Swallowing

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Objectives

- Outline the mechanisms of
  - Swallowing
  - Chewing
- Describe how swallowing is regulated
- List the types of dysphagia
- Describe the composition saliva and its functions

Mechanism of swallowing

Swallowing

- Swallowing is initiated voluntarily.
- Occurs in 3 stages;

1. **Oral phase (stage) – voluntary stage**
    1. **Oral preparatory phase**
    2. **Oral propulsive phase**
2. **Pharyngeal phase**
3. **Oesophageal phase**

1. Oral phase

- The oral preparatory phase refers to processing of the bolus to render it swallowable.

- The oral propulsive phase refers to the propelling of food from the oral cavity into the oropharynx.

1. food bolus is propelled towards the pharynx by the tongue (A).
2. soft palate is elevated and closes off the entrance to the nasal passages (B).

Oral phase cont..

- Total swallow time from oral cavity to stomach is no more than 20 seconds
- This phase requires intact dentition and is negatively affected by poor salivary gland function (lubrication), surgical defects, and neurological disorders.

Oral phase cont..

- The process begins with contractions of the tongue and striated muscles of mastication.
- In the oral phase, a formed bolus is positioned in the middle of the tongue. The bolus is then pressed firmly against the tonsillar pillars, triggering the pharyngeal phase.
- The cerebellum controls output for the motor nuclei of cranial nerves V (trigeminal), VII (facial), and XII (hypoglossal).

Oral phase cont..

- The oral phase is affected by weakness of the tongue or other neurologic disabilities in oral cavity. These deficits can lead to leakage of oral contents before or after the swallow, resulting in leakage into the airway.

- Common symptoms of Oral Phase:
  - Drooling
  - Oral retention
  - Difficulty in Chewing or inadequately chewed food
  - Stranded phlegm
  - Pocketing/ squirreling, food sticking

2. Pharyngeal phase

- Pharyngeal phase is the beginning of involuntary reflex activity.
- At the start vocal cords approximate & close the glottis.
- Respiration is inhibited and the larynx is pulled upwards and forwards
- The bolus pushes the epiglottis back over the glottis (B). Prevent food entering the respiratory tract

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Pharyngeal and oral propulsive phases are brief (last <1sec.)

- The upper esophageal sphincter relaxes during the pharyngeal phase and is pulled open by the forward movement of the hyoid bone and larynx.
- This sphincter closes after passage of the food, and the pharyngeal structures then return to reference position.

- The pharyngeal phase of swallowing is involuntary and totally reflexive, so no pharyngeal activity occurs until the swallowing reflex is triggered.
- This stage involves the motor and sensory tracts from cranial nerves IX (glossopharyngeal) and X (vagus).

Symptoms pharyngeal disorders

- Foamy phlegm, nasal regurgitation,
- Coughing while eating/ drinking,
- Coughing before/ after swallow,
- Wet/hoarse/breathy voice, weak cough, inappropriate breathing,
- Swallowing incoordination,
- Aspiration, and food ‘sticking’

3. Oesophageal phase

- Commences after food enters the oesophagus. This initiates a peristaltic wave that pushes the bolus into the oesophagus.

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- Bolus passes down into the oesophagus; initiates a peristaltic wave in the oesophagus (D)

↓

- Propels the bolus into the stomach

- Fluids pass down the oesophagus ahead of the peristaltic wave due to the effect of gravity

- Here the symptoms may include
  food sticking, pain, regurgitation, hiccups, more difficulty with solids

Stimulation of pharyngeal receptors

\+ IX and X cranial nerves

Swallowing centre

Evoke a coordinated sequential output of efferent activity via the nucleus ambiguous and nuclei of 5,7,12 cranial nerves

X

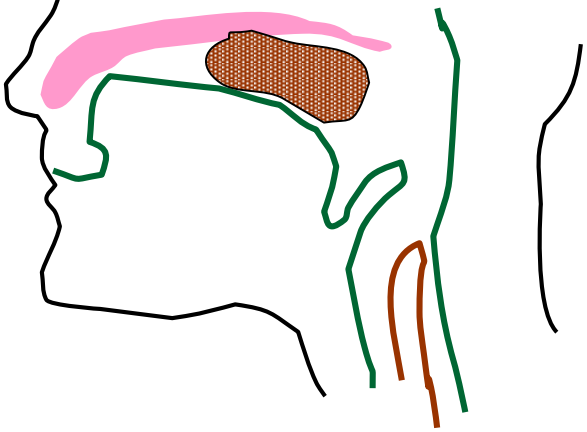
Sequentially activates the muscles of the pharynx and oesophagus

Receptors in the pharynx and oesophagus

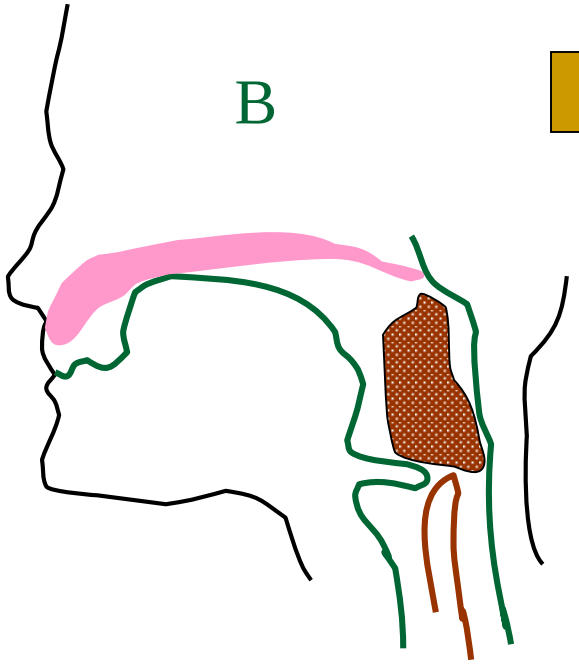
Feedback information to the swallowing centre causes further coordination of muscle contraction


0.5/s
406.0

A



B



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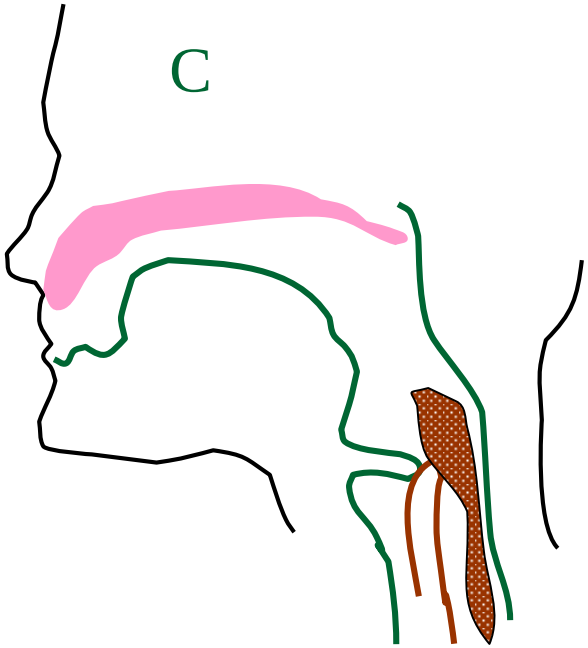

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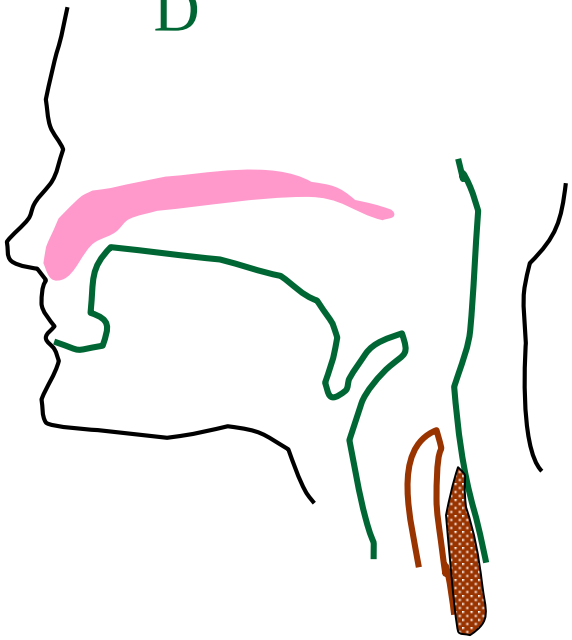


Dysphagia

Difficulty in swallowing

Common causes

1. Neurological
2. Oro-pharyngeal
3. Oesophageal

Disorders involving swallowing - dysphagia

- The swallow reflex is a complex neurologic event involving participation of high cortical centers, brain stem centers such as the tract of the nucleus solitarius and nucleus ambiguous, and cranial nerves V, VII, IX, X, and XII.

- Neurologic deficits in any of these areas can result in dysphagia.

Oropharyngeal	Oesophageal
Specific diseases cerebrovascular disease, hypothyroidism, myasthenia gravis, muscular dystrophy, Parkinson's disease, and polymyositis.	Neuromuscular disorders (e.g. achalasia, diffuse esophageal spasm), many nonspecific motility abnormalities, and intrinsic or extrinsic obstructive lesions that may be benign or malignant.

Oropharyngeal	Oesophageal
Trouble getting liquids or solids to the back of the throat or that food sticks in the back of the throat	Patients with esophageal dysphagia most often describe a feeling of food sticking at the sternal notch or in the substernal region

Oropharyngeal	**Oesophageal**
Coughing, nasal regurgitation, or choking immediately after swallowing suggests oropharyngeal dysphagia. Greater difficulty swallowing liquids than solids	Observe the patient swallow in an attempt to determine the timing of the symptom; With OD, the sensation of dysphagia onsets several seconds after swallowing begins.

Investigations for Dysphagia:

Plain Films	Inflammatory (epiglottitis, Retro-Pharyngeal abscess), radio-opaque foreign bodies.
Barium Oesophagram	Indicated in patients in whom structural disorders are suspected (e.g. dysphagia to solid foods)
Manometry	Rarely used except in cases where elevated intraluminal pressures must be followed (e.g. achalasia).
Bolus Scintigraphy	Indicated to follow improvement in a patient with h/O aspiration or to follow esophageal emptying in achalasia.
Video fluoroscopic examination or modified barium swallow	"Gold standard", integrity of the oral and pharyngeal stages of the swallowing process.

Swallowing video

Swallowing video

https://www.youtube.com/watch?v=umnnA50IDIY

Chewing

Chewing (mastication)

Functions of chewing

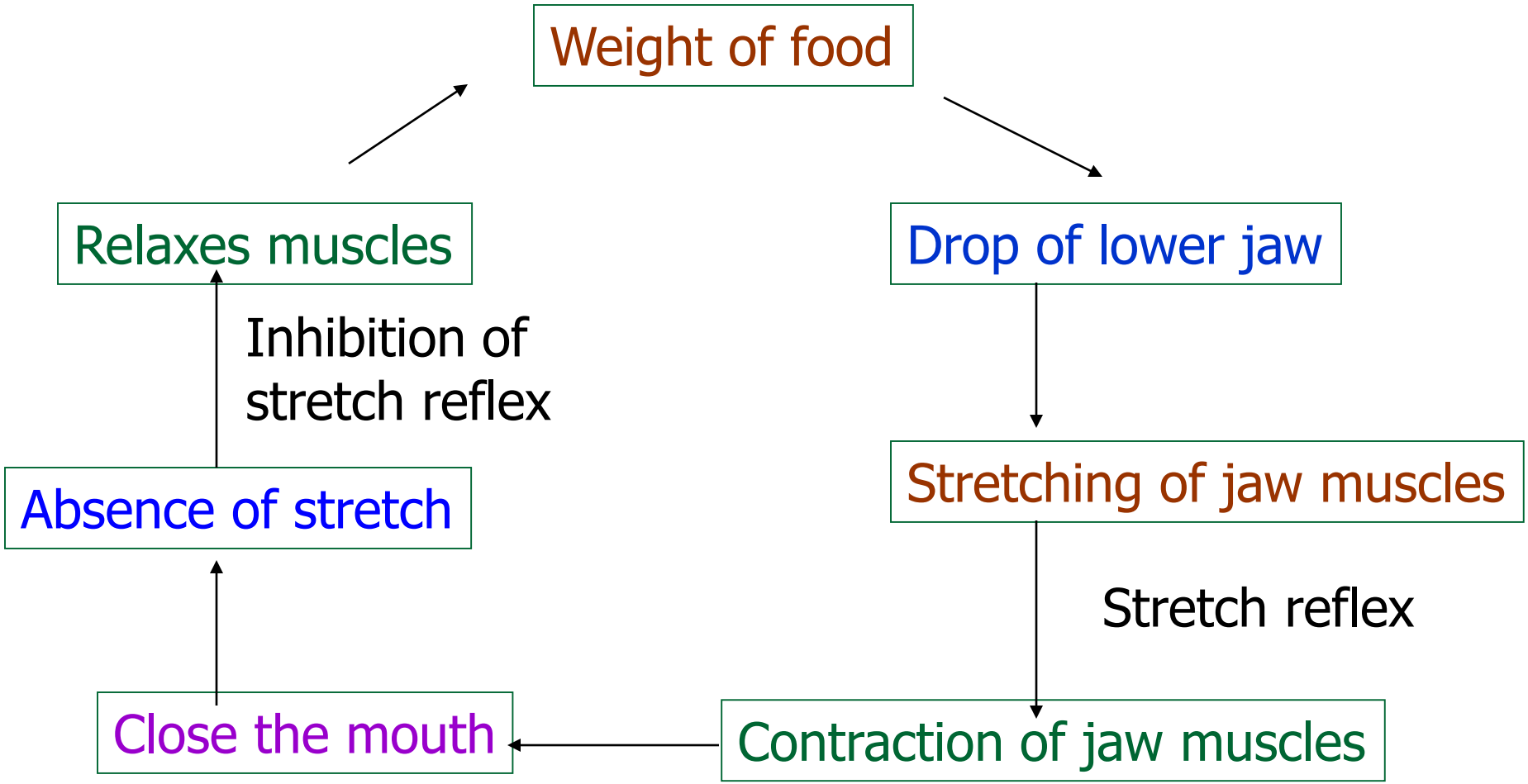
1. Mixes food with saliva
    - lubricates & facilitates swallowing
    - exposes starch in food to salivary amylase
2. Reduces the size of food particles
    - facilitate swallowing

During chewing

- Anterior teeth (incisors) have strong cutting action
- Poster teeth (molar) has grinding action

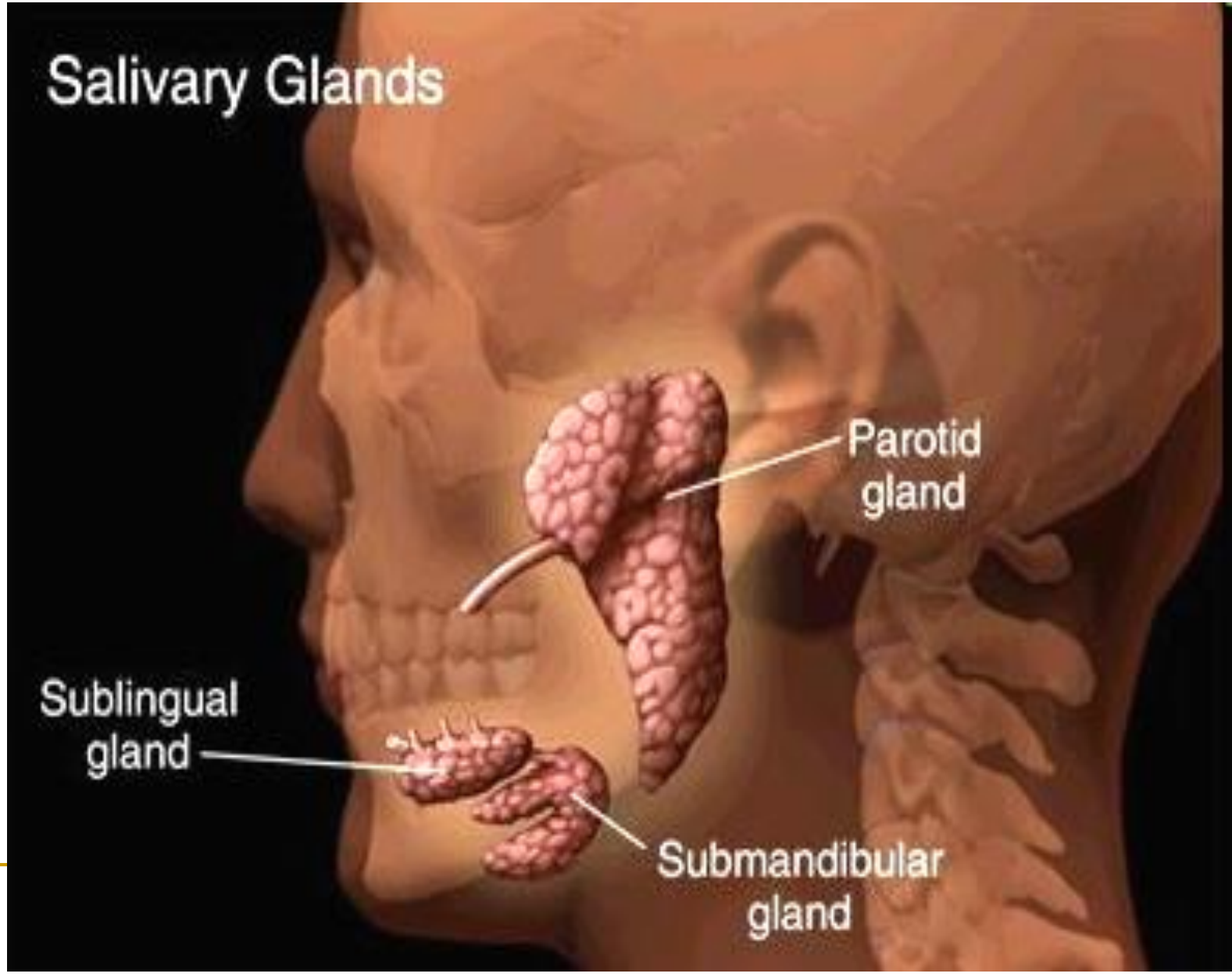
- The act of chewing both voluntary and involuntary
- Most of the time proceeds by reflex actions void of conscious input
- liquids - propelled immediately from the mouth and to the oropharynx and swallowed

Chewing reflex



Saliva

Saliva


Salivary Glands
Parotid gland
Sublingual gland
Submandibular gland

SALIVARY SECRETIONS

In humans

- about 1.5L of saliva each day
- Clear fluid, slightly alkaline

It is secreted by the paired

1. Parotid gland
   - 20% of salivary secretion
   - Serous
2. Sublingual
   - 5% of salivary secretion
   - Viscous
3. submandibular
   - 70% of salivary secretion
   - Mixed – moderately viscous

Composition of saliva

- Hypotonic
- water
- ions (Na^{+}, K^{+}, Cl^{-},HCO_3^{-},Ca^{+2})
- mucin
- digestive enzymes (salivary amylase -ptyalin)
- other components in small amounts (RNAase, DNAase, lysozyme, peroxidase, lingual lipase, secretory IgA, lactoferrin)

Functions of saliva-

1. Digestion – enzymes
   - Starch – salivary amylaze
   - Lipid – lingual lipase
2. Lubrication – mucin
   - Protect oral mucosa
   - Assist speech and swallowing
3. Defense – IgA, lactoferrin, lysozyme

4. Protect teeth
   - Wash teeth
   - Proline rich protein
   - Saturated with calcium

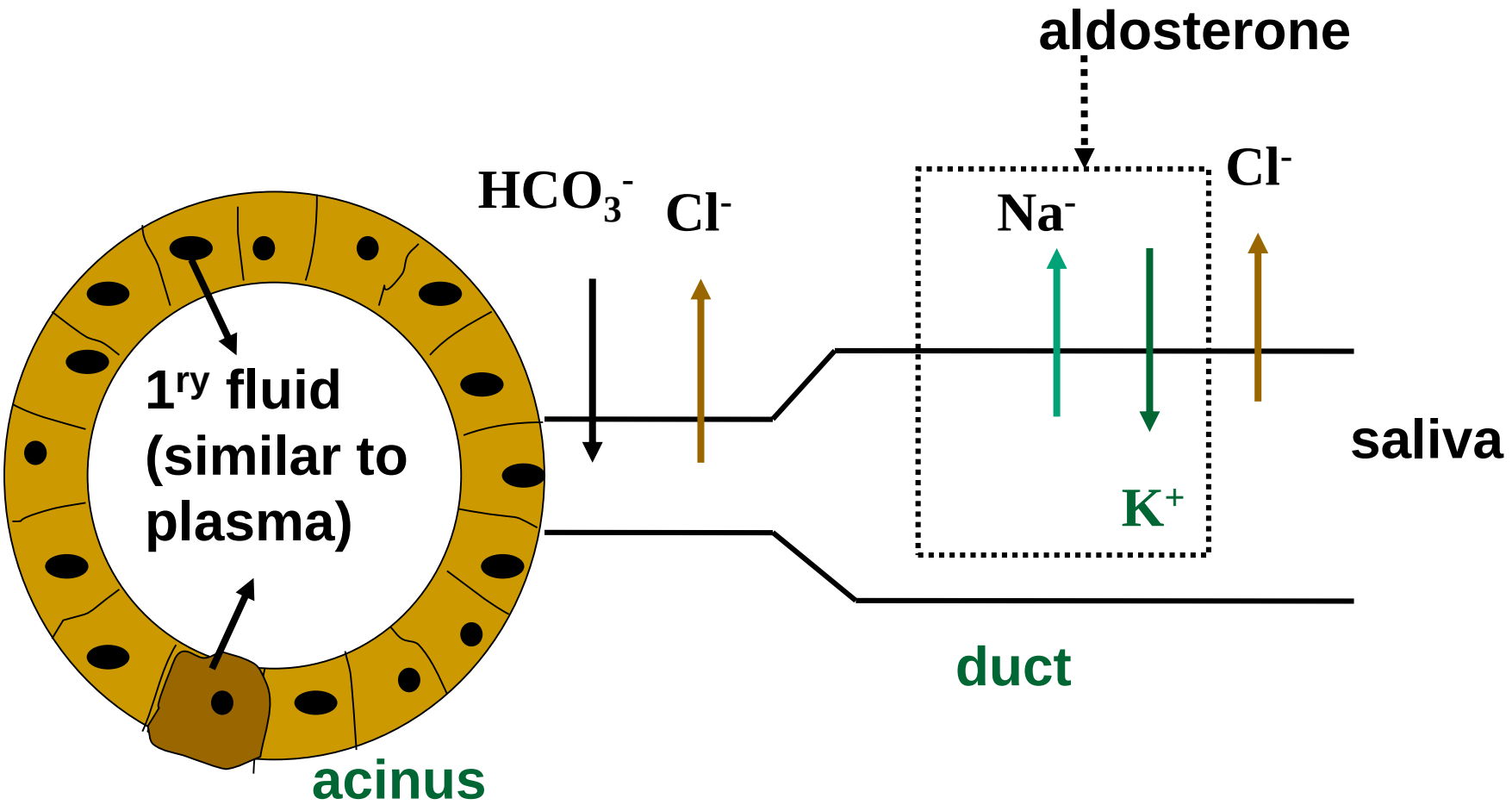
5. Bind toxins
   - Prolein rich protein – bind tanin

6. Chelate iron – lactoferrin

7. Taste
   - dissolve food particles help stimulating taste buds

8. Neutralize acid regurgitated into oesophagus

Salivary secretion



Formation of saliva-

- At low secretory rates it is hypotonic (more time for Na^+ and Cl^- reabsorption) and approaches isotonicity at maximal rates.

- Concentration of Na^+ and Cl^- in saliva < in plasma
  Concentration of K^+ in saliva > in plasma.

- Concentration of HCO_3^- in saliva >in plasma except at low flow rates (when the gland activity increases, salivary gland agonists act on ionic channels to maintain the HCO_3^- secretion)

Regulation of salivary secretion by the CNS

Regulation of salivary secretion by the CNS

- **chewing**
- **taste; smell**
- **nausea**
- **conditioned reflexes**

Salivary nucleus in the medulla

sleep
fatigue
dehydration
fear

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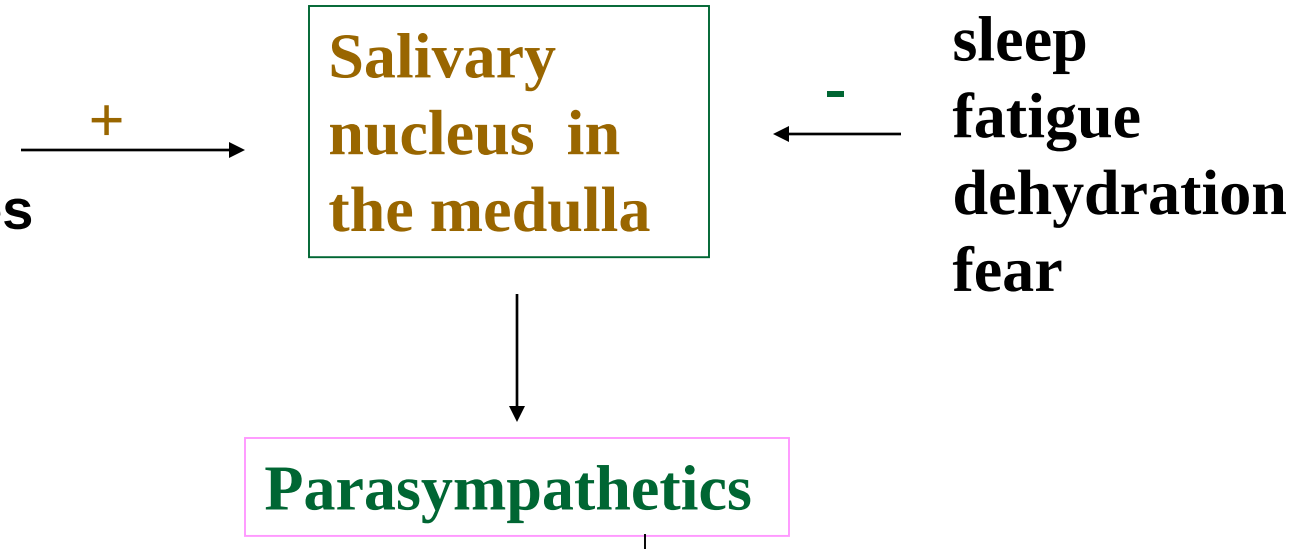


Regulation of salivary secretion by the CNS

- chewing
- taste; smell
- nausea
- conditioned reflexes

+

Salivary nucleus in the medulla

-

sleep
fatigue
dehydration
fear

Parasympathetics

9^{th} CN

7^{th} CN

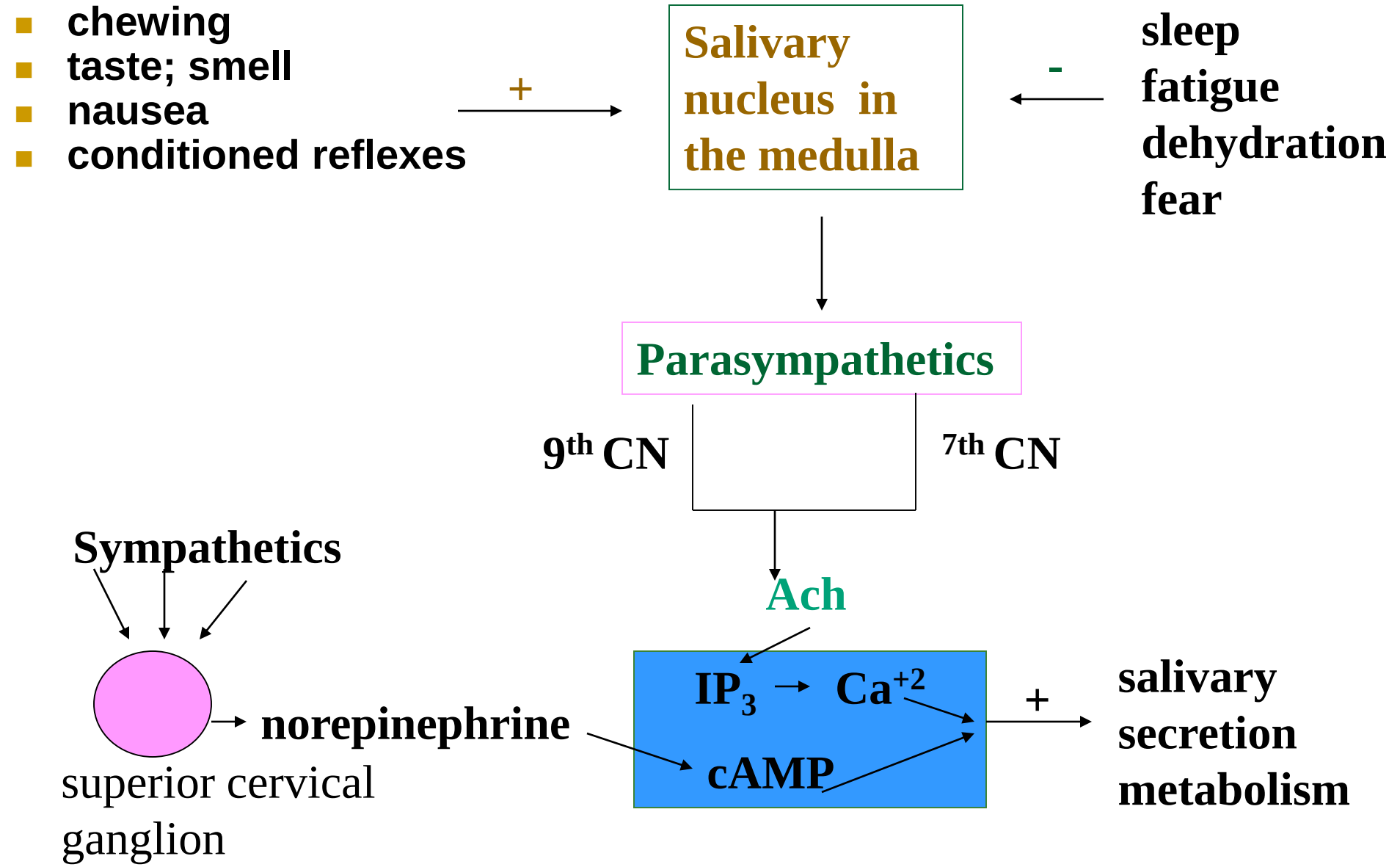
Ach

$IP_3 \rightarrow Ca^{+2}$

+

salivary secretion
metabolism

Regulation of salivary secretion by the CNS



Regulation of salivary secretion

- Salivation is under total control of the autonomic nervous system
- Both sympathetic and parasympathetic nervous system when stimulated increase salivary secretion. **Parasympathetic stimulation is more important**
- Aldosterone & ADH modify the ionic content of saliva but do not regulate the flow rate
- Agonists that increase Ca^{+2} have a greater effect on the volume of acinar secretion.
- Agonists that increase intracellular cAMP increases the enzyme & mucus content of saliva

Effects of impaired salivary secretion

Features of dry mouth (xerostomia)

- difficulty in swallowing food
- difficulty in speaking (e.g. in fear)
- increase in the incidence of dental caries
- increase in the incidence of infections in the
- buccal mucosa