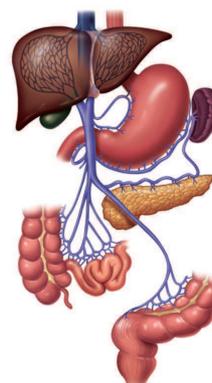


Chapter

7



Coordination in life processes

Human body is a wonderful machine. It is a complicated structure than it appears. Did you ever imagine the complexity of your body? Different life processes in living organisms like respiration, digestion, blood circulation, excretion, nervous system etc., are inbuilt in our body at their specific places and carry out their specific functions. We have studied each of the processes in detail nearly in isolation except in the chapter on ‘Control and Coordination’. There we studied how several functions of our body go on in a coordinated manner. In this chapter, we shall study one of the life processes to show how complex the relation between different systems are and how the processes are integrated in the living body.

Let’s recall the parts of the digestive canal or gut, that are involved in the digestive process where the food is broken down at different stages.

- Write down the parts of the gut where the journey of food starts from mouth to anus.
- Which life \ processes would be involved in the breakdown of food in the stomach?
- If any of those processes fail to function, what effect would it have on our body?

Every process is dependent on other to keep the body in good condition. To understand this concept we analyze how digestive system is coordinated with other systems as an example. We shall study the digestive system from feeling hungry to utilization of food , illustrating the interconnected processes going on in our body.

Feeling Hungry

- Why do we feel hungry?
- What is the cause of sensation of hunger?
- How do we know that we need food?

Activity-1

Let us observe the following table. Identify and *tick* the causes for hunger in your point of view- and discuss with your group.

Table 1

Smell of food	Taste of food	Sight of food	Being tired and exhausted	Need of food	Thought of food

- What factors stimulate hunger?
- What would be the resultant of stimulation of hunger?
- Which system do you think would send the signals to make us realize that we are hungry?

Well, a major cause for feeling hungry is the secretion of the hormone “Ghrelin” in the stomach when it goes empty. Ghrelin is secreted from certain cells in the wall of the stomach. Hunger contractions (hunger pangs) start to occur in the stomach due to hunger generating signals that reach the brain from the stomach due to the secretion of this hormone. It is believed that the Diencephalon in fore brain and vagus nerve (10th cranial nerve) plays an important role in carrying these signals(See figure for location of vagus nerve) to the brain. Hunger pangs continue up to 30- 45 minutes. Increase in ghrelin levels results in sensation of hunger and motivation to consume food.

- Is the sensation of hunger controlled by Central Nervous system or is it by Peripheral nervous system?
- What kinds of controls are exercised during sensation of hunger? Are they hormonal or nervous or both?
- Can you suggest any 4 systems involved in the process of generating hunger sensation?

When you feel your stomach is full and there is no need of food any more, another hormone *leptin* is secreted that suppresses hunger.

Usually we take food at a particular time. Every day regularly at that time, we feel hungry. You have experienced this in your school during lunch hour. You also notice that there is a relation between hunger pangs and lunch bell.

Outcome of sensation of hunger

We find that different organ systems are involved together in the digestive process of the mouth.

Let us find more about how the organ and organ systems are involved. Feeling hungry leads us to consume food. Sometimes you may have often experienced that stale food is out rightly ejected even before intake.

- What plays a major role to identify stale food?
- If you are having a tasty dish don't you think the smell of it increases your appetite?

Taste and smell are intimately entwined. This close relationship is most apparent in how we perceive the flavors of food. Anyone with severe cough and cold can attest, food “tastes” different when the sense of smell is impaired. Actually, what is really being affected is the flavor of the food, or the combination of taste and smell. That's because only the taste, not the food odors, are being detected. Taste itself is focused on distinguishing chemicals that have a sweet, salty, sour, bitter, or umami taste (umami is Japanese for “savory”). However, interactions between the senses of taste and smell enhance our perceptions of the foods we eat.

The following activity helps us to observe how are taste is affected by the sense of smell.

Activity-2

Chewing, zeera(fenugreek), sounf(fennel seeds), potato and apple

First close your nose with your fingers. Pop in some zeera in your mouth and chew it for some time. After that, chew some sounf. Could you recognize the taste? How long has it taken to know the taste? After some time wash your mouth and repeat the activity by chewing a piece of an apple followed by a potato(remember to close your nose).

- What are your observations?

To conclude, if you want to taste the food material, the food should dissolve in saliva. On the other hand, we can taste the food that is in the

form of liquid only. We know that different types of taste buds are present on the tongue. You have also learnt about different types of papillae (taste buds) on the tongue for different tastes in ninth class. Let us recall them. Only after the dissolved food enters into the cup like taste buds, the sense of taste is carried to the brain for analysis. Then only we will know the taste of the food material.

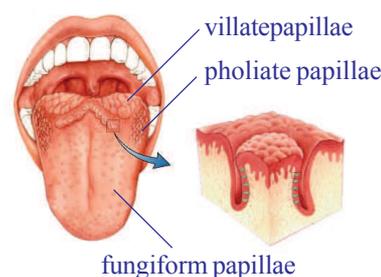


fig-1: Papillae on tongue

- Could you know the taste of both or did it taste the same? Why?

Taste and smell are closely related.

When we smell, the air borne substances get dissolved in the watery film of nasal mucus. The chemoreceptors which are otherwise called olfactory receptors present in the nose and the tongue trigger signals in the form of nerve impulses to the brain where the smell and taste is detected.

- What happens when we put a food material in our mouth?
- Name the parts in the mouth that help us to taste food.

Let's find out more about the role of these parts.

Activity-3

Take a pinch of asafoetida powder / garlic and rub it on hand kerchief/ tissue paper.

Close your eyes and smell it. Then try to identify taste of different types of food materials with the help of your friend.

- How many food materials you have identified correctly?
- Do you think that there is a relation between smell and taste?
- Can you say that a particular food is tasty just by looking at it?

Sometimes mouth starts watering just by hearing the name like tamarind/lime/mango etc.,

Now let us summarize the result of the activities with the help of your answers. In general, we prefer the food material, which is attractive to our eyes, and flavor to nose, then we taste it.

Therefore, when we eat, without our knowledge, we use our sight, nose and tongue for selecting food for ingestion.

Russian scientist Pavlov has conducted an experiments and found that even the thought of food will water your mouth (conditioned reflexes). You have discussed about Pavlov experiment in the chapter animal behavior in class 9th.

Taste is something connected to the tongue and the palate.



Do you know

Taste and temperature.

Is temperature effects our tasting ability? If you want to taste a food material, the temperature of the food should be nearer to our body temperature. If the food is too hot or too cold, we cannot find the taste properly. Try to drink a glass of warm water; we do not feel the actual taste of water. The same is the case of cool drinks or ice creams. We will be able to taste them when we keep them in our mouth for some time till it reaches to our body temperature.

Activity- 4

Sugar crystals over tongue

Place some sugar crystals on your tongue keep your mouth opened and see that your tongue doesn't touch the palate. Record the time from the moment you placed the crystals on your tongue till you got the taste by using stop watch.

Now repeat the test by placing the sugar crystals on the tongue and pressing it against the palate. Record the time from placing sugar crystals to getting the taste .Or put a drop of sugar solution on your tongue by using dropper.

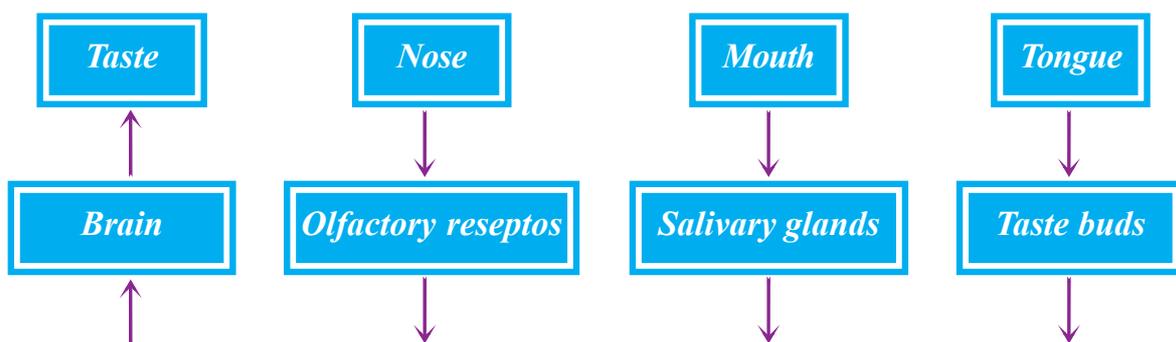
- Which way helped you taste faster ? Why?



fig-2: Tongue and palate

Taste is something connected to the tongue and the palate

Based on the above activity we know that taste can be identified easily when the tongue is pressed against the palate. As we know the tongue is sensory in function and contains taste buds. These taste buds are tiny papillae with an opening on top. Within them there are several taste sensitive cells. Any food substance when placed on the tongue gets dissolved in the



saliva secreted by salivary glands in the mouth. When the tongue is pressed against the palate the food substance is pressed against the opening of the taste bud letting it to reach the taste cells and triggering taste signals. Finally the taste is recognized in the brain.

- What pathways connected to sensation of taste does the diagram show?

Mouth the munching machine

Would you be able to comfortably munch your food if you had lost some of your teeth?

Activity-5

To show break down of food by using the model of chalkpiece kept in vinegar.

Break a piece of chalk into two halves. Crush one half to tiny pieces leaving the other as it is. Take two small mineral water bottles ($\frac{1}{2}$ ltr bottle) cut them into two equal halves and discard the upper portion. Now we have two beakers from the lower cut portion.

Fill them half with vinegar and add the crushed chalk to one beaker and the half full chalk to the other. Observe them after half an hour or so.

- Which one dissolved faster the crushed chalk or the whole one ?

The above experiment tells us the need of mechanical crushing of food. Hence the food in the mouth has to be broken down into tiny pieces to increase the surface area for action of substances that aid in digestion.

- How does this process of mechanical crushing goes on in the mouth?
- Which parts in the mouth are involved in this?
- What are the systems involved in this process?

You know that teeth helps in chewing food material. Let us know about different types of teeth in our mouth and how they helps in digestive process.

Activity-6

Observe the model or chart of jaw, how teeth are arranged? Are all the teeth similar in shape and size? Is there any relation between shape and function of the teeth? Dental formula explains the arrangement of teeth. Now fill up the following table with proper information based on the figure given here.

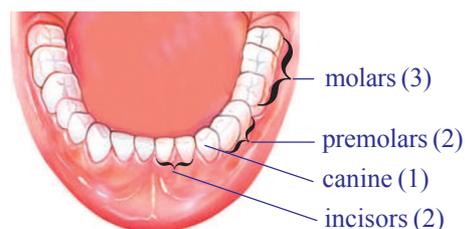


fig-3: Dentition

Table-

Name of Teeth	Number	Shape	Function

The circular muscles of the mouth enable the food to be pushed into the oral cavity and to be moved around. As the food cannot be swallowed directly the teeth grind, chew and shred. This process is called mastication. For this purpose the surface muscles of the jaw help in biting and chewing actions, while the deep muscles of the jaw move the jaw up, down, forward and backward during food mastication. You may have observed your lower jaw moving up and down as you chew food. The teeth help in cutting and grinding while tongue movements evenly spread out the food and help in mixing it with saliva. The muscles of the mouth enable the food to be pushed in the oral cavity and to be moved around. The fifth cranial nerve has been found to control the movement of muscles in the jaw.

- Does the level of saliva secretion change due to presence of food in the mouth?
- Can the process of chewing go on in the absence of saliva?
- Does the saliva have other roles to play as well?

Let us find out the role of saliva.

Activity-7

Action of saliva on flour (ata)

Take a test tube half filled with water and add a pinch of flour to it. Shake the test tube well till the flour gets mixed. Take a few drops of this in a watch glass and test for the presence of starch by putting a drop of diluted tincture iodine in it. A blue black color confirms the presence of starch. Now divide the mixture into two equal halves by transferring it to another test tube. Note that both the test tubes have the same amount of solution. Add a teaspoon of saliva to one of the test tube and mark it. Do not add anything in the other test tube. After some time (45mts) add a drop of dil. Tincture Iodine solution to test tubes containing the solution.

- Do you observe any change in the solutions? Why does the change occur?
- Do you think the same process goes on in the mouth when the food is taken?

Under the action of autonomous nervous system saliva secreted by three pairs of the salivary glands moisten the food to make chewing and swallowing easier. As a result of chewing, food forms into a slurry mass called 'bolus' that is transported into the oesophagus by the action of swallowing with the help of the tongue. The enzyme salivary amylase in the saliva breaks down the large starch molecule into smaller subunits usually into sugars. The mechanism for swallowing is also under nervous coordination and its control center is somewhere in the brain stem (medulla oblongata and others). During mastication food size become convenient to swallow.

- What is the use of such an increase in surface area of food?
- What about the nature of medium of for salivary amylase to act on food component?
- Do you think the pH of our mouth changes?

Activity-8

Testing pH of mouth at intervals of one hour.

Ask your chemistry teacher to give you a strip of pH paper with a colour chart.

You can do this in your school by taking a small piece of the pH paper and touching it to your tongue. Match the colour with the colour chart and note the pH. See to it that you are able to take some readings after having your food at lunch break. Compare your readings with that of your friend. Take at least 4 readings and draw a graph of pH against time.

- What is the usual range of pH of your mouth? Acidic or basic?
- Did you observe any change in pH? What caused the change?
- In what kind of pH do you think salivary amylase acts well?
- Does even the type of food have any role to play on the pH of our mouth?

Test with different types of food as you eat them and check just after you have swallowed them.

Do not hurry to complete the table. Take your own time.

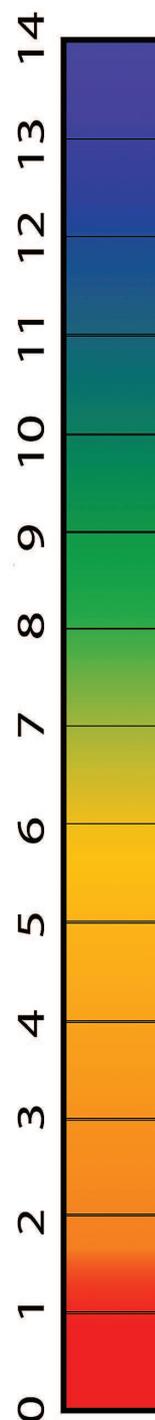


fig-4: pH scale

(pH beyond 7 is alkaline, pH- below 7 is acidic, pH 7 is neutral).

Based on the above tests we know that the saliva secreted causes the medium to change to alkaline as it aids in action of enzyme, salivary amylase.

Why do we salivate during a nap of daytime?



Do you know ?

You have heard about Nocturnal animals, which are active during nights, but we are active during daytime and take rest at night. All the systems of our body are active in function during the time of our activity. Hence, man is a diurnal animal. Our digestive system is also active and ready to receive the food for digestion. If we sleep during daytime saliva oozes out of our mouth and wets the pillows. This will not happen during nighttime.

- What are the different systems that contribute to the proper functioning of digestion in the mouth?
- After the digestive process in the mouth where does the food moves to?

Travel of food through oesophagus .

The oesophagus receives the food pushed by the swallowing action of the mouth.

- What are the systems that come into play for swallowing food?

Oesophagus is a tube like structure. Its upper end connects to pharynx and lower end connects to the stomach. When we swallow slippery food is falls down in oesophagus. Let us observe movement of food material in oesophagus.

Activity-9

Making a model of oesophagus to observe how bolus moves forward.

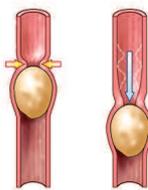


fig-5: Potato in cycle tube

Take a piece of waste cycle tube and insert one or two potatoes into it. Lubricate the inner side of the tube with oil. In the same way smear oil over the potatoes. Insert oil coated potatoes in the tube. Now try to push the potatoes by squeezing the tube.

- How do you squeeze the tube to make the potatoes pass through?
- Do you think that the muscles in the wall of the oesophagus have to do something like this?

Peristaltic movement in oesophagus

Look at the diagrams which shows the wave like movement of wall of oesophagus and observe the position of the food bolus.

- How did the position of the bolus change?

What is the similarity of movement of food illustrated in the diagram and the activity performed by you?

The wall of the oesophagus is made up of two kinds of smooth muscles. The inner layer consisting of circular muscles and the outer layer with longitudinal muscles. Contraction of the circular muscles results in narrowing of the oesophagus just behind the bolus. So the food is squeezed downwards. Contraction of the longitudinal muscles in front of the bolus widen the tube, this results in shortening of that particular part of the oesophagus. Contraction and relaxation of these muscles bring in a wave like motion that propels the food bolus into the stomach by the action called “*peristalsis*” (you have studied about this in the chapter on nutrition). This is involuntary and under the control of autonomous nervous system.

- What make the movement of the food bolus in the oesophagus easy?

The walls of the food pipe secrete a slippery substance called mucus. Mucus lubricates and protects the oesophageal walls from damage. This helps the food bolus to slide down easily just as the oiled potatoes that move in the tube. Besides this, the saliva in the bolus also aids in easy movement of food, which moves into the stomach.

Think why people are advised not to swallow food without chewing properly or do not eat in hurry.

Stomach the mixer and digester

- Why do you think the stomach is structured like a bag rather than a tube like oesophagus?

The food taken has to remain in the stomach for a long time. So it has to be processed for proper digestion and absorption. If it was like a tube it would just pass down without undergoing much changes.

- What sets such processes into action?

When the food is in the oral cavity, the nerves in the cheek and tongue are stimulated. These carry messages in the form of nerve impulses-to the

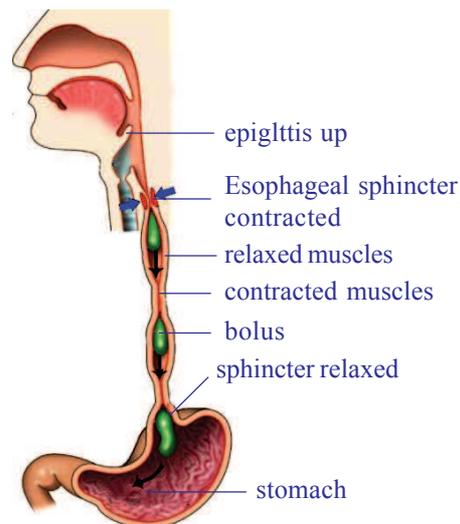


fig-6: Peristaltic movement of bolus

brain. These messages are transmitted from the brain, to the wall of the stomach, and stimulate the gastric glands to produce gastric juice.

The walls of stomach secrete strong hydrochloric acid (HCl) and other juices as the food is about to reach it or even when we feel hungry. This is stimulated by the nervous system. The contraction of the stomach muscles squeeze and mix the food with the acids and juices of the stomach. These digestive juices turns the food into a smooth porridge like consistency called *chyme*. Some large protein molecules are also broken down here.

- What stimulates stomach muscle into action?
- What causes the stomach to churn and mix the food?

As the process of digestion in the stomach nears completion, the contractions of the stomach decrease. This prompts the muscles, called as pyloric sphincter at the opening of the stomach into the first part of the small intestine or duodenum, to contract. This opens the pathway into duodenum releasing the partially digested food (chyme) in small quantities into the duodenum.

- Why partially digested food travels in small quantities from stomach to duodenum?

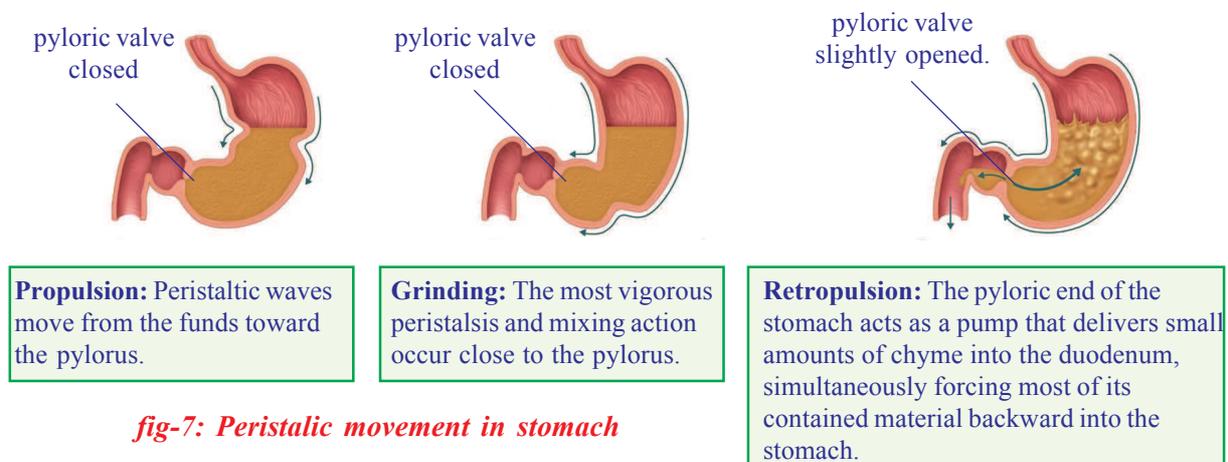


fig-7: Peristaltic movement in stomach

Peristalsis involves the contraction of the muscle behind the food and the relaxation of the muscle in front of the food giving rise to a thrust that pushes the food forward through the digestive canal. A wave of contraction followed by relaxation in muscles helps in forward movement of food.

- What is involved in bringing about peristalsis?
- What is the direction of peristalsis (which end of the gut does it begin)?
- What happens to its direction when we vomit?

Even semi digested food in form of chyme may squirt back as we vomit.

Try to mark the direction of peristaltic wave of such reflexes in the above diagram.

Have you observed a ruminating cow/ buffalo under a tree or somewhere else? Carefully observe its neck and throat. Do you see something moving from its throat to mouth? After that, the cow /buffaloe starts chewing. Can you tell what is the happening in it ?It is the bolus moving from a part near the stomach of the animal to its mouth. It is reverse peristalsis. Though it is a common process in ruminants such as the cow, buffalo etc. that have an extra pouch in the stomach to store quickly swollen food., in human beings it is mainly a protective mechanism of expelling unwanted substances from the food canal.

We observe that digestion of food starts from mouth. While travelling the food through the alimentary canal settles some time for digestion at every stage. So this do not move uniformly through the digestive system. Let us observe the time period.

Table-

Percentage	Emptying of stomach	Emptying of small intestine
50%	2.5 to 3 hours	2 .5 hours
Total 100%	4 to 5 hours	30 to 40 hours (Transit through colon)

(These are only averages. The movement of materials varies among individuals and time after different meals.)

Our stomach is not like a bag with specific volume. It is like a pouch which is elastic in nature. the size of the stomach increase based on the food that we intake. Digestive juices are produced depending on the quantity of food material. If the stomach produce same amount of digestive juices irrespective of the food quantity the walls of stomach may destroy. The size and shape of stomach become crumbled in persons having habit of vigorous fasting.

If we eat undigested or unwanted food, the digestive mechanism recognize and refuse to digest it. Under control of autonomic nerves system stomach walls irritates and squirts out an undigested food along with chime. We call it as vomiting. Sometimes sudden belching with fluid from the stomach moves up the food pipe and enters the mouth too. It is followed by burning sensation in the throat and chest. This is due to the upward flow

of acids is a good example for reflexes of the food canal. All such muscular contractions are involuntary and under the control of the X cranial nerve of autonomous nervous system.

We know the stomach secretes strong acids during digestion. The HCl secreted by the walls of the stomach is strong enough to digest the hard bones as well..Then how is the stomach protected from the secretions of its own acids. To understand this we will perform the following experiment.

Take a green leaves collected from your school garden. Grease one leaf with petroleum jelly leaving the other free. Add 1 or 2 drops of some weak acid on both the leaves .Observe them after half an hour or so and write your observation in your note book.

- What kind of change did you observe in the leaves?
- Which leaf showed change and which did not? Give reasons.

Though the gastric glands of the stomach secrete acids .Some of the glands in the walls of the stomach produce mucus as well. Resultant a thin lining of mucus covers the walls of the stomach internally. This counters the action of acid. The function petrolium jelly can be compared to that of mucus lining the stomach walls. Hence the stomach is protected from damage being caused by the secretion of its own acids.

Travel of food from the stomach to the intestine

Food is a soup like mixture when it leaves the stomach and enters the small intestine. When the food enters the intestine the acidic nature of the chyme initiates the production of hormones Secretin and Cholecystochynin which stimulate pancreas, liver and walls of small intestine to secrete pancreatic juice, bile juice and succus entericus.

The absorption of nutrients by villi in the small intestine is a very selective process. The walls of the intestine allows only tiny nutrient particles to pass through and leaving the larger ones trapped inside. Let us recall transportation of materials across plasma membrane that you have studied in class 9th.

- Why small intestine is long and coiled?

Activity-10

Paper tube and folded papers

Provide the students with a piece of paper. Let them calculate the area of one side of the paper and make a roll of it. Try to fill the tube by inserting

few folded papers as much as possible in it. Pull out the papers from the tube, unfold them and find out the whole area of the papers.

- Compare the area of the folded papers with that of the roll. Do you find any increase in the area? If so try to find out the reasons?

The inner surface of the small intestine contains thousands of finger like projections called Villi. In what way are these projections related to the paper folds?

The villi present inside increases the surface area so that the food retained in the folds can remain longer thereby enhancing absorption.

- What systems do you think are working together here?
- Do you think those systems work together in the whole length of the digestive canal? Why / Why not?

The digestive tract is unique among internal organs because it is exposed to a large variety of physicochemical stimuli from the external world in the form of ingested food. As a consequence, the intestine has developed a rich store of coordinated movements of its muscular apparatus along with neural apparatus to ensure the appropriate mixing and propulsion of contents during digestion, absorption, and excretion.

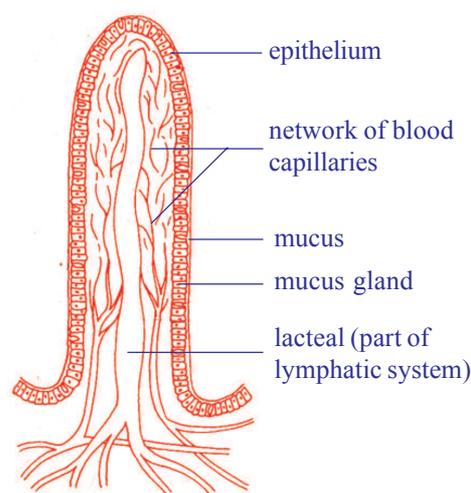


fig-8: Schematic diagram of a villus

The neural apparatus of our digestive tract comprises of such a vast and complicated network of neurons that it has been nicknamed by scientists as the second brain!

Research in this area is currently investigating how the second brain mediates the body's immune response; after all, at least 70 percent of our immune system is aimed at the gut to expel and kill foreign invaders.

Scientists are also working to find out how trillions of bacteria in the gut '*communicate*' with the cells of gut nervous system.

A deeper understanding of this mass of neural tissue, filled with important neurotransmitters, is revealing that it does much more than merely handle digestion or inflict the occasional nervous pang of hunger. The little brain in our inner yards, in connection with the big one in our skull, partly determines our mental state and plays key roles in certain diseases throughout the body.

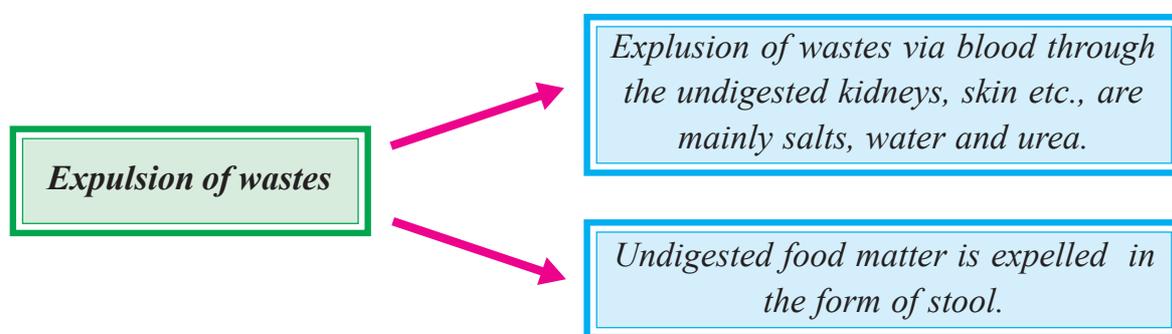
Often you may have experienced that if you have tension for some reason you start having loose motions.

- What does this show us?

Although its influence is far-reaching, the second brain is not the seat of any conscious thoughts or decision-making. Technically known as the enteric nervous system, the second brain consists of sheaths of neurons embedded in the walls of the long tube of our gut, or alimentary canal, which measures about nine meters end to end from the esophagus to the anus. The second brain contains some 100 million neurons, more than in either the spinal cord or the peripheral nervous system. This multitude of neurons in the enteric nervous system enables us to “feel” the inner world of our gut and its contents. Stimulating and coordinating the breaking down of food, absorbing nutrients, and expelling of waste requires chemical processing, mechanical mixing and rhythmic muscle contractions that move everything down the line.

Thus equipped with its own reflexes and senses, the second brain can control several gut functions often independently of the brain. Several scientists also believe that the system is a way too complicated to have evolved only to make sure things move through and out of our gut smoothly.

- What moves out of the gut?



- Two major pathways of waste expulsion are shown above. Which of the two do you think happens exclusively through the gut?

Obviously it's path way of the left side. The larger food particles reach the large intestine to be sent out. But how?

Imagine you made a roll by wrapping a hand full of left over tea leaves in a tissue paper. Later you pressed the roll gently and opened it. What did you observe? You find the tissue paper had absorbed the water from the tea leaves.

Similarly when the unwanted waste material (stools / faeces) reach

the large intestine. The peristaltic waves move the stool from the left side of the colon into the rectum. The left side of the colon acts like a storage tank of faeces. Water gets reabsorbed and the remaining wastes usually the hard mass gets stored in the last part (Rectum) of the large intestine. This smelly yellowish faecal mass usually called as toilet is later expelled out of the body through the anus.

- What controls the exit of stools from the body?
- Do you think the control is voluntary? Why / why not?

There are two muscular layers forming the anal sphincters. One that is under involuntary control the internal anal sphincter and the other is voluntary the external anal sphincter which you have control over it.

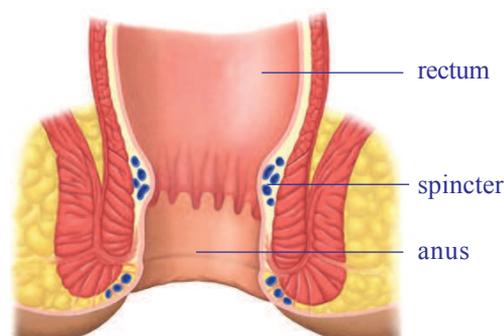


fig-9: Anal sphincter

In a sick person the glands of alimentary canal stop functioning, in other words the flow of digestive juices come to a standstill. This is due to the blood flow being directed to other actively working parts like those that lungs, kidneys, brain etc., the person does not notice this. He Takes food and it gets digested. How does this process go on?

This was a mystery recently solved by the Physicians. The digestive juices secreted by a faulty gland are stored in the lining of the intestines that help in digestion during such conditions. Sometimes the nervous signals to the Gastro Intestinal tract are stopped temporarily, still peristalsis and other functions of digestive process goes on. This is because, the signals necessary for contraction are generated in the smooth muscle cells, to overcome adverse conditions.

We have so far seen how several systems work together to bring about the process of digestion. Where does this process draw energy to run smoothly?

Moreover what is the fate of the digested substances that move into blood from the intestine?

If energy has to be obtained from food it has to be oxidised. For this purpose respiration has to go on. Then how is energy released from food in this process?

During inhalation oxygen moves across the walls of the alveoli and enters the blood. From here it enters the red blood cells and gets distributed throughout the cells of our body. At the same time carbon

dioxide from the blood moves into the alveoli of the lungs and breathed out during exhalation. Nutrients in the cells get oxidized and energy is released.

- Where this released energy stored in the cells?

During respiration we breathe continually by inhaling and exhaling air. This is an involuntary process controlled by the medulla oblongata of the autonomous nerves system (ANS). During respiration the movement of inter costal muscles/diaphragm moves the ribs cage inflating and deflating the lungs. Air containing more of oxygen enters the blood stream through lungs. If the oxygen has to reach the tissues it has to be circulated through blood. How does this process go on?

Hence the process of digestion which is a complex process that involves many organs and organ systems. Though digestion occurs in the food canal, co-ordination of respiration and blood circulation is necessary otherwise oxidation of food and transport of substances which is vital for energy releasing process will not take place. This may lead to shut down of systems that are interdependent on each other.



Key words

Ghrelin, Leptin, Gustatory, Chemoreceptors, Papillae, Food bolus, Peristalsis, Chyme, Pyloric Sphincter, Villi, Medulla oblongata, Brain stem.



What we have learnt

- The food taken by us it has to be broken down into constituent substances for proper digestion, assimilation and energy releasing processes.
- The human digestive digestive system involves both the muscular and nervous systems.
- A special nervous system that exists in the gut consist of nearly 100 billion nerves that coordinates the muscular activity ,blood flow,digestion and absorption of nutrients and other activities of the food canal (gastro intestinal tract).
- The hormone Ghrelin secreted in the stomach is responsible for hunger generating sensations. Another hormone leptin that gets secreted suppresses hunger.
- Taste can be identified easily only when the tongue is pressed against the palate.

- Taste and smell are closely related. The chemoreceptors present in the nose and the tongue trigger signals in the form of nerve impulses to the brain where the smell and taste is detected.
- The saliva secreted maintains an alkaline medium that aids in digestion of starch. Our mouth secretes acid as well, this gives protection to our mouth from harmful bacteria etc., Under the action of autonomous nervous system Saliva released by the salivary glands moistens the food to make chewing and swallowing easier.
- The muscular and sensory organ in the oral cavity is the tongue which is not only gustatory in function but also performs different functions including, shifting and mixing the food in the oral cavity and swallowing.
- The mechanism for swallowing is coordinated by the swallowing centre in the brain stem.
- Contraction and relaxation of the muscles in the gut brings in a wave like motion that propels the food forward, is called peristalsis. This is a muscular wave that travels the entire length of the food canal. This is involuntary and under the control of autonomous nervous system as well as gut nervous system.
- The muscular contractions of the stomach churns the food into a semiliquid substance known as chyme. Entry of chyme into the duodenum is regulated by a muscle called as the pyloric sphincter.
- The strong acid (HCl) renders the pH in stomach acidic causing the protein digesting enzymes to swing into function.
- Juices secreted in the stomach breaks down the food into a smooth mixture called chyme.
- The mucus lining of the stomach protects it from damage by its own acids.
- The coordination among the processes of digestion, respiration and circulation is necessary for utilization and oxidation of food and transport of the nutrients. Muscular and nervous control helps to carry out the processes in a regulated manner.



Improve your learning

1. What do you mean by hungerpangs? (AS1)
2. What are the body systems involved in digestion of food which we eat? (AS1)
3. Rafi said smell also increase our appetite can you support this statement. how? (AS1)
4. Give reasons
 - a) If we press tongue against the palate we can recognise taste easily.
 - b) If can't identify taste when food is hot.

- c) In mouth food forms into a slurry mass.
 d) Small intestine is similar to a coiled pipe.
5. Draw the block diagram of showing sensation of taste from food material to brain. (AS5)
 6. How can you mouth is munching machine? (AS1)
 7. What is mastication? Explain the role of different teeth in this process. (AS1)
 8. What experiment you perform to understand action of saliva on flour? Explain it's procedure and operatus that you followed. (AS3)
 9. What happen if salivary ducts are closed? (AS2)
 10. During the journey of food from mouth to stomach through oesophagus. How muscular system coordinate in this process? (AS1)
 11. Write difference between the following
 - a) bolus - chyme
 - b) small intestine - large intestine
 - c) mastication - rumination
 - d)
 12. Draw a neatly labeled diagram showing a peristaltic movement in oesophagus. Explain the importance of mucus on the walls of food pipe. (AS5)
 13. Write a note on peristalsis and sphincter function in stomach. (AS1)
 14. Observe the given part of the digestive system. What is it? What is it's role during digestion? (AS1)
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15. Draw a schematic diagram of villus in small intestine. Explain how digestive system coordinate with circulatory system. (AS5)
 16. If size an shape of small intestine like oesophagus what will happen? (AS2)
 17. Prepare a questionnaire to understand nervous coordination in digestion process. (AS2)
 18. Collect information related to feeling and hunger from your school library and prepare a note on it. (AS4)
 19. Prepare a cartoon on Pavlov's experiment with a suitable caption. (AS6)
 20. There is a great variety in diversified life processes, express your feelings in the form a poem. (AS7)
 21. Suggest any two important habitual actions to your friend while eating food, keeping in view of this chapter. (AS7)
 22. Fill in the blanks with suitable words.
 1. 3:2:1:2 is the ratio of our dentition. Here 1 represents _____
 2. Large protein molecule are broken down in _____ of digestive track.
 3. _____ is the strong acid which secreats during digestion.
 4. Olfactory reseptors present in _____ triggering signals to brain.

5. pH of saliva is _____ in nature.

Choose correct answers.

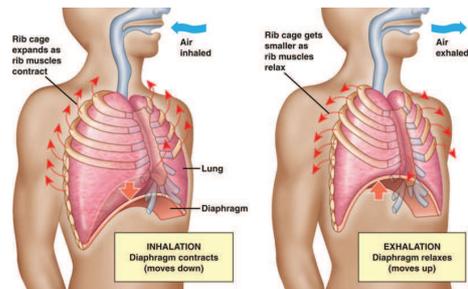
1. Which of the following situation you can taste quickly.
 - a. Put sugar crystals on tongue.
 - b. Put sugar solution on tongue.
 - c. Press the tongue slowly against the palate.
 - d. Swallow directly without grind and shred.
2. Peristalsis is because of
 - a. Contraction of longitudinal muscles.
 - b. Contraction of circular muscles.
 - c. Under control of autonomous nervous system.
 - d. Digestive secretions.
3. Sphincter that helps in opening of stomach into duodenum
 - a. Cardiac
 - b. Pyloric
 - c. Anal
 - d. Gastric
4. Glucose and amino acids are absorbed through the following part of villi.
 - a. epithelial cells
 - b. blood capillary
 - c. lymphatic vessel
 - d. all
5. Brain portion that controls hunger signals
 - a. medulla
 - b. diencephalon
 - c. cerebrum
 - d. mid brain
6. Human organism is an internal combustion machine because of
 - a. assimilation of energy from food
 - b. liberate CO_2 during respiration
 - c. Expel waste food at the end state digestion
 - d. Secrete powerful digestive juices

- 1) Rajesh feels hungry upon seeing food. Sheela says no more food as she is not hungry. What makes Rajesh hungry and what suppresses Sheela's hunger?
- 2) Suggest a simple experiment to prove the role of palate in recognizing taste.
- 3) How is taste and smell related?
- 4) With the help of a diagram show the movement of food from mouth to the stomach. What muscles and nerves are involved in the movement of food and what is this action called as?
- 5) List out the sphincter muscles of the food canal you have observed and give a brief description ?
- 6) How do you appreciate stomach as a churning machine .How does this coordination go on?
- 7) Is there any reason for the intestine to be coiled with many folds. In what way is it helpful during the process of digestion?
- 8) The mere smell or sight of food stimulates hunger .Describe the process through a neat diagram?
- 9) Refer to the diagram on breathing mechanism and explain how air is forced in and out of the lungs?
- 10) The mechanism of respiration in men and woman is same. True or false support your answer with suitable explanation.
- 11) skim through these parts Stomach Small intestine Large intestine and name the process in the Boxes.
- 12) What is the function of peristalsis in these parts ?
a) Oesophagus b) stomach c) small intestine d) large intestine
- 13) How can you justify the enteric nervous system as the second brain of the gut ?

Fill in the blanks with suitable words given below.

- a) . Fluctuations of hormone—1—— levels results in sensation of hunger and motivation of consuming food. When you feel your stomach is full and there is no need of food any more. Another hormone ——2—— that gets secreted suppresses hunger. When we take food into the mouth it has to be chewed

thoroughly. For this purpose the _____3_____ muscles help in chewing actions, while the _____4_____ muscles of the jaw moves the jaw up, down, forward and backward during food mastication. The _____5_____ nerve controls the muscles of the jaw. Under the action of _____6_____ nervous system Saliva is released by the salivary glands moistens the food to make chewing and swallowing easier. The salivary _____7_____ in the saliva breaks down the starch into sugars. As a result of chewing the food is transported into the oesophagus by the action of swallowing which is coordinated by the swallowing centre in the _____8_____ and the _____9_____. The tongue which is gustatory recognizes the taste and _____10_____ nerve plays an important role in sensation of taste.



Choose the right ones.

- 1) leptin, grehlin gastrin secretin.
- 2) ghrelin leptin secretin gastrin.
- 3) deep muscles, surface muscles, circular muscles, striated muscles.
- 4) surface muscles, deep muscles, neck muscles, long muscle.
- 5) fifth cranial nerve, second cranial nerve, fifth facial nerve, spinal nerve.
- 6) central nervous system, peripheral nervous system autonomous nervous system.
- 7) lipase, sucrase, galactase, amylase.
- 8) medulla oblongata, cerebrum, 8th spinal nerve, cranial nerve. 7th cranial nerve.
- 9) Pons varoli, brain stem, medulla oblongata, mid brain.
- 10) 6th cranial nerve, 5th cranial nrv, 10th cranial nerve, optic nerve.

Contraction and relaxation of the _____11_____ in the oesophagus propels the food bolus into the stomach. This action is also called as _____12_____ which is _____13_____ and under the control of autonomous nervous system. The muscular movements of the stomach _____14_____ the food and breakdown it into a semiliquid substance known as _____15_____. The _____16_____ muscle at the end of the stomach regulates the entry of food into the duodenum. The _____17_____ wave pushes the food into the small intestine and the folds in the intestine increase the area of _____18_____, and the _____19_____ in the intestine absorb the nutrients. When the food enters the large intestine Water gets reabsorbed and the remaining wastes gets stored in the _____20_____ last part of the large intestine. The exit of stools is controlled by two muscles the internal sphincter and the external sphincter of the _____21_____..

Choose the right answer.

- 11) wall muscle, hard muscle, smooth muscle, long muscle.
- 12) peristalsis, plasmolysis, osmolysis,
- 14) Frodistraction by A.P. Goyal selected,
- 15) presses, churns, pushes.

Historical evidence of human digestion that led to discovery of other truths

The man with a window in his stomach.

One fine morning at Fort Mackinac on the upper Michigan peninsula a 19 year Voyageur Alex St.Martin had a gun wound in his stomach that was fired accidentally. The wound perforated the abdominal wall and stomach with profused bleeding. Dr.Beaumont the army surgeon was called on to attend the wounded man. Dr. Beaumont cleaned the wound and pushed the protruding portions of lungs and stomach back into the cavity and dressed the wound.

Dr. Beaumont was surprised to see St. Martin alive the next day as he never expected so. With his medical expertise Dr. Beaumont treated the wound and did his best to extend his life. When the wound got healed completely, the stomach had fused with the body wall leaving a hole. Part of the wound formed a small flap that resembled a natural valve. This allowed Dr.Beaumont to draw out fluids from Martin's stomach for testing.

Dr.Beaumont turned St.Martin to the left side depressing the flap he inserted a 5-6 inch tube into the stomach gathered gastric juice had its components identified. He introduced food through the hole of the stomach with a string attached to it so that he could retrieve the partially digested food for further examination. He conducted many experiments on food digestion to know the function of stomach which had not been done before. He discovered many things that were new to science.

For centuries stomach was thought that cooks food by producing heat. Also the Stomach was viewed as a mill, a fermenting vat or a stew pan. Through his experiments Dr.Beaumonts experiments revolutioned the concepts of digestion. June -on16,1822 became the beginning for the the most pioneering experiments in medicine. He recounted many of his observations and experiments in his journal which says "I consider myself but a humble experimenter" in which the information provided still obeyed scientific method basing all the inferences on direct experimentation.

Some of the discoveries of Dr.Beaumont were.

.1) He measured the temperature of the stomach during digestion .To his surprise he found there was no change or alteration in temperature. He found the temperature being maintained constant (100F/38C).

2) He found out that pure gastric juice contains large amounts of HCl, contrary to the previous opinions that gastric was nothing but contains simply water. As suggested by some authors as the most general solvent in nature and of the alimentary canal. Even the hardest bone cannot withstand its action. Even outside the stomach it is capable of effecting digestion. Based on the evidences he concluded that HCl as chemical agent that aids in chemical reaction.

3) He found Gastric juice is not stored in the stomach. But, is secreted when the food is taken. When the food enters the stomach it exits the vessels to discharge its contents immediately for digestion.

4) He understood that digestion begins immediately when the food enters the stomach. He tested the contents

Of the stomach exactly 20 mts after taking food (dinner containing ordinary food of boiled and salted beef, potatoes, bread, beef and turnips) by collecting the fluids from the flap and found digestion had commenced

and was progressing well at that time.

5) He also discovered that food in the stomach satisfies hunger even though it is not eaten. (food reaching the stomach without passing the mouth and oesophagus) To confirm his assumptions he made St. martin fast from breakfast time till 4'0 Clock and then introduced food into the stomach through the flap. The sensation of hunger subsided.

Though it was fortuitous experiments in medicine connected to digestion raised many questions.

*What is the cause of hunger ? *How does the brain know the happenings of the stomach? *What causes the gastric juices to secrete ? How and what makes the food to be mixed with the digestive juices? *Does the process of digestion occur independently or involves other systems like nervous and muscular as well ?