



Esophageal Motility & Pathophysiology of Reflux Disease

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Objectives

- Mastication & chewing
- Salivary glands
- Secretion of saliva
- Contents of saliva
- Functions of saliva
- Control of salivary secretion
- Swallowing
- Types of esophageal peristalsis
- Function of lower esophageal sphincter



The Early Response to a Meal

What is the Early Response of the GIT to a Meal

It can be divided into phases;

1. ***The Cephalic Phase*** → Before food is ingested.
2. ***The Oral Phase*** → When ingested food is in the mouth.
3. ***The Esophageal Phase*** → When food is transferred from mouth to esophagus.



A stylized anatomical diagram of the human digestive system. It features a pink tongue at the top, a long orange esophagus, a red liver, a green stomach, a purple pancreas, and a green small intestine. The large intestine is shown in orange, and the rectum is at the bottom. The diagram is positioned on the left side of the slide.

The Cephalic Phase

- Occurs before ingesting food.
- Thinking or anticipating food, smelling or seeing food.
- Aim to prepare the GIT for the meal.
- Stimuli cause an increase in parasympathetic neural outflow to gut leading to enhanced GI secretions (salivary, gastric, pancreatic.. Etc).

A stylized anatomical diagram of the human digestive system. It features a pink tongue at the top, a red liver, a green gallbladder, a purple stomach, and a green pancreas. The large and small intestines are shown in orange and green. A long orange tube represents the esophagus, extending from the mouth area down to the stomach.

The Oral Phase

- Occurs when food is in the mouth.
- Same features as cephalic phase but here there is contact between food and GI surface.
- Adding more stimuli from mouth → taste.
- The response is similar to the cephalic phase → an increase in parasympathetic neural outflow to gut leading to enhanced GI secretions (salivary, gastric, pancreatic.. Etc).



The Mouth

Where Does Food Digestion Start From?



TEETH

Incisors

Canine

Premolars

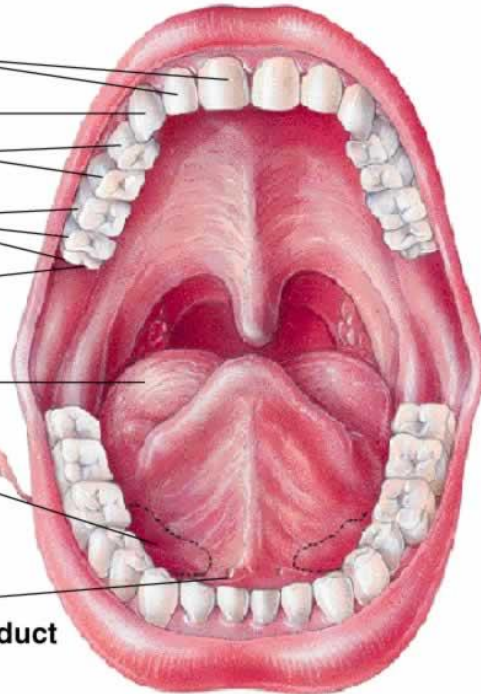
Molars

“Wisdom”
tooth

Tongue

Salivary
glands

Opening of a
salivary gland duct



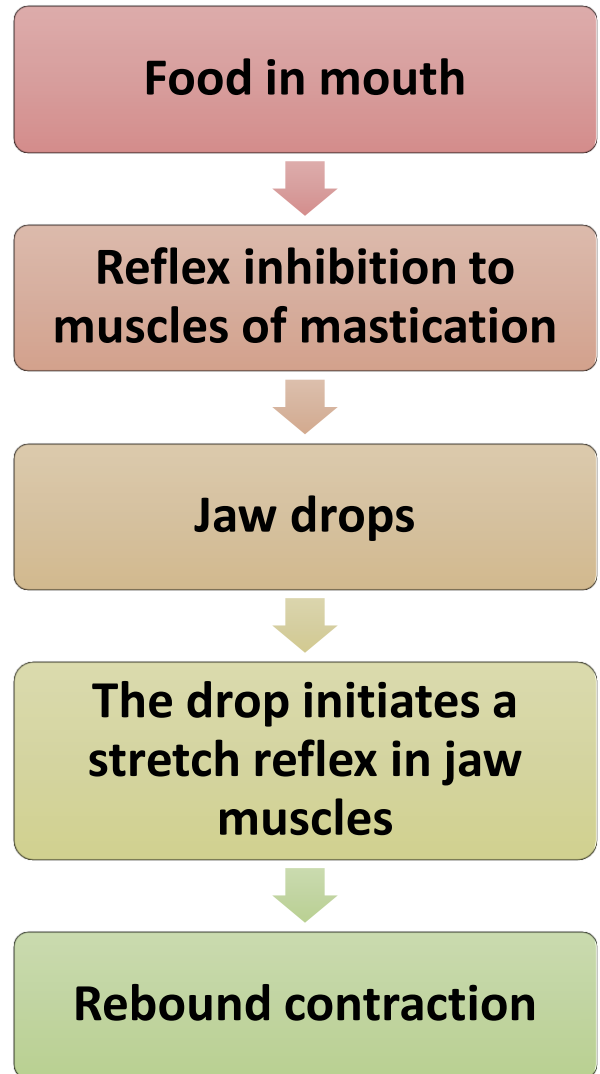
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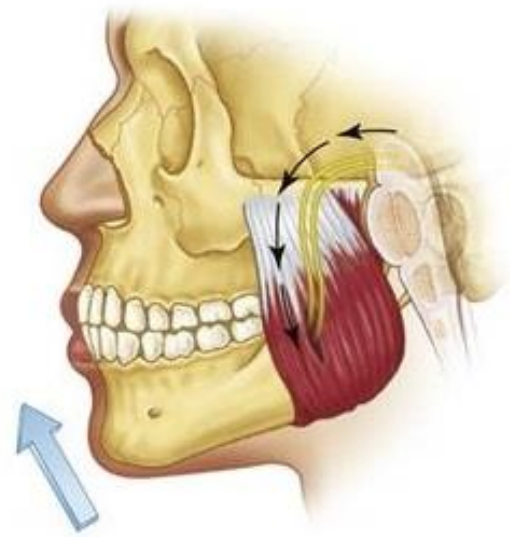
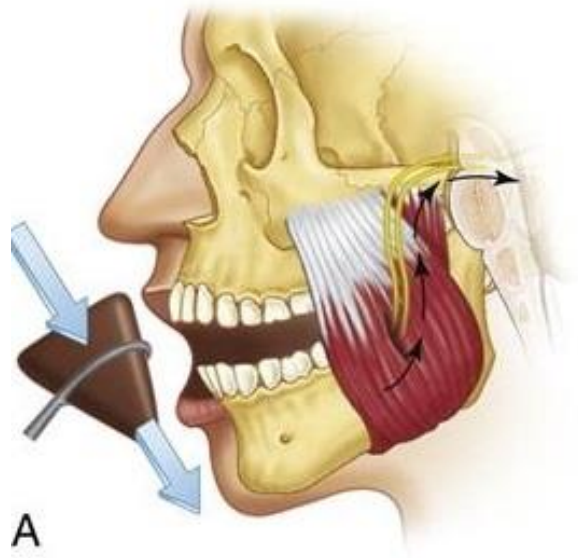
- At the mouth (oral cavity)
- *What is meant by digestion?*
- *What are the types of digestion?*
 - ✓ Mechanical.
 - ✓ Chemical.
- *What is the role of the mouth in digestion?*

Chewing (Mastication)



- Teeth perform cutting and grinding action.
- Chewing is largely a *reflex* (5th CN).
- ***What is the importance of mastication?***





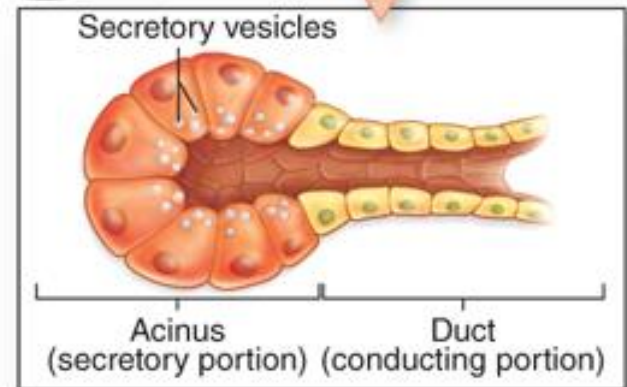
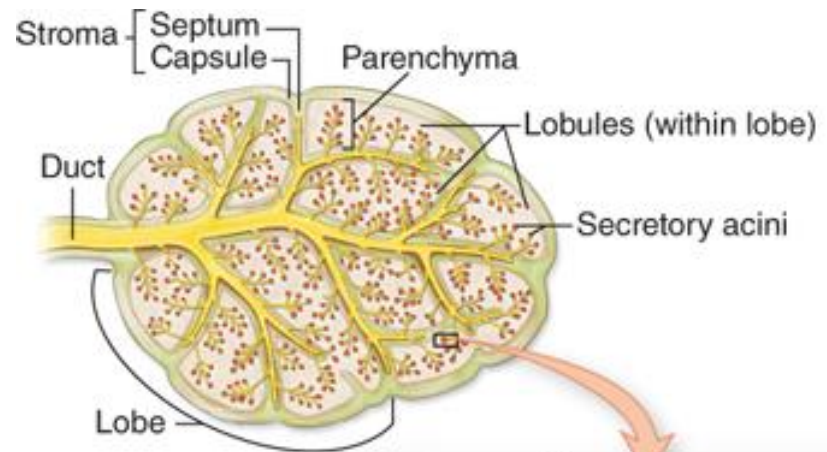


The Salivary Glands

Salivary Glands

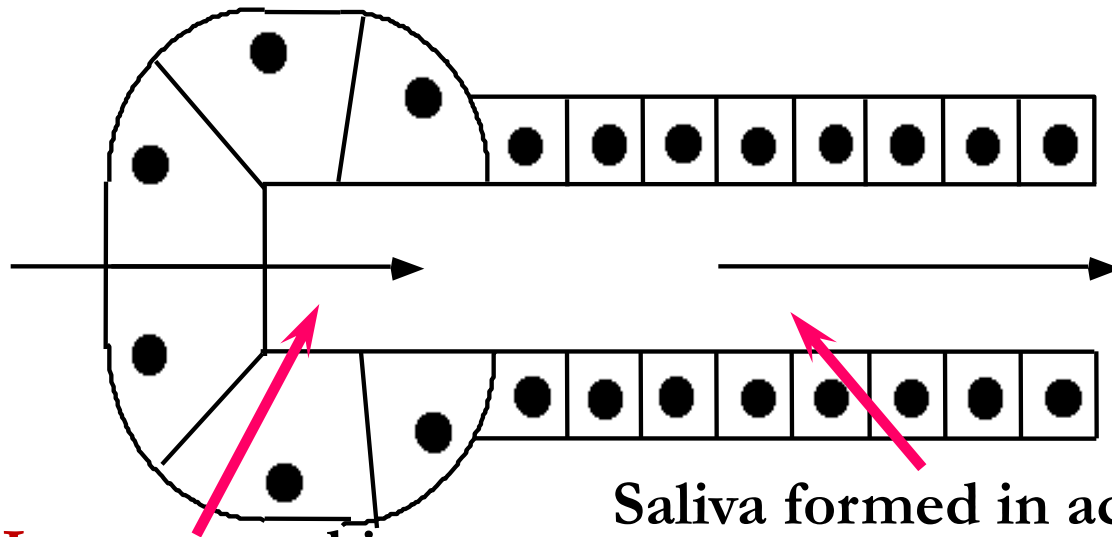
Are exocrine glands.

The secretory unit is made up of acini and ducts.



THE SECRETORY UNIT

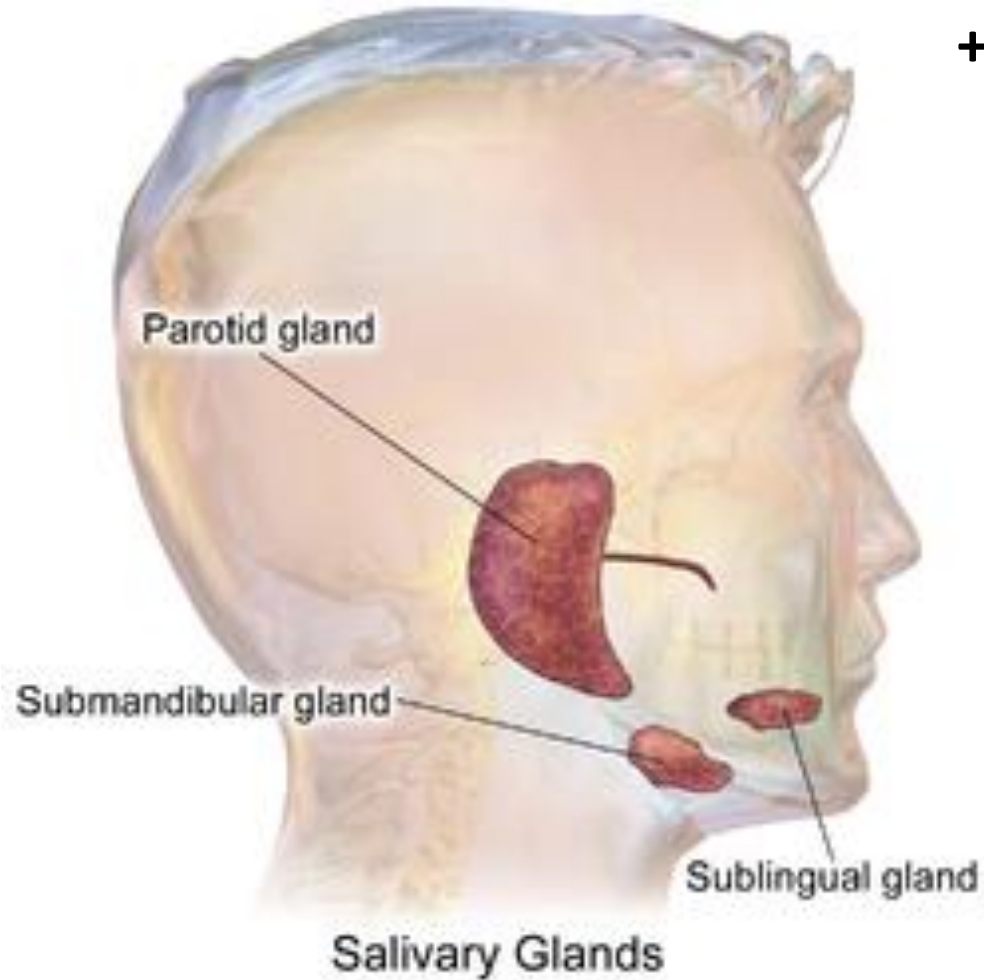
The basic building block of all salivary glands



ACINI - water and ions
derived from plasma

Saliva formed in acini flows
down **DUCTS** to empty into the
oral cavity.

Salivary Glands



+ Many tiny buccal glands

Salivary Glands

Based on type of secretion they are classified into

Serous

Clear, salty, watery containing ptyalin (α -amylase).

e.g. ***Parotid gland***

Mucinous

Thick slimy secretion of mucus (mucin).

e.g. ***buccal glands***

Mixed

A mixture of both

e.g. ***Submandibular & sublingual***



Salivary Secretions

- We secrete \approx 800 – 1500ml of saliva per day (average 1L).
- pH of saliva = 6.0-7.0
- ***What are the functions of saliva?***
 - ✓ Digestion.
 - ✓ Lubrication.
 - ✓ Cleansing.
 - ✓ Protection
 - ✓ Proteolytic enzymes.
 - ✓ Antibodies.

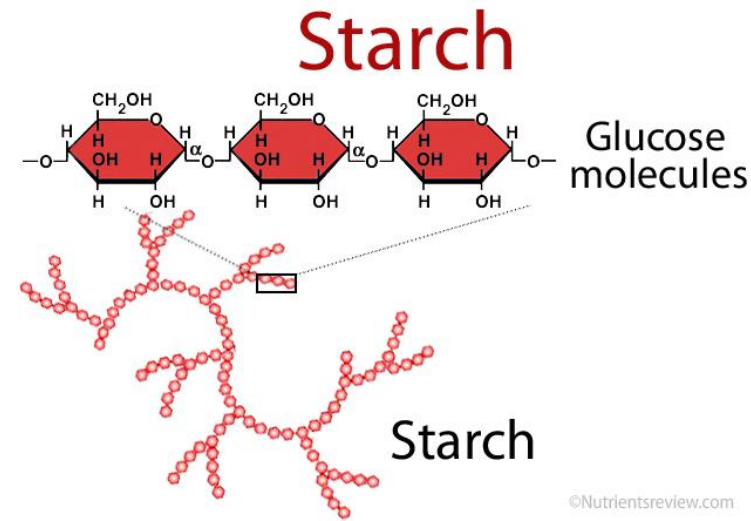




Table 27-1. Functions of Saliva and Chewing

Disruption of food to produce smaller particles
Formation of a bolus for swallowing
Initiation of starch and lipid digestion
Facilitation of taste
Production of intraluminal stimuli in the stomach
Regulation of food intake and ingestive behavior
Cleansing of the mouth and selective antibacterial action
Neutralization of refluxed gastric contents
Mucosal growth and protection in the rest of the GI tract
Aid in speech

Mechanism of Salivary Secretion



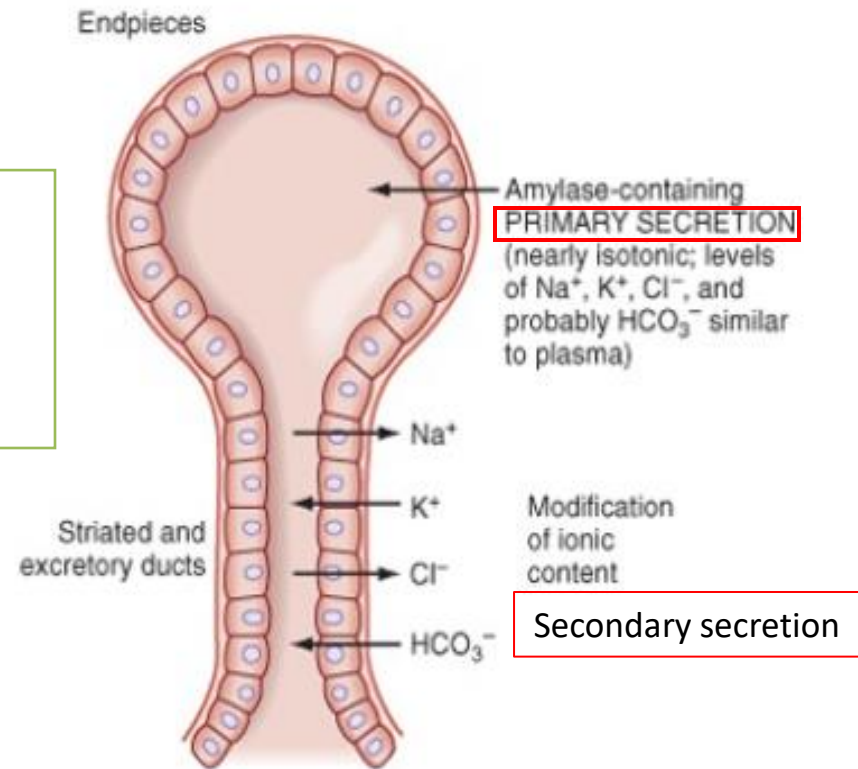
Two stage process

1st stage → Acini

Isotonic
concentration of major
ions similar to that in
plasma

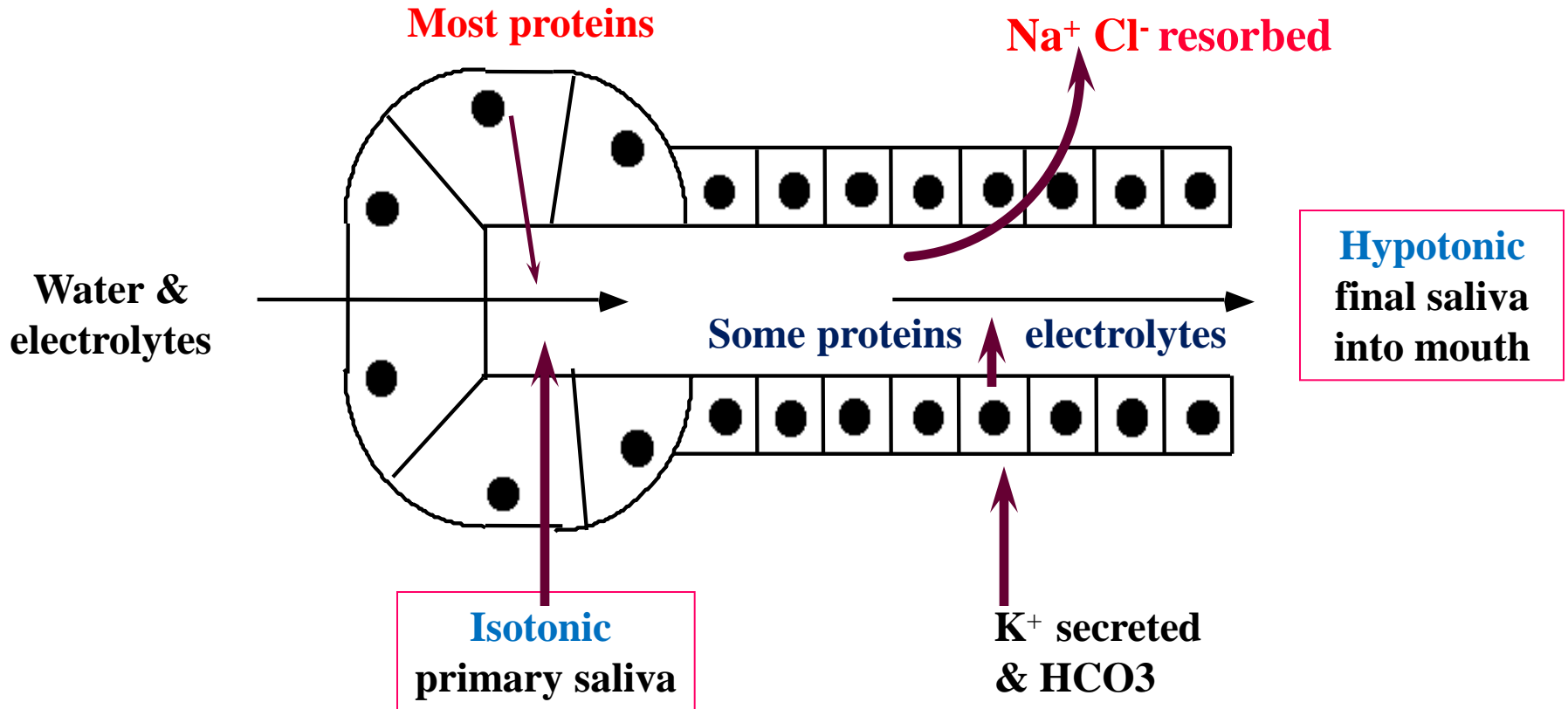
2nd stage → Ducts

hypotonic



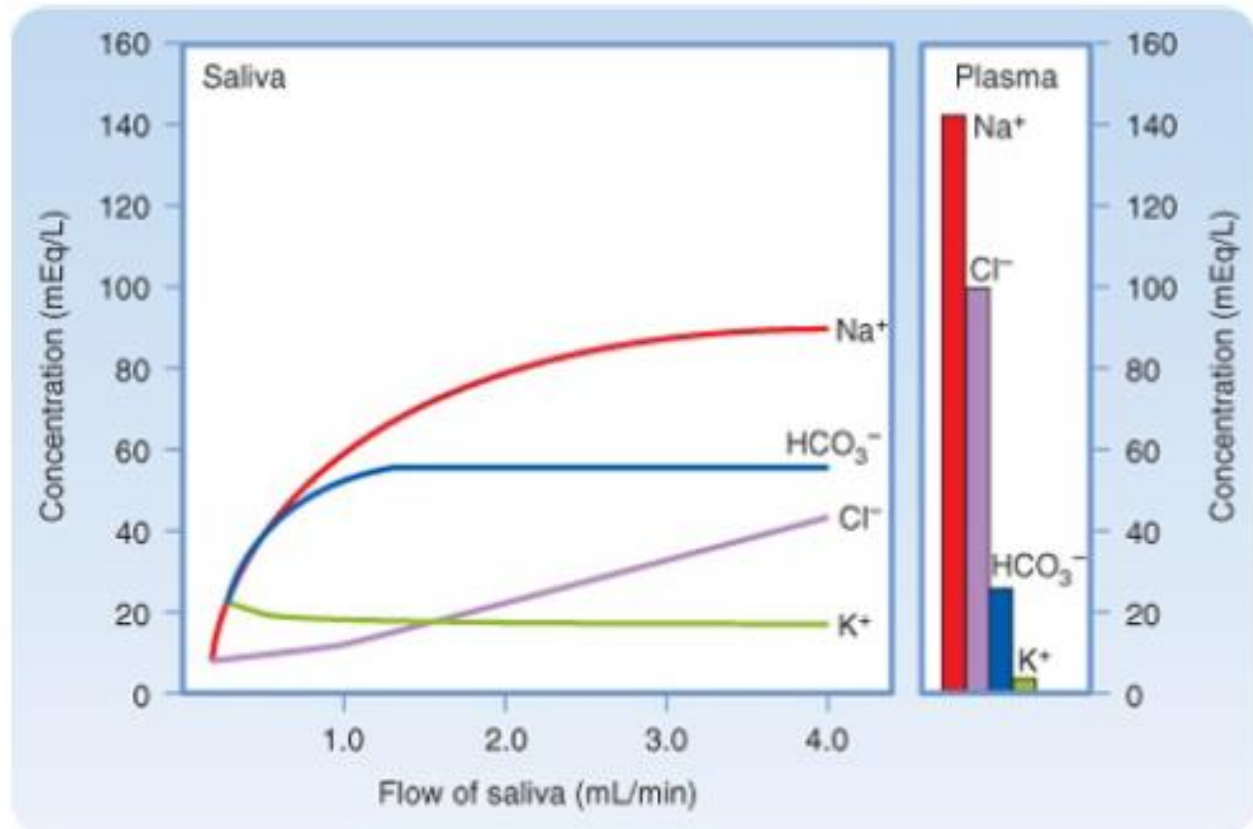
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TWO STAGE HYPOTHESIS OF SALIVA FORMATION



Ions in Saliva

- What is the normal composition of saliva?
- How does the level of ions compare to their level in plasma?
- What happens to the composition of saliva in cases of increased flow of secretion?



Regulation of Salivary Secretion

- Exclusively neural.
- Increased secretion of salivary glands in response to a meal is a reflex, two types of salivary reflexes;
 - **Unconditioned** (born with it).
 - **Conditioned reflex** (learnt by experience).
- Salivation may occur in response to reflexes originating in the stomach and upper small intestine. E.g. Nauseas, presence of irritating food.





Control of Salivary Secretion by Reflexes

Simple (unconditioned)

Chemo / pressure receptors in mouth activated in presence of food (or other stimulus)

Impulses sent *via* afferent nerves

Salivary centre in medulla

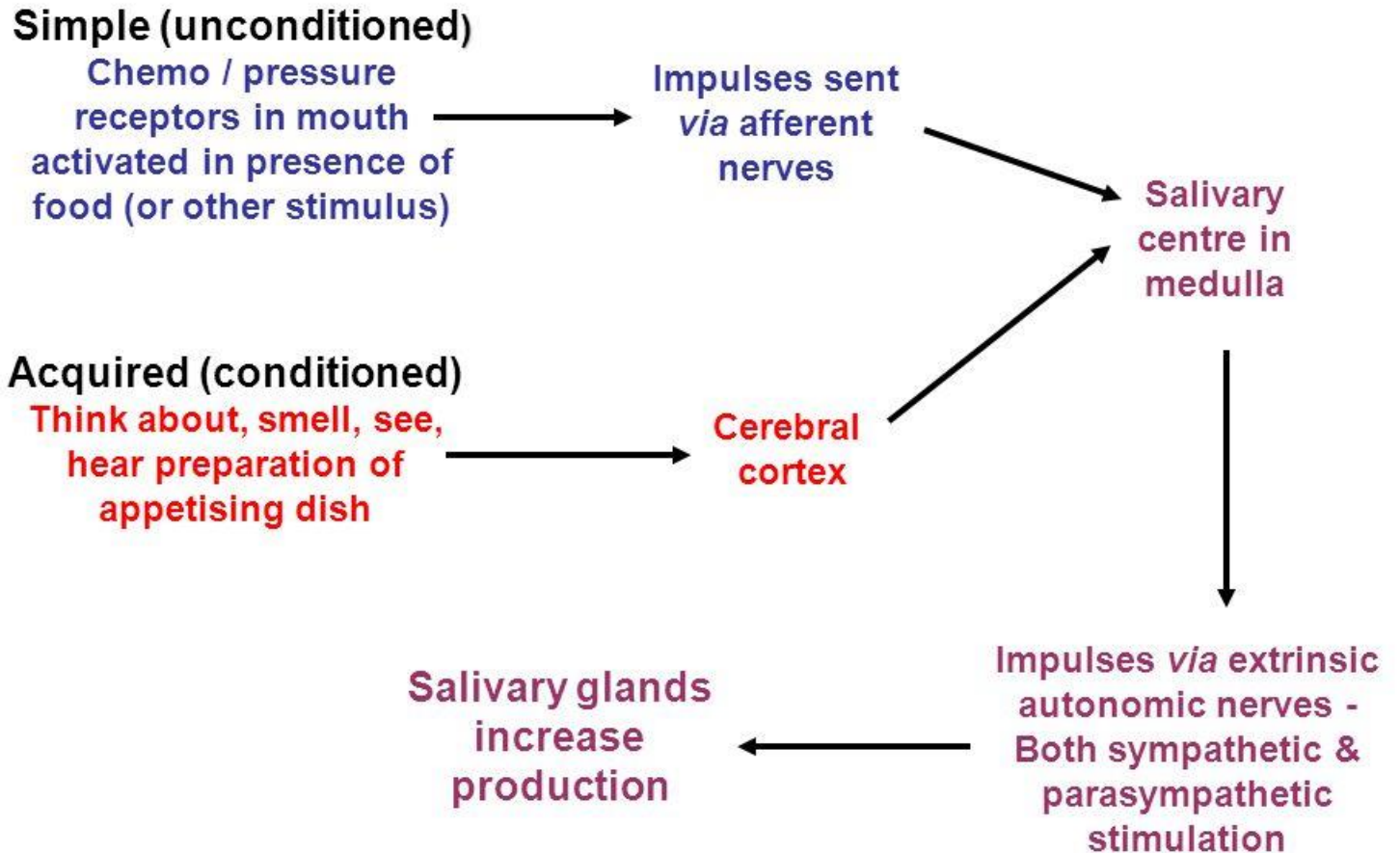
Acquired (conditioned)

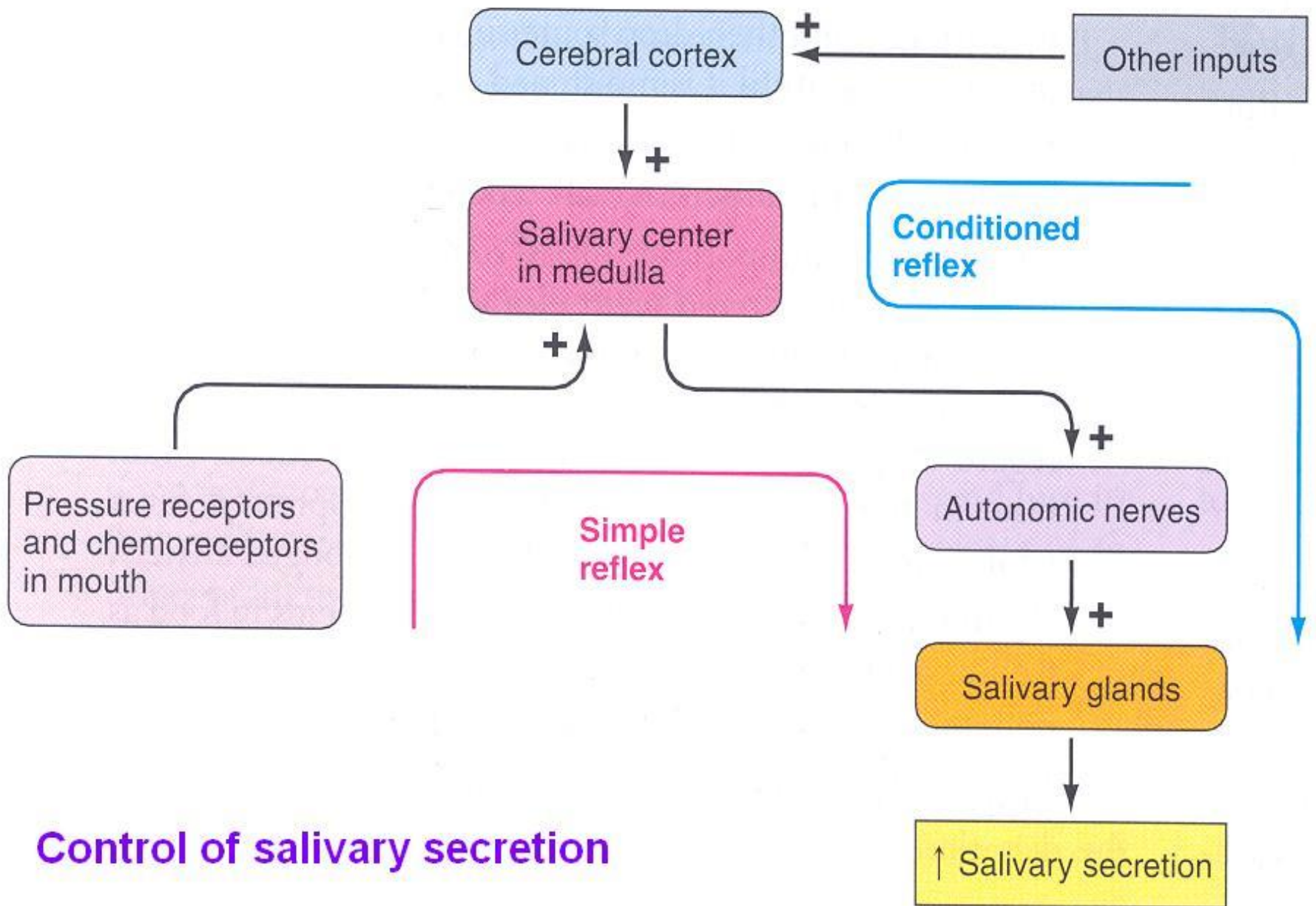
Think about, smell, see, hear preparation of appetising dish

Cerebral cortex

Salivary glands increase production

Impulses *via* extrinsic autonomic nerves - Both sympathetic & parasympathetic stimulation





Control of salivary secretion

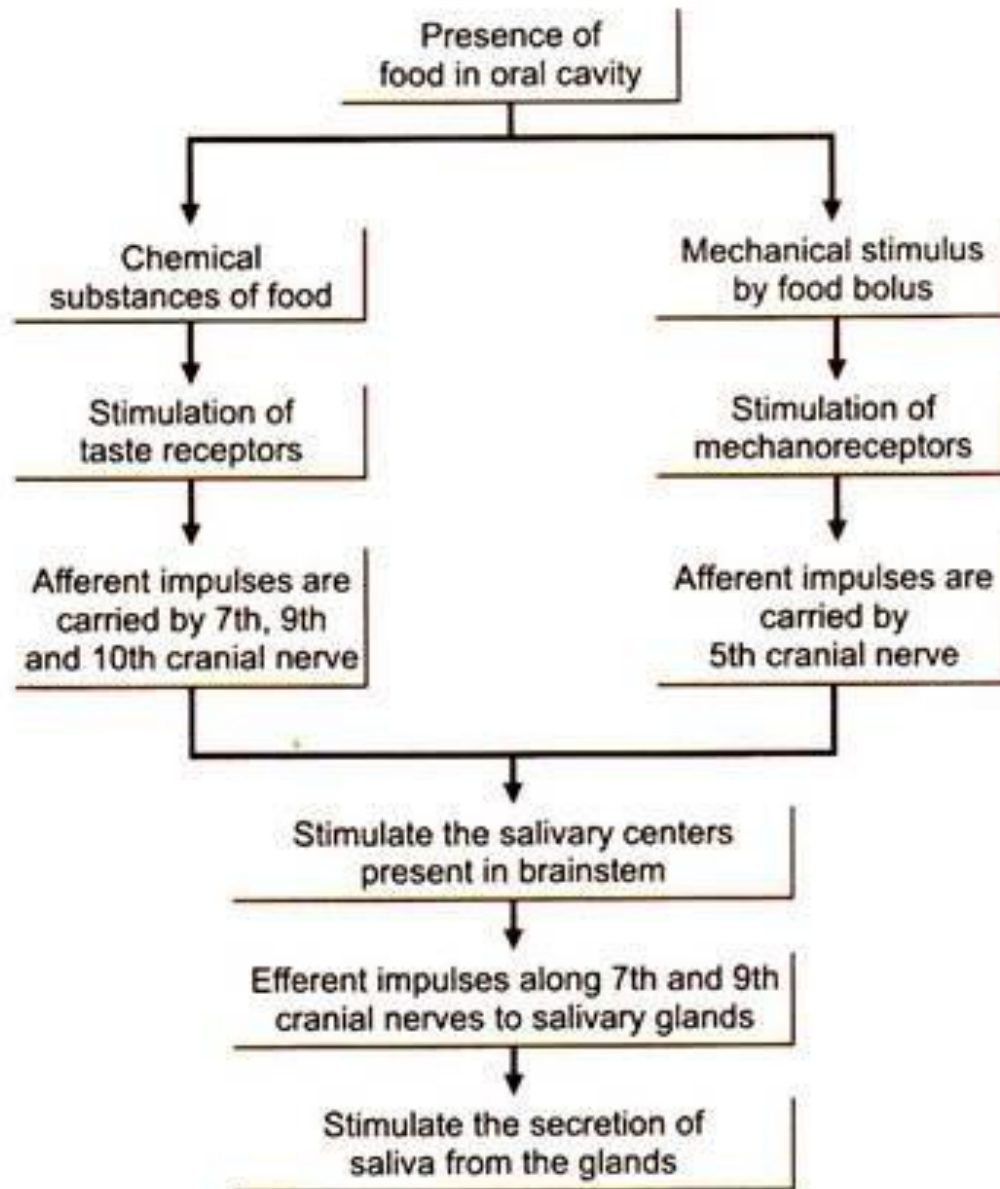
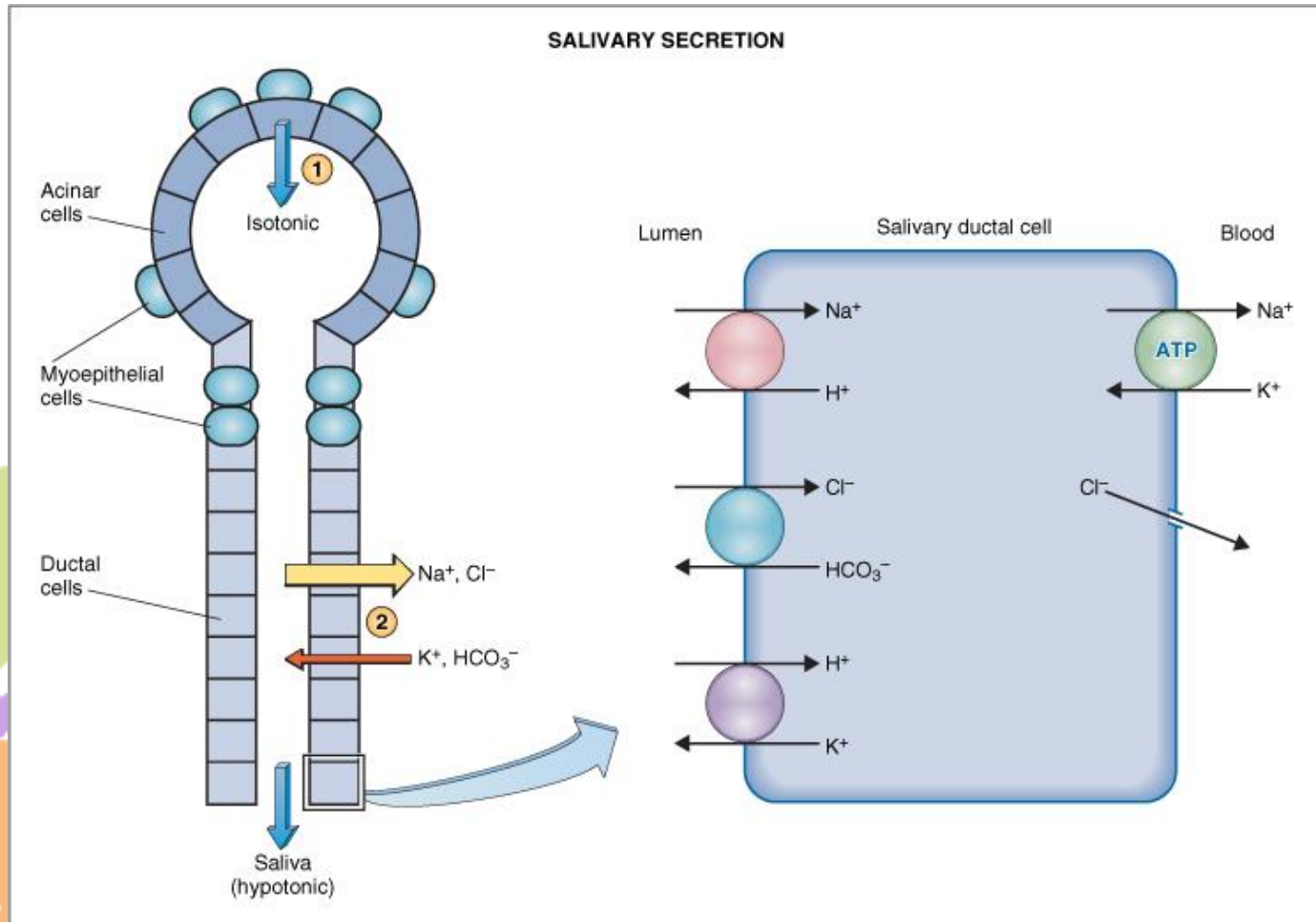


Fig. 5.6: Flow chart detailing the unconditioned salivary secretion



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Mechanism of salivary secretion. Initial saliva is produced by acinar cells (1) and subsequently modified by ductal epithelial cells (2). ATP, Adenosine triphosphate



- **Nerve supply of salivary glands**

- **I- Sympathetic nerves**

Originate in the superior cervical ganglion and reach the 3 pairs of salivary glands through blood vessels

- **Functions:-**

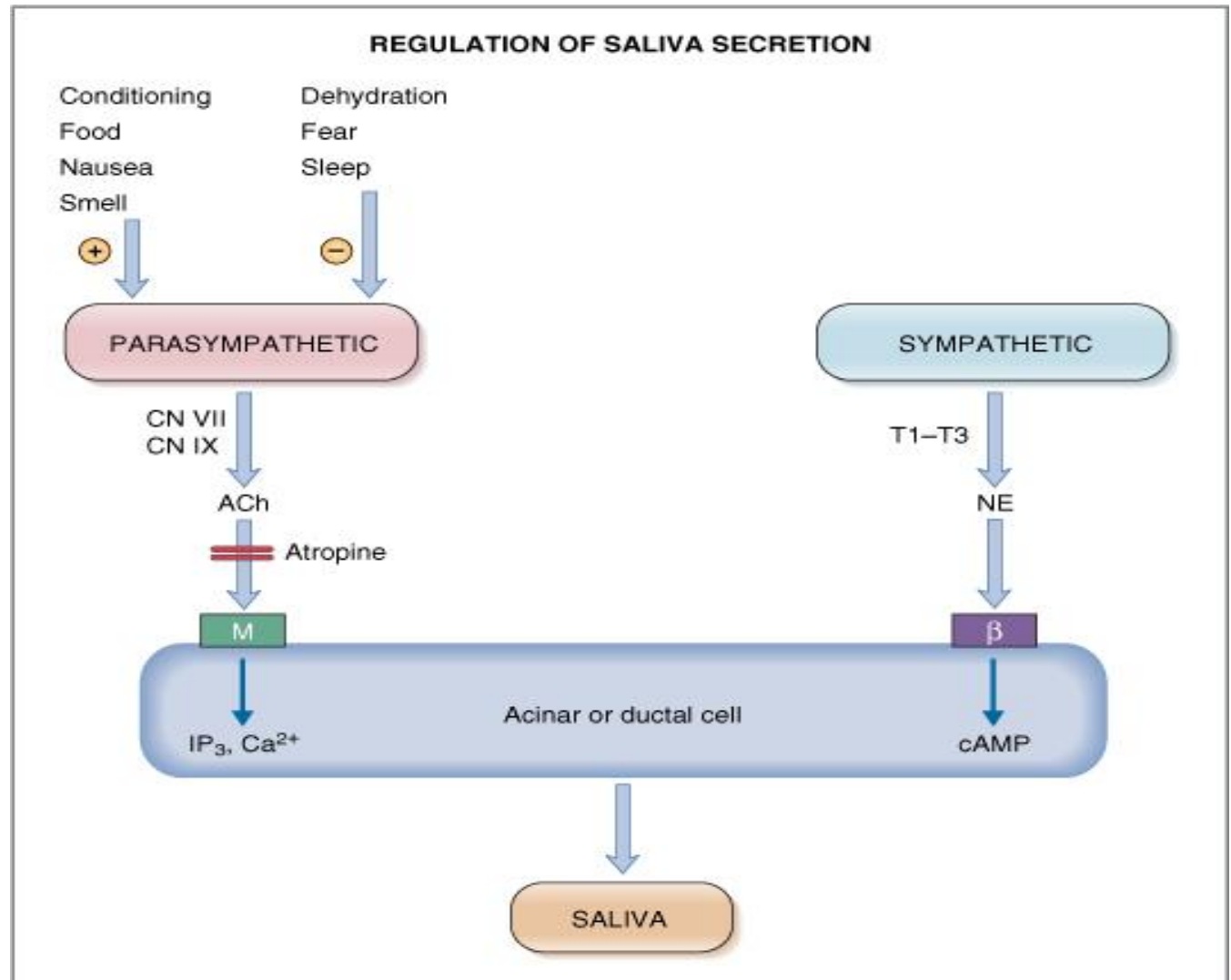
- Act on mucous cells and produce small amount of viscous secretion.
- Cause vasoconstriction.



◎ **II- Parasympathetic nerves**

- ◎ *Originate in the superior & inferior salivary nuclei in brain stem.*
- *Fibers from the **superior** salivary nucleus leave in **VII cranial nerve** supply both submandibular and sublingual glands.*
 - *Fibers from the **inferior** salivary nucleus leave the medulla in **IX cranial nerve** supply the parotid gland.*

Stimulation of both sympathetic and parasympathetic nerves stimulates salivary secretion.



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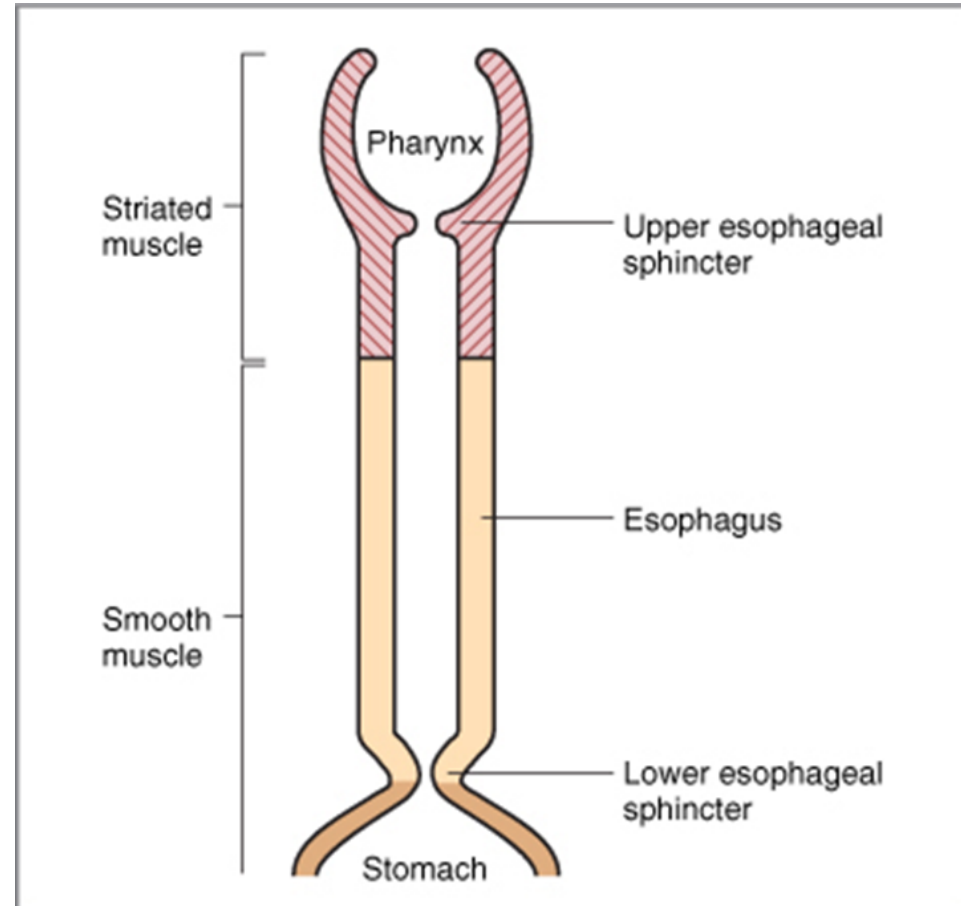
Regulation of salivary secretion by the autonomic nervous system. ACh, Acetylcholine; β , β receptor; cAMP, cyclic adenosine monophosphate; CN, cranial nerve; M, muscarinic receptor; NE, norepinephrine; T1-T3, thoracic segments.



The Esophageal Phase

Esophagus

- Collapsible muscular tube that conveys food from pharynx to stomach (10 inches long).
- Food passes through quickly because of **peristalsis**



Esophageal Sphincters

1. Upper esophageal sphincter.
 2. Lower esophageal sphincter.
- Propel food from mouth to stomach.
 - Protect airway during swallowing.
 - Protect esophagus from acidic gastric contents.



Swallowing (Deglutition)

- Propels food from mouth to stomach.
- Complicated process since pharynx is a shared space between respiration & swallowing.
- Food should move without compromising respiration.



Stages of Swallowing

1. *Voluntary stage.*

2. *Pharyngeal stage.*

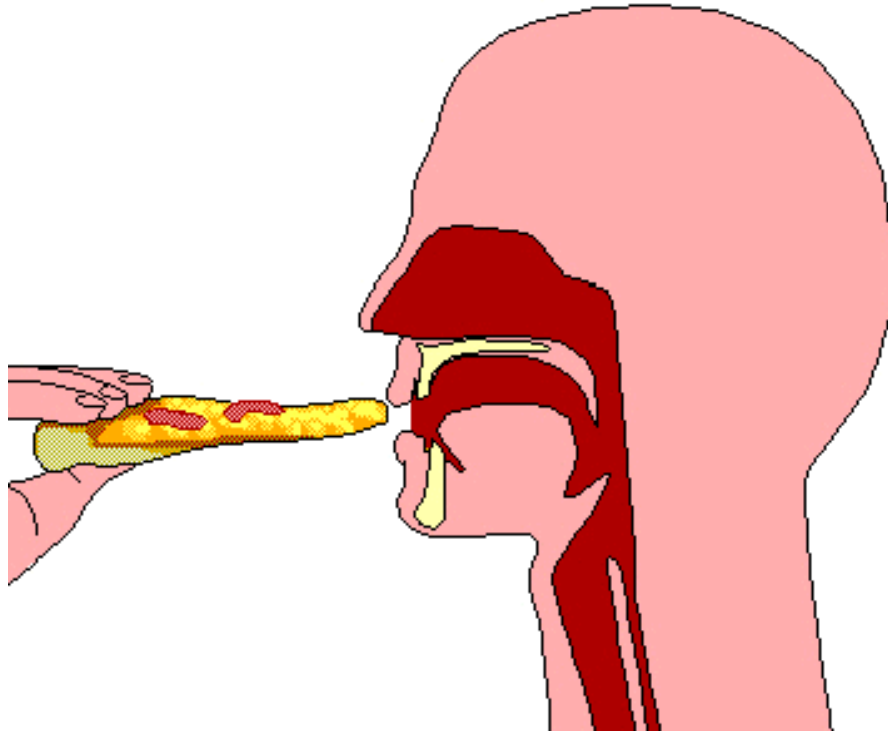
3. *Esophageal stage.*

Involuntary

- Voluntary moves bolus of food from mouth to pharynx.
- Pharyngeal stage moves bolus of food from pharynx to esophagus.
- Esophageal stage move bolus from esophagus to stomach.



Swallowing (Deglutition)



Swallowing (Deglutition)



Stage

Voluntary stage

Pharyngeal stage

Esophageal stage

Changes

Food is “squeezed” posteriorly into the pharynx by the tongue

Soft palate-up
Larynx – anterior & up.
Epiglottis –down
Esophagus opens
UES –relaxes
Respiration inhibited
A wave of peristalsis starts

Primary peristalsis
Secondary peristalsis
LES- relax

Nervous control

Food stimulates touch receptors in pharynx
Afferent via CN V & IX
Swallowing center
Motor efferent via CN V, IX, X, & XII

Swallowing reflex

Myenteric plexus
Vagus



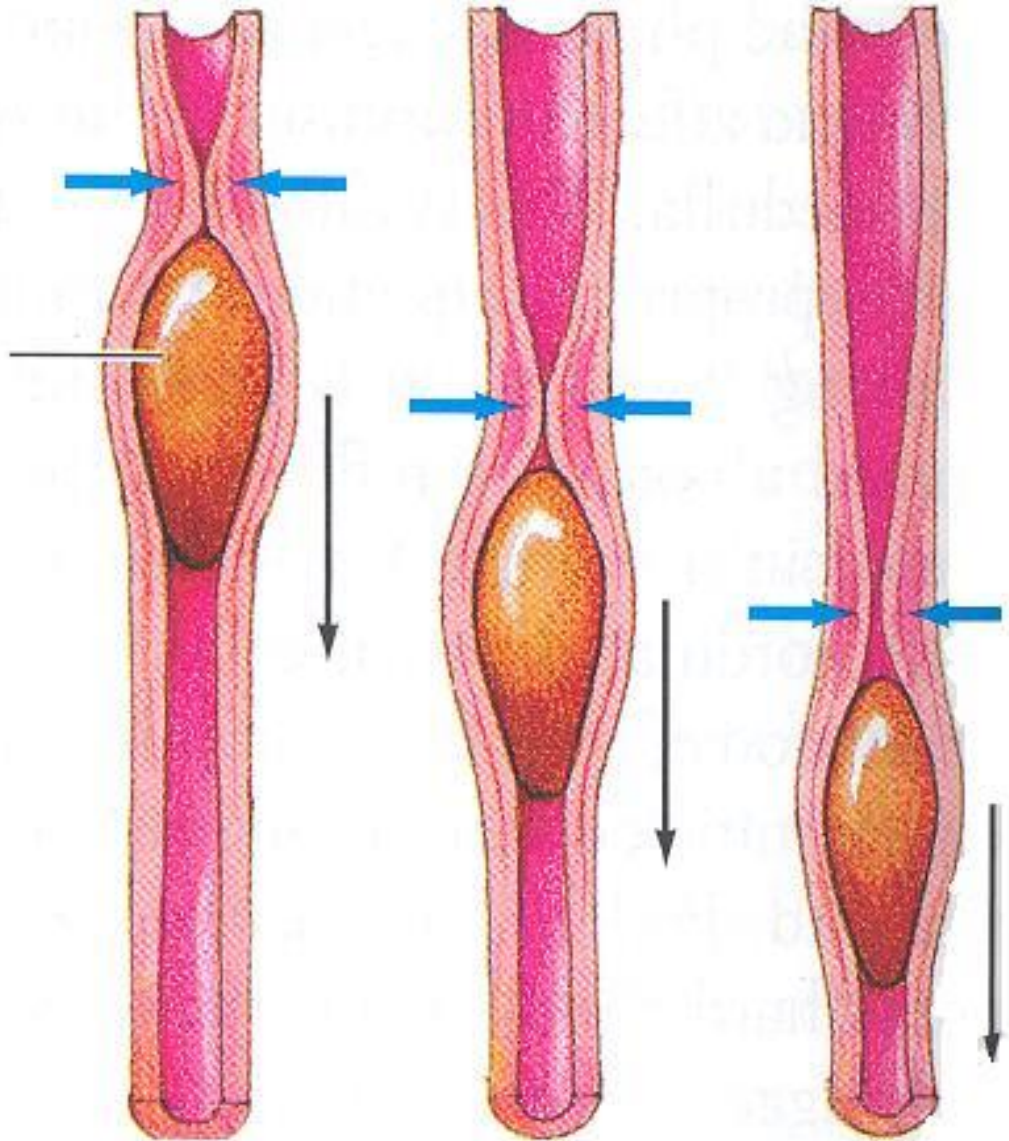
Esophageal Stage

- **Primary peristalsis** → continuation of the peristaltic wave that started in the pharynx.
- **Secondary peristalsis** → starts at the point of esophageal distention by retained food.
- “**Receptive relaxation**” of LES & stomach → a wave of relaxation that travels along the myenteric plexus ahead of peristaltic wave. Allows LES & stomach to prepare to receive the food bolus.

Ringlike peristaltic contraction sweeping down the esophagus

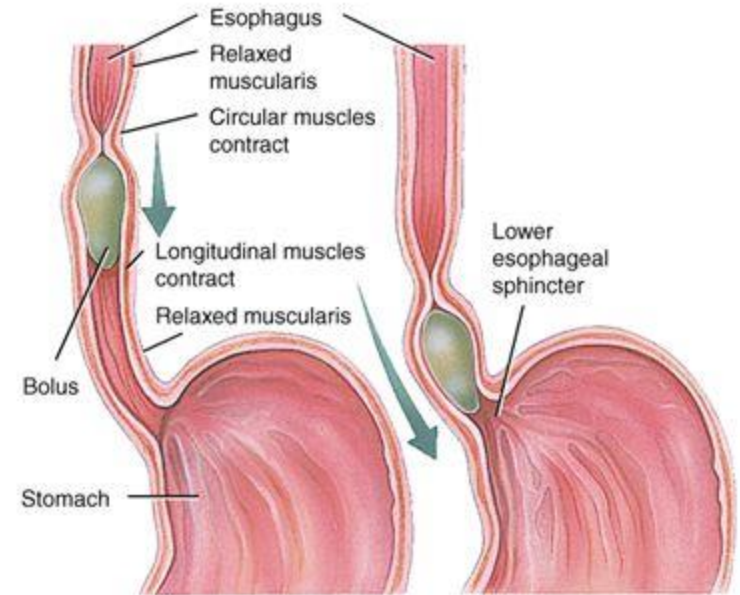
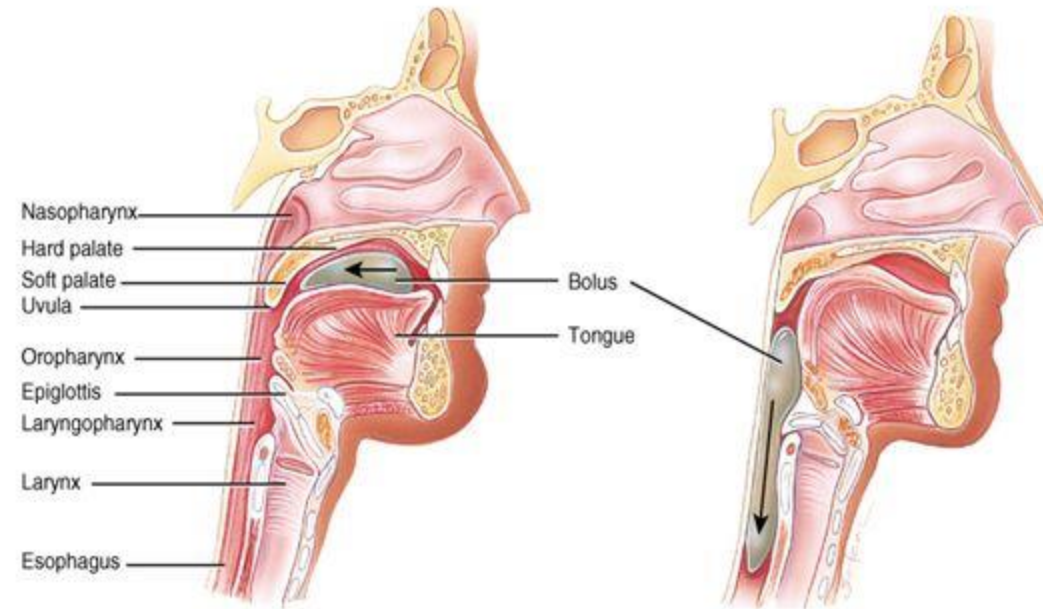
Primary
Secondary

Bolus



Peristalsis in esophagus

Physiology of the Esophagus - Swallowing



- **Voluntary phase**---tongue pushes food to back of oral cavity
- **Involuntary phase**----**pharyngeal stage**
 - breathing stops & airways are closed
 - soft palate & uvula are lifted to close off nasopharynx
 - vocal cords close
 - epiglottis is bent over airway as larynx is lifted
 - controlled by autonomic nervous system

Esophageal stage

- Peristalsis pushes food down
 - circular fibers behind bolus
 - longitudinal fibers in front of bolus shorten the distance of travel
- Travel time is 4-8 seconds for solids and 1 sec for liquids
- Lower sphincter relaxes as food approaches



Lower Esophageal Sphincter

- Also known as gastroesophageal sphincter
- Extends **3cm above** its junction with stomach
- Formed by circular muscles
- Normally remains tonically constricted
- Relaxes ahead of esophageal peristaltic wave
- Helps to **prevent reflux** of gastric juice
- **Valvelike mechanism** of short portion of esophagus that extend slightly into the stomach also helps in preventing reflux



Thank you