during binges.
Attacks occur twice a week and involve rich foods such as cakes and chocolates and dairy products.

Digestive System of Cockroach

NUTRITION
OMNIVOROUS, i.e. It can eat any kind of organic matter.
They search their food by antennae.
TYPE OF DIGESTIVE SYSTEM
TABULAR DIGESTIVE SYSTEM, i.e. straight slightly coiled dig tube, open at both ends, complete dig. system.
ORGANS OF DIGESTIVE SYSTEM
+ ALIMENTARY CANAL
It is divisible into 3 parts
1. FORE GUT / STOMODAEUM

- MOUTH
- BUCCAL CAVITY
- OESOPHAGUS
- CROP
- GIZZARD

2. MIDGUT / MESENTERON / VENTRICULUS

- HEPATIC CAECA

3. HIND GUT / PROCTODAEUM

- ILEUM
- COLON
- RECTUM
- ANUS

+ ASSOCIATED GLAND

- SALIVARY GLANDS

1.FORE GUT
MOUTH

It lies at base of pre-oval cavity which is bounded by mouth part.

LABRUM / UPPER LIP

Appendage of 3rd head segment.

MANDIBLES

Appendage of 4th head segment. They help in mastication

MAXILLAE

Appendages of 5th head segment. They pick up and bring food.

LABIUM / LOWER LIP

Appendages of 6th head segment.

BUCCAL CAVITY

The mouth opens into buccal cavity which is short and receives the common duct of salivary glands.

Saliva cantain 'AMYLASE' which act upon carbohydrates.

OESOPHAGUS

Buccal cavity opens into pharynx which in turn opens into oesophagus which is a long and thin tube lying in thorax.

CROP

It is a large thin walled and pear shaped structure meant for storing food.

GIZZARD

Crop opens into thick walled, rounded gizzard with muscular chitins lining which is internally produced six teeth for grinding and straining the food.

2. MID-GUT

It is narrow, short and tubular portion originate from gizzard. At beginning it receives eight hepatic caeca hanging in haemocoel (body cavity filled with white colour blood), ending blindly but opening in gut.

ENZYMES FROM HEPATIC CAECA

They are lined by glandular cells, which secrete enzymes. Enzymes from hepatic caeca and mid-gut flow back into crop where digestion takes place.

ENZYMES

1. PEDTIDASES AND TRYPSIN LIKE ENZYME -> digest proteins.
2. AMYLASES -> complete digestion of starches
3. LIPASE -> digestion of fats.

Digested food form a bolus and enclosed in a thin chitinous tube secreted by stomodael valve of gizzard. This covering is called PERITROPHIC MEMBRANE.

It is permeable to enzymes and digested food. This membrane protects the lining of mid gut from damage by hard indigestible components of food.

Digested food is absorbed in mid gut.

3. HIND-GUT

It has a cuticular ectodermal lining.

ILEUM

Short, narrow and muscular ileum. The beginning of ileum is marked by 60-70 fine and long, greenish yellow MALPHIGIAN TUBULES. (excretory in function)

COLON

Colon is long, wider and coiled portion of hind gut

RECTUM

Rectum is broad last part of hind gut. It absorbs H_2O and conserves the much needed H_2O from undigested food before expelling out the faeces.

ANUS

Anus is the last opening of digestive system by which hind gut opens to outside.

SALIVARY GLANDS

Salivary glands are 2 in number. each present on the sides of oesophagus. Saliva contain amylase for digestion of carbohydrates.