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Digestive physiology of fish

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Digestive physiology of fish

The hypothalamus has been implicated as one of the major control centre of appetite regulation.

The hypothalamic control of appetite will be of 2 types.

Chemostatic hypothesis:

The hypothalamus is sensitive to circulating blood nutrient levels, such as sugar or lipid.

When these levels become too low, the hypothalamuses send signals to begin eating.

Once the blood nutrient is elevated, stimuli from the feeding centre are inhibited.



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Thermostatic hypothesis:

The hypothalamus plays an important role in hunger regulation

decrease in hypothalamic temperature will induce eating.

Factors like distention of digestive tract, habits, living environment, stress and anxiety, physiological factors such as disease and pollution may alter appetite.



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- Olfaction, chemical sense, lateral lines, eyes auditory system helps to locate a prey.
- Finally the taste buds help to screen the final food
- The feeding quantity differ based on
- circadian rhythm
- behaviour – nocturnal and diurnal
- season –
- migration –
- Reproduction cycle
- Feed (nutritive) quality



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Mouth

Mouth is playing role is

Prehension – the act of bringing food into mouth

Mastication – the act of physical grinding and tearing and food

Digestion – the act of swallowing

The mouth parts also helps to separate nutritive food from non nutritive debris. This process is called winnowing.

pharyngeal jaws; the food plant particles are finely grounded and it passes directly into the approximately slightly neutral or slightly alkaline intestine.



Digestive fluids and enzymes

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A. Gastric secretions

a. Hydrochloric acid

The hydrochloric acid is produced by parietal type of cells (or oxyntic cells) stomach.

The stomach pH varies between 3.0 to 5.0 and in Tilapia it was recorded as 2.0.

This chemical and other enzymatic trituration is termed as type I mechanism of digestion.



Digestive fluids and enzymes

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Enzymes

- Gastric fluid contains several types of protease especially acid protease.
- It is secreted by gastric gland cells (chief cells or peptic cell) as a zymogen called pepsinogen
- During the activation process aminoacids are split off from the NH_2 – terminal end of the molecule as a mixture of peptides.
- A few non-proteolytic enzymes like Amylase, esterase, chitinase also noted in gastric mucosa.
- Cellulase is not observed in fish.
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B. Pancreatic secretions

Pancreatic juice is rich in enzymes (mostly as zymogens) which serve in digestion of protein, carbohydrate, fat and nucleotides.

The pancreatic juice contains bicarbonate that neutralize hydrochloric acid entering the intestine.

By way of emelocytosis (cell vomiting) the pancreatic juice is poured in intestine.



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B. Pancreatic secretions....

• **Proteases**

- Trypsin, chymotrypsin, carboxy peptidase and elactaze are stored in the pancreatic cells as proenzymes or inactive zymogen granules.
- Trypsin is formed by removal of a hexapeptide from the trypsinogen molecule as a result of the hydrolysis of a lysine-isoleucine bond.
- Trypsin is an endopeptidase with optimal action at pH of about 7.
- Trypsinogen or trypsin, has been found in intestinal wall and from intestinal ceca of various teleosts
- Chymotrypsin is formed by the action of trypsin on chymotrypsinogen.



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B. Pancreatic secretions

Amylase has been found in all parts of the digestive tract.

- In tilapia the amylase has a pH optimum at 6.7 and the pH of the stomach is too low for the enzyme to show appreciable activity.

Chitinase

Lipase



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Bile

Usually the bile is stored in a gall bladder with contractile walls.

- By contraction of the smooth muscles of the gall bladder the bile is ejected into the lumen of the intestine.
- concentrated bile in gall bladder contains bile salts, cholesterol, phospholipids, bile pigments, organic anions, glycoproteins, and inorganic ions.
- Bile salts are special types of steroids which are synthesized in the liver from cholesterol.



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Intestinal enzymes

Digestive enzymes produced by intestinal cells are located mainly in the brush border of the epithelium.

The intestinal mucosa produce aminopeptidases, di- and tripeptidases,

alkaline and acid nucleosidases (which split nucleosides),
poly nucleotidases (which split nucleic acids),

lecithinase (which splits phospholipids into glycerol fatty acids, phosphoric acid and choline)



Regulation of secretory Activities

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a) Gastric acid secretion:

- Histamine is an effective stimulus for gastric acid secretion.
- Cerulein like peptide substance act as a 'gastrin – an intestinal hormone which also plays a role in gastric juice secretion.

b) Pepsinogen secretion

- The stomach of fishes is richly supplied by vagal fibres which in turn influence the production of pepsinogen.

c) Pancreatic secretion

- The anterior intestine and stomach induce pancreatic exocrine by “secretin” hormone which induce the secretion of pancreas.

d) Secretion and Release of bile

- Release of bile into the intestine is produced by contraction of the smooth muscles of the muscularis of the gall bladder.

f) Intestinal micro-organisms :-

- Chitinolytic bacteria



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Digestion and Absorption

Protein

Digestion of protein begins in the stomach.

The endopeptidase activity of the gastric juice renders protein soluble and more readily digested by pancreatic and intestinal proteases.

- In intestinal digestion of proteins, trypsin and chymotrypsin from the pancreas.

Enzymes such as elastase and collagenase attack special proteins.

The protein digestion leads to a mixture in the intestinal lumen of low molecular peptides and amino acids.



Digestion and Absorption

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- Mostly absorption of the products of digestion takes place by diffusion and by active transport (movement of nutrients across a membrane against concentration gradient).
- The degraded products of protein are absorbed from the intestinal content as amino acids or peptides.
- Individual amino acids are absorbed against concentration gradient and their absorption is coupled to transport of inorganic ions.
- Some fractions of peptides can also be absorbed by pinocytosis. (Pinocytosis is (cell drinking) is the process by which dissolved materials are taken into the cells through an invagination and subsequent dissolving of a part of the cell membrane.



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b. Fat

Lipase hydrolyze neutral fat (triglycerides) into diglycerides, monoglycerides, glycerol and free fatty acids.

The epithelial cells of the anterior part of intestine absorb lipids.

The absorbed fat is transported from the intestine mainly by lymph in chyle vessel (lacteals).



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Carbohydrate

Carbohydrate- digesting enzymes from the pancreas and in the intestinal epithelium transform oligo and polysacharies into hexose and pentose.

Some are digested by enzymes (like cellulose, chitinase) produced by micro organisms

Simple sugars are absorbed by the intestinal epithelium occurs by an active mechanism and can take place against considerable concentration gradient.

Glucose absorpition occurs primarily anterior intestine.



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Salt and water

Freshwater teleosts drink little water but marine teleosts continuously drink water.

The absorption of water by the fish intestine is secondary to active transport of sodium.

Calcium

Iron



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Enzymes in digestion

Enzymes	Source site of secretion	Site of action	Substrate	End producer
Pepsin	Stomach	Stomach	Protein (ends)	peptides
Trypsin	Pancreas	Intestine	Protein peptides (ends)	peptides
Chymotrypsin	Pancreas	Intestine	Protein peptides (ends)	peptides
Carboxy peptidase	Pancreas	Intestine	Protein peptides (ends)	Amino acids and peptides
Aminopeptidase	Intestine	Intestine	Protein peptides (ends)	Amino acids and peptides
Di-tri peptidase	Intestine	Intestine	Diltri peptides	Amino acids
Lipase	Pancrease	Intestine	Triachyl glycerol	Fatty acids monoacyl glycerols



Gastro intestinal hormones

Hormone	Origin	Stimulant	Physiological function
Gastrin	Pancreatic islets	Presence and protein in stomach	Stimulate gastric acid (Hcl) and pepsin
Enterogastron	Intestine	Fat	Inhibit gastric acid (Hcl)
Chole cystokinin	Intestine	Presence of fat and protein digestive products	Secretion of pancreatic enzymes
Secretinin	Intestine	Presence of acid and protein	Secretion of pancreatic fluid
Enterocrinin	Intestine	Presence of chyme	Secretion of intestinal enzymes
Villikinin	Intestine	Presence of chyme	Increase contraction of villi
Glucogen like Immuno reactive factor	Intestine	chyme	Increase insuline secretion
Cerulean like substance	Stomach		
Histamine	Stomach/intestine		