كُلُّ نَفْسٍ ذَآئِقَةُ الْمَوْتِ

Every soul will taste death.

Qur'an, Surah Al-Imran 3:185

The Taste Pathway

BY DR SARAH SHAHID

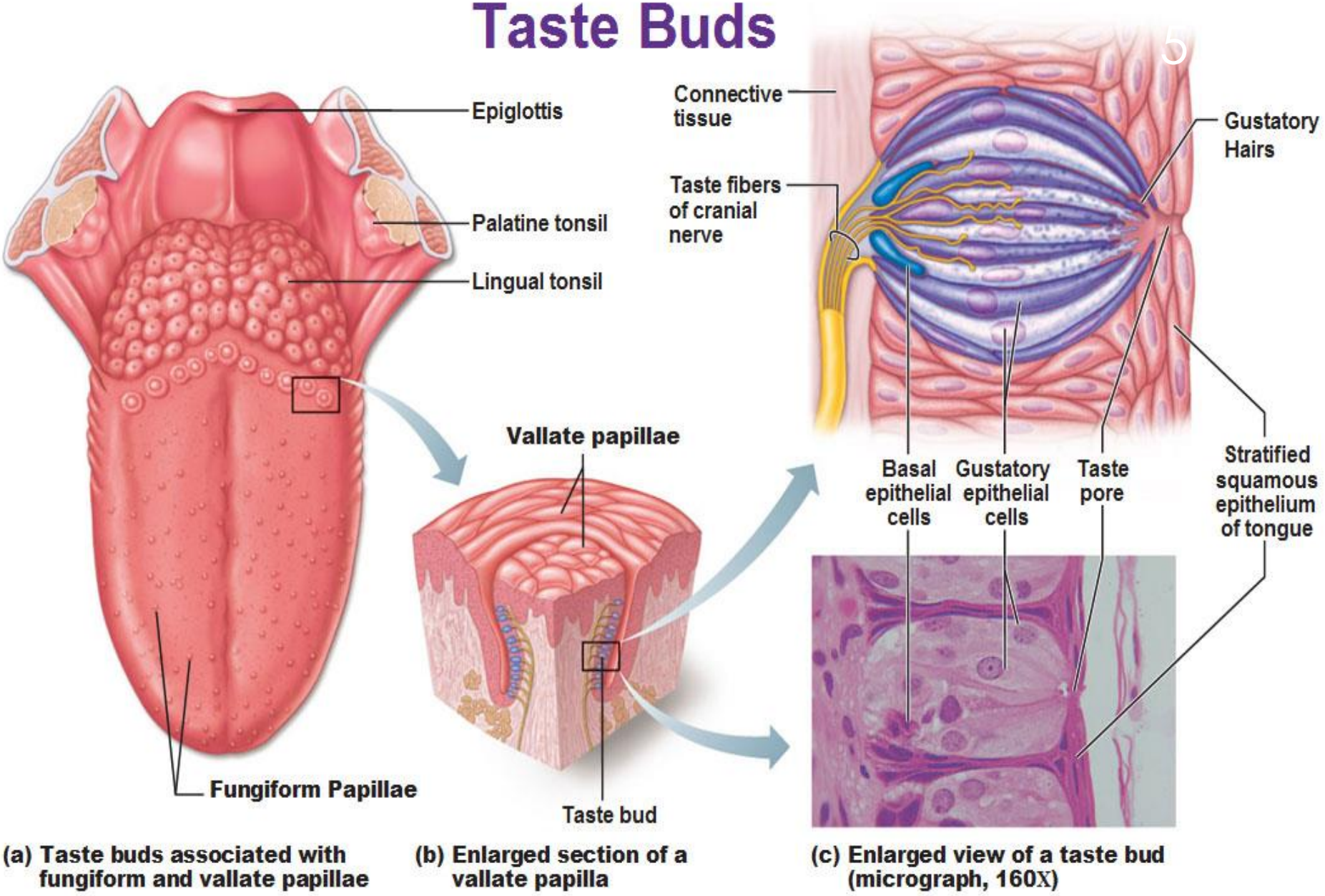
LEARNING OBJECTIVES

- Name the major taste receptors and signal transduction mechanisms in these receptors.
- Outline the pathways by which impulses generated are transmitted to the brain.
- Identify the cortical areas involved in gustation.
- Name the abnormalities of taste sensation.

Recap…

- Mainly a function of taste buds in mouth, but one's sense of smell also contributes strongly to taste perception.
- We can perceive hundreds of different tastes but their are Five primary taste modalities.
- Four major types of lingual papillae which contain the taste buds.
- Taste bud is composed of taste receptor cells, supporting cells , the microvilli which bind to the tastant .
- Interwoven around the cells are branching terminal network of taste nerve fibers from the cranial nerves

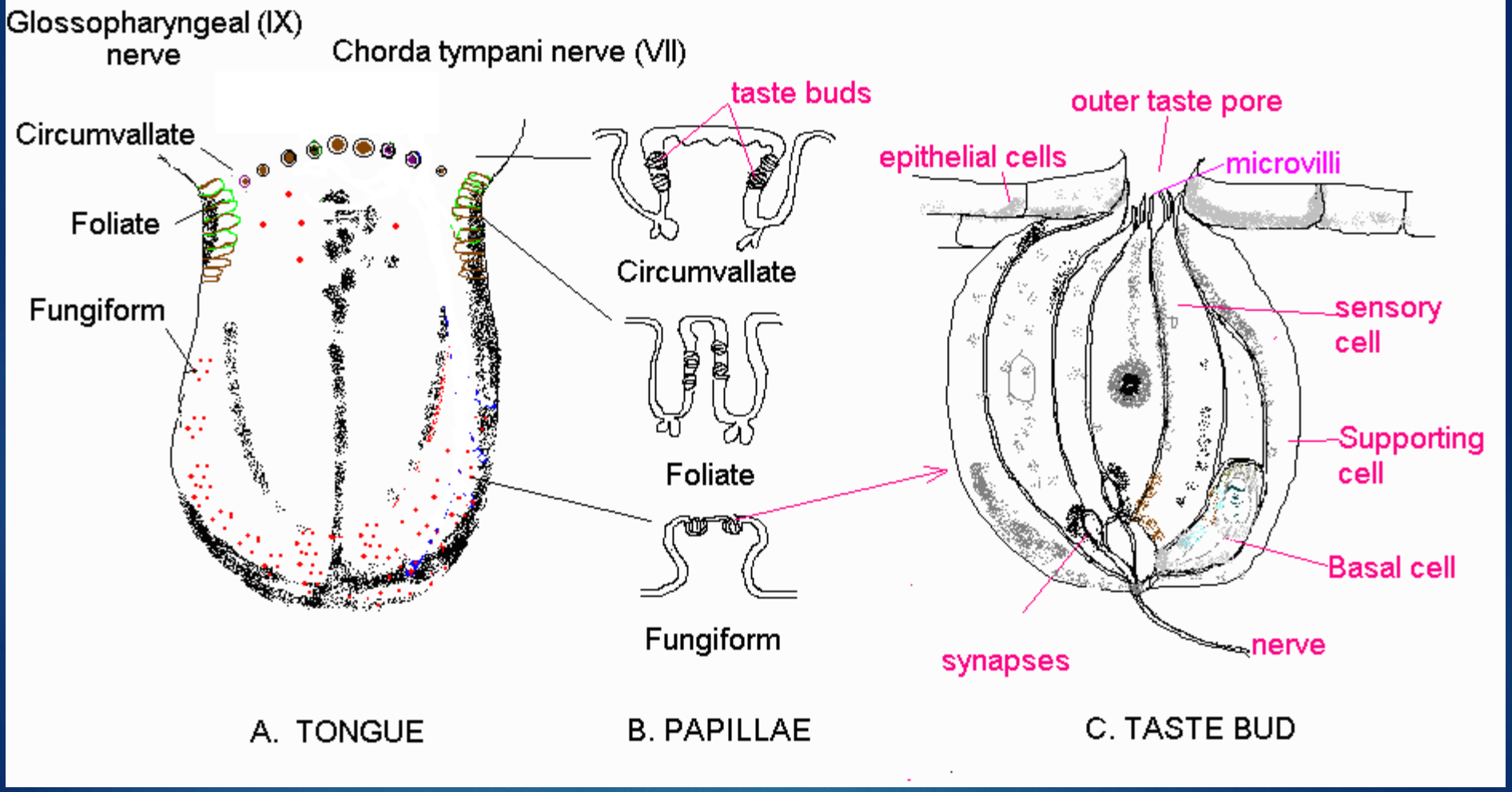
Taste Buds



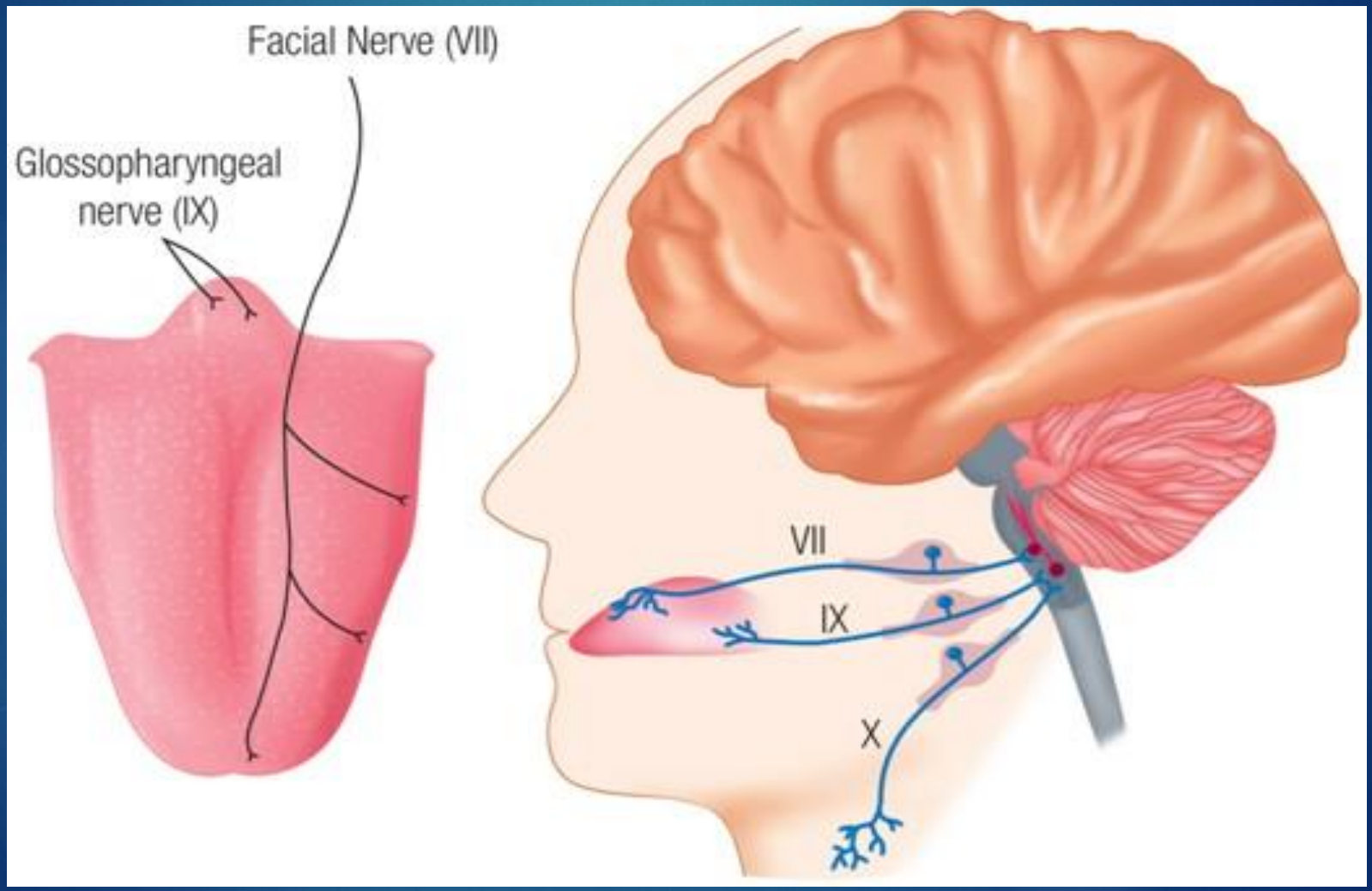
(a) Taste buds associated with fungiform and vallate papillae

(b) Enlarged section of a vallate papilla

(c) Enlarged view of a taste bud (micrograph, 160X)


Glossopharyngeal (IX) nerve
Chorda tympani nerve (VII)
Circumvallate
Foliate
Fungiform
taste buds
Circumvallate
Foliate
Fungiform
outer taste pore
epithelial cells
microvilli
sensory cell
Supporting cell
Basal cell
synapses
nerve
A. TONGUE
B. PAPILLAE
C. TASTE BUD

Innervation of the tongue



Mechanism of Taste Receptors Stimulation

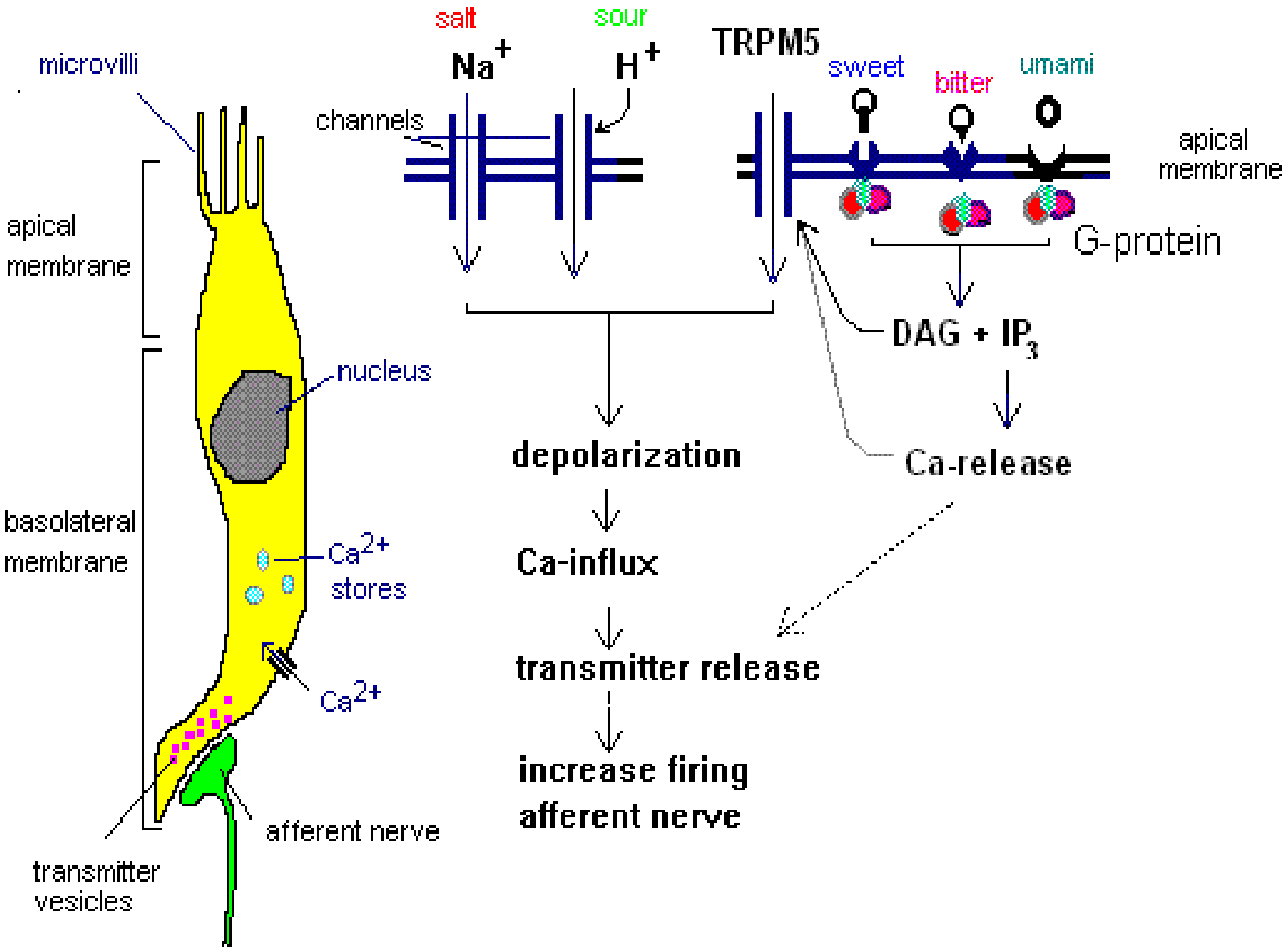
Physiology of Taste

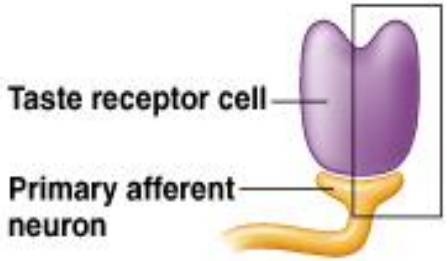
- two mechanisms of action
  - **activate 2nd messenger systems**
    - sugars, alkaloids, and glutamate bind to receptors which activates G proteins and second-messenger systems within the cell
  - **depolarize cells directly**
    - sodium and acids penetrate cells and depolarize it directly
- either mechanism results in release of neurotransmitters that stimulate dendrites at base of taste cells

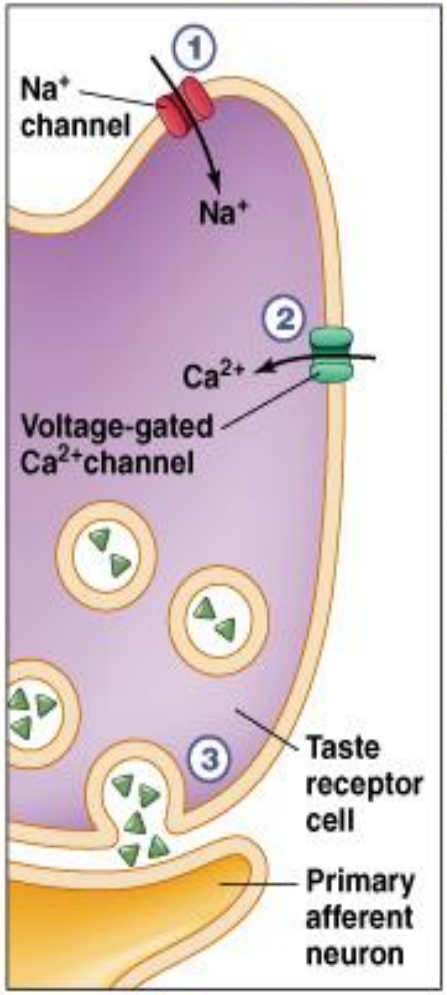
Mechanism Of Stimulation Of Taste Buds

- The membrane of taste cell, like that of most other sensory receptors cells, is negatively charged on the inside with respect to the outside

- Application of a taste substance to taste hairs causes partial loss of this negative potential – that is, taste cell becomes depolarized

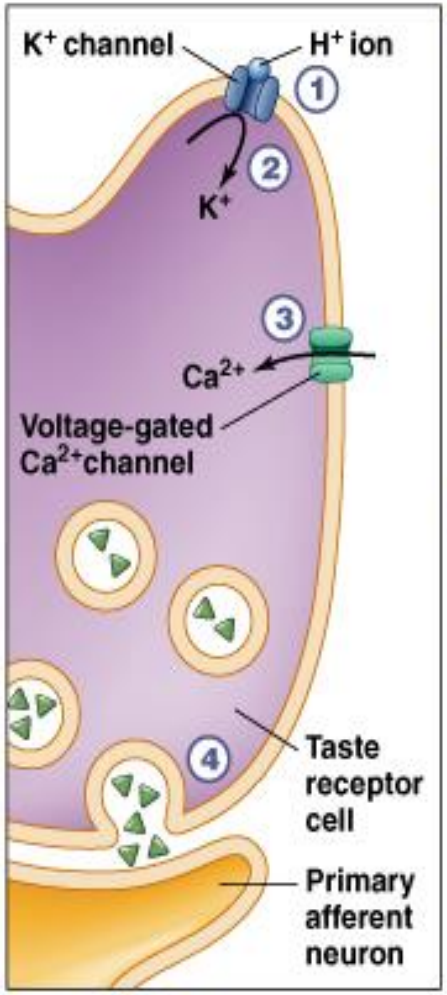

microvilli
apical membrane
nucleus
basolateral membrane
Ca^{2+} stores
Ca^{2+}
afferent nerve
transmitter vesicles
salt
sour
Na^+
H^+
channels
TRPM5
sweet
bitter
umami
apical membrane
G-protein
DAG + IP_3
depolarization
Ca-release
Ca-influx
transmitter release
increase firing afferent nerve





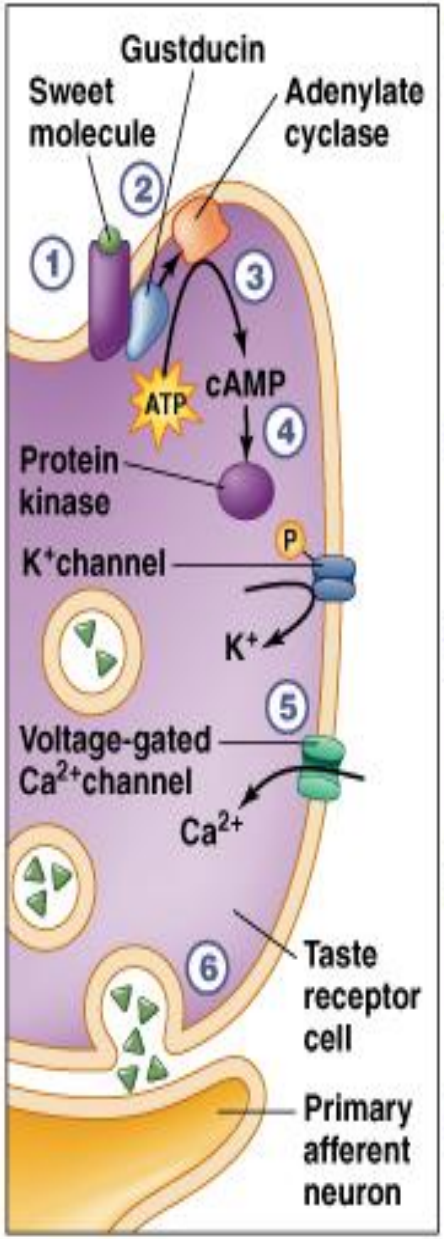
1. Na^+ from salty food enters through a Na^+ channel.
2. The resulting depolarization opens voltage-gated Ca^{2+} channels.
3. The influx of Ca^{2+} causes neurotransmitter release.

(a) Salty



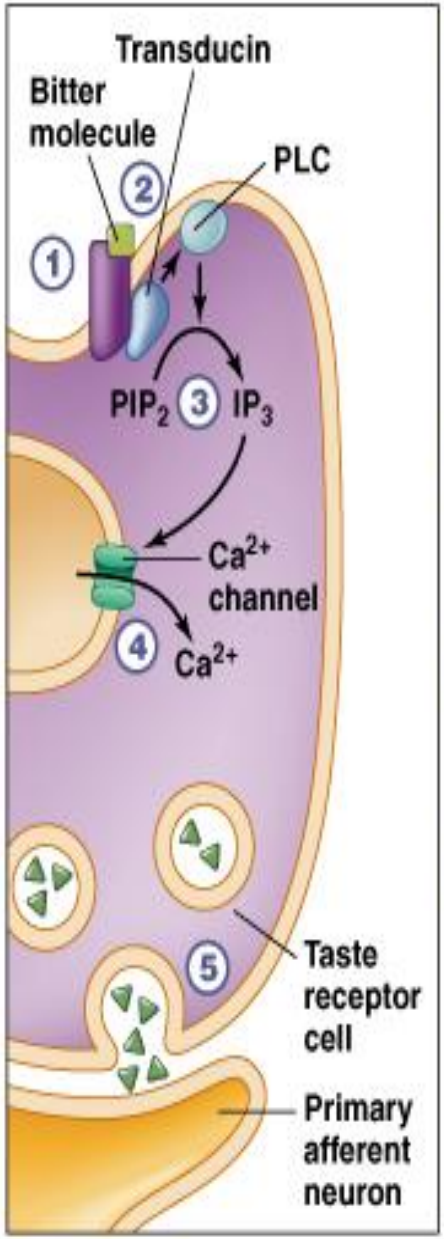
1. H^+ ions from sour foods block the K^+ channel.
2. This blockage prevents K^+ from leaving the cell.
3. The resulting depolarization opens voltage-gated Ca^{2+} channels.
4. The influx of Ca^{2+} causes neurotransmitter release.

(b) Sour



1. A sweet substance binds to its receptor, causing a conformational change.
2. The activated G protein, gustducin, activates adenylate cyclase.
3. Adenylate cyclase catalyzes the conversion of ATP to cAMP.
4. The cAMP activates a protein kinase that phosphorylates and closes a K^+ channel.
5. The resulting depolarization opens voltage-gated Ca^{2+} channels.
6. The influx of Ca^{2+} causes neurotransmitter release.

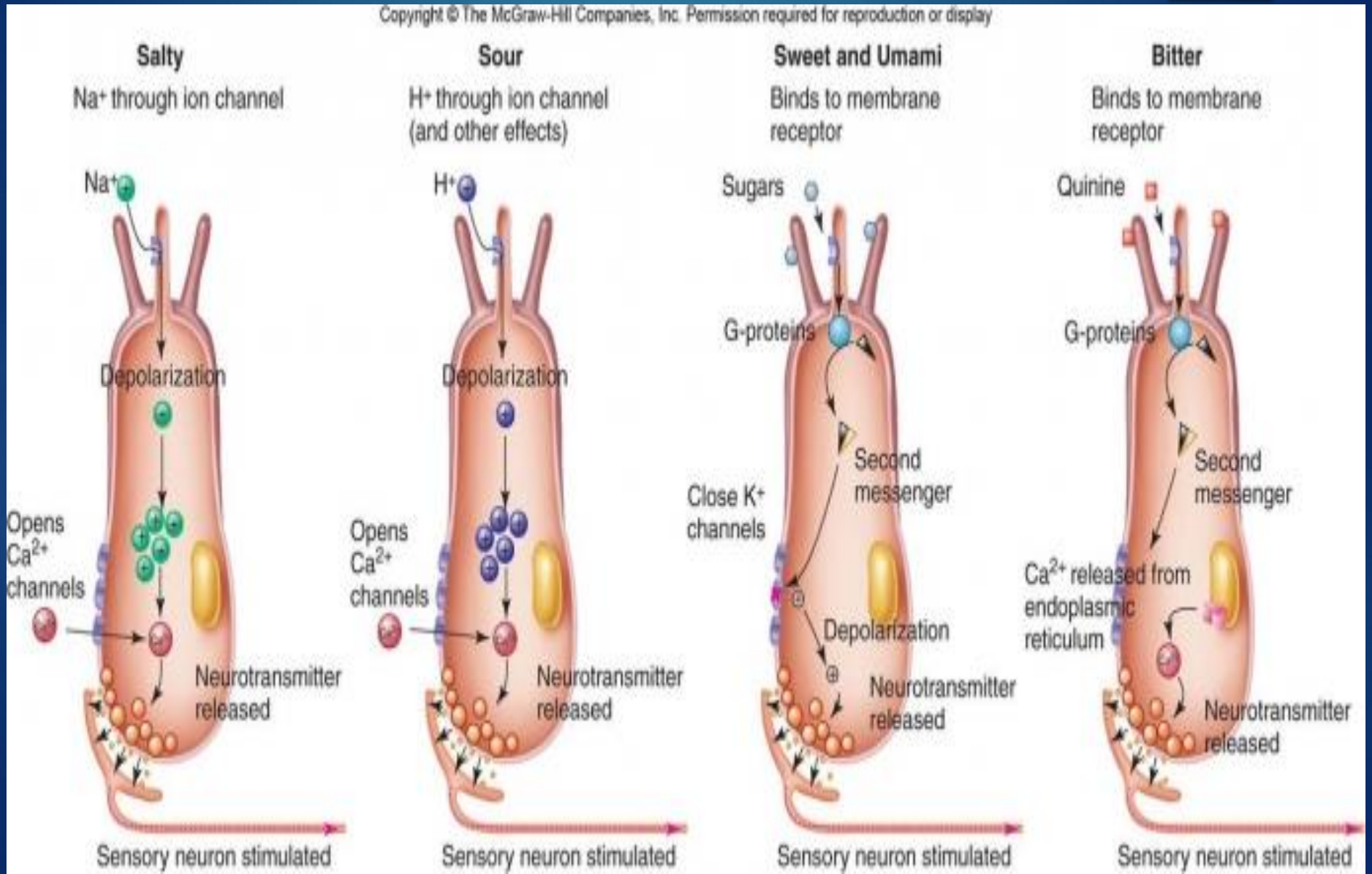
(c) Sweet



1. A bitter substance binds to its receptor, causing a conformational change.
2. The activated G protein, transducin, activates phospholipase C (PLC).
3. PLC catalyzes the conversion of PIP_2 into the second messenger IP_3.
4. IP_3 causes the release of Ca^{2+} from intracellular stores.
5. The influx of Ca^{2+} causes neurotransmitter release.

(d) Bitter

Mechanism Of Stimulation Of Taste Buds



MECHANISM OF STIMULATION OF TASTE BUDS

Testant (in sol. form) enters pores of taste buds

↓

Reacts with receptor molecule on microvilli

↓

Opening/closure of ion channels (diff. for diff. taste modalities)

↓

Partial loss of negative potential (receptor potential)

↓

Increase in Ca^{++} within taste cell

↓

Neurotransmitter release

↓

Action potential in sensory nerve

"I don't know... it tastes funny!"

The Gustatory Pathway

Generation Of Nerve Impulses By Taste Buds

- On **first application** of taste stimulus → rate of discharge of nerve fibers from taste buds rises to a peak in a small fraction of a second but then adapts within the next few seconds back to a lower, steady level as long as taste stimulus remains

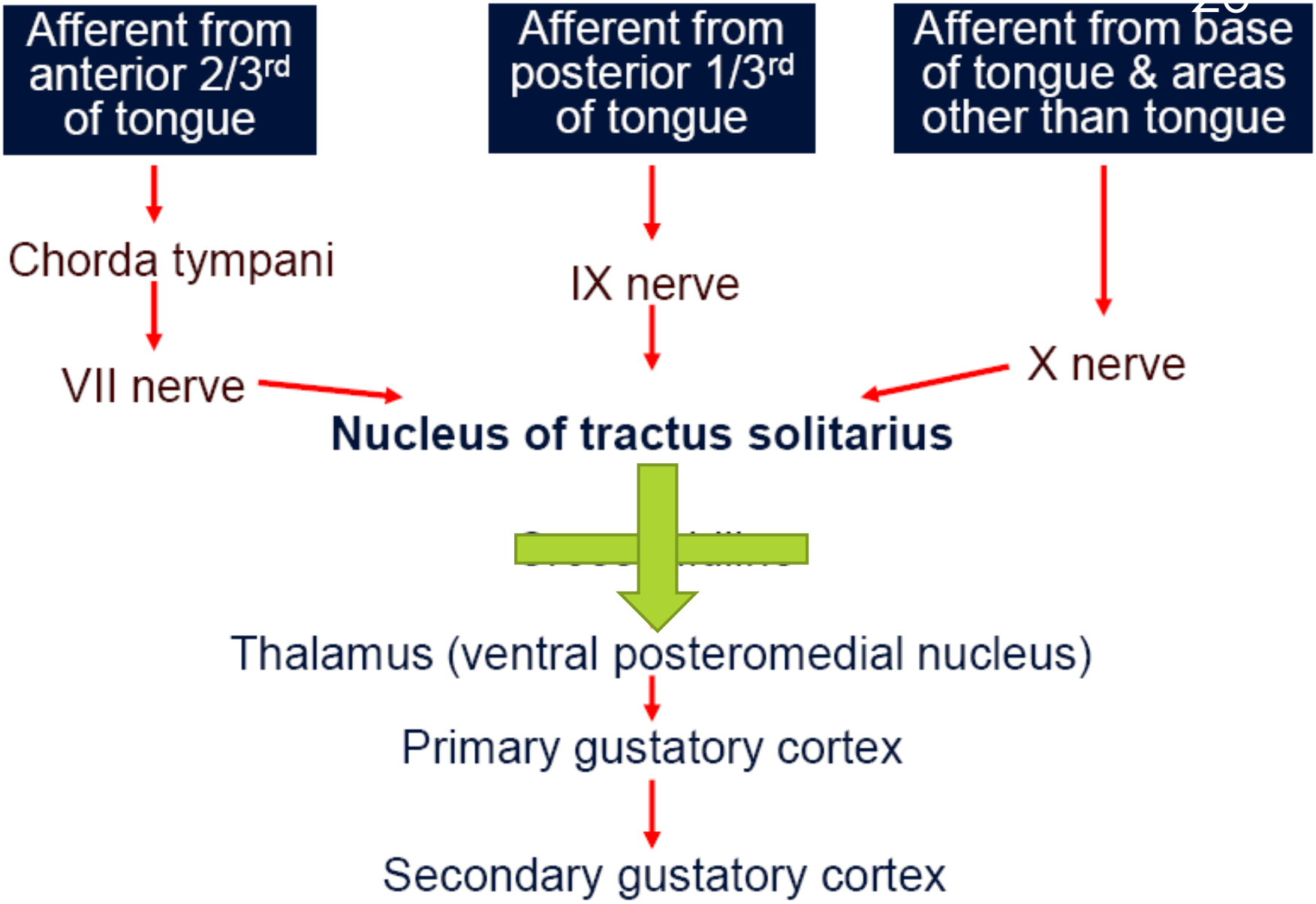
- A strong immediate signal is transmitted by taste nerve, and a weaker continuous signal is transmitted as long as taste bud is exposed to taste stimulus

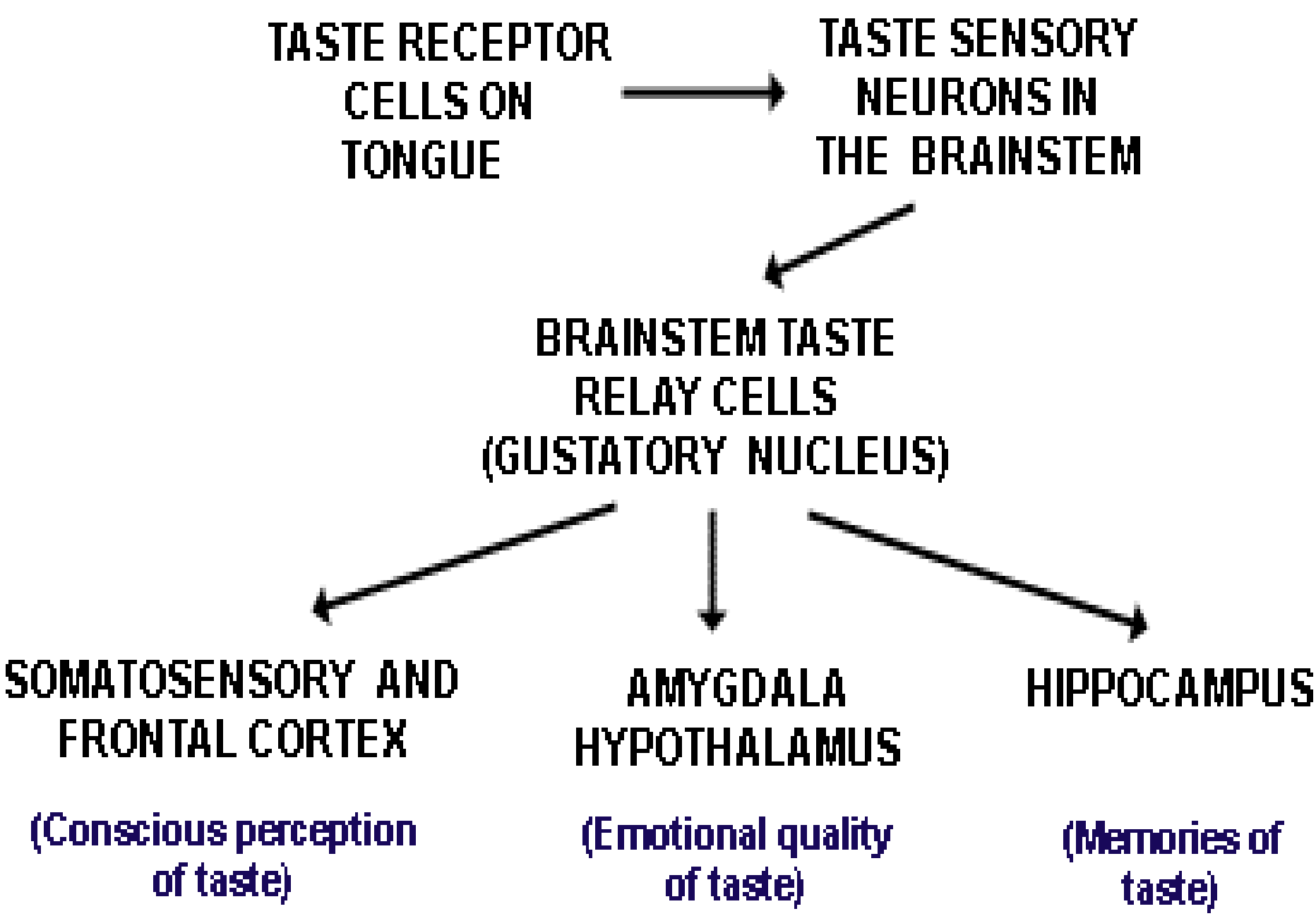
The Gustatory Pathway

Gustatory Pathway

- ***gustatory fibers/axons*** found in three cranial nerves
  - VII (facial) serves anterior 2/3 of tongue
  - IX (glossopharyngeal) serves posterior 1/3 of tongue
  - X (vagus) serves palate & epiglottis
- Signals travel to thalamus - extend from the thalamus to the ***primary gustatory area*** on parietal lobe of the cerebral cortex
  - provide conscious perception of taste
- Taste fibers also extend to limbic system – association of taste with a memory

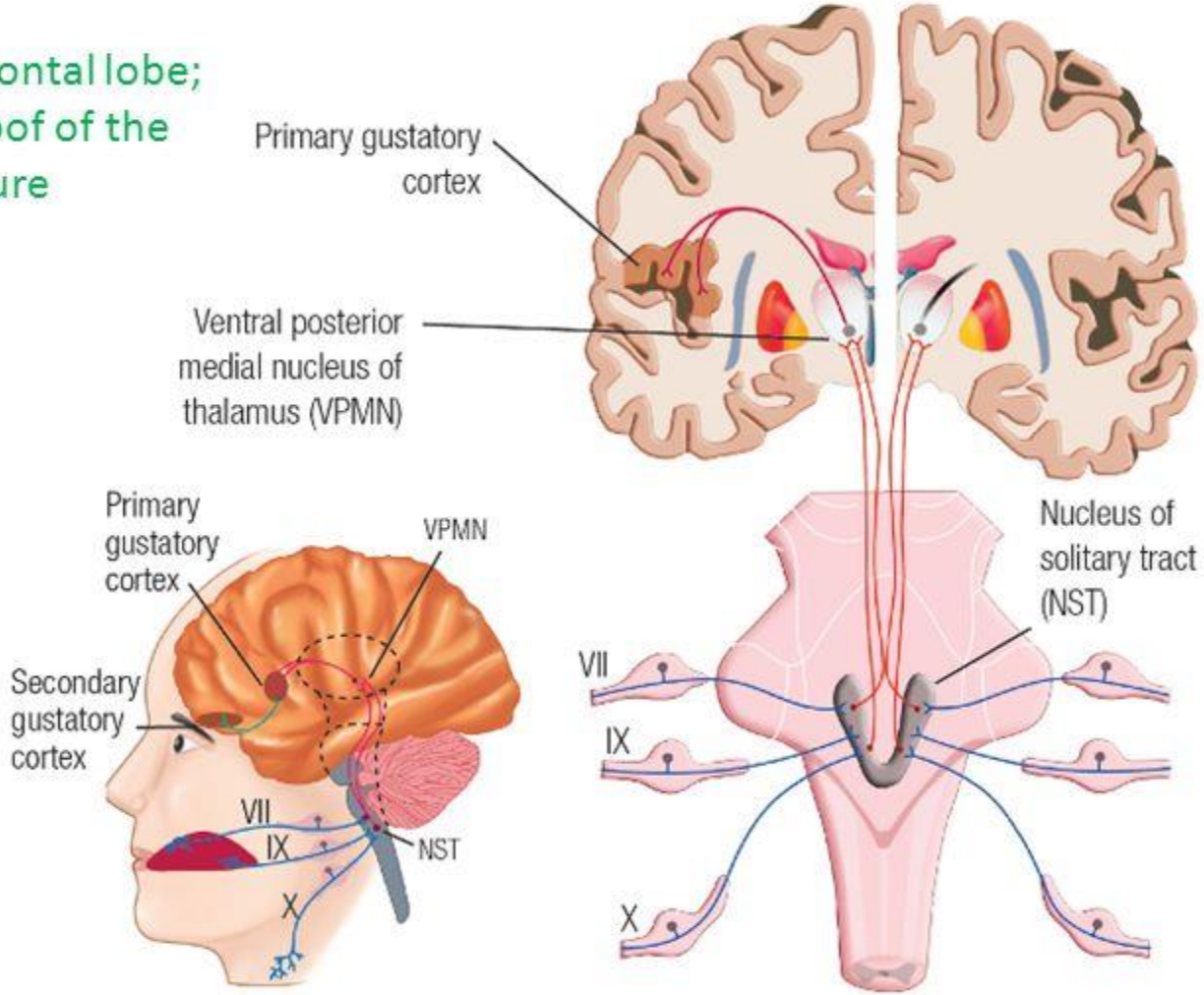
TRANSMISSION OF TASTE SIGNALS INTO CNS




TASTE RECEPTOR CELLS ON TONGUE
TASTE SENSORY NEURONS IN THE BRAINSTEM
BRAINSTEM TASTE RELAY CELLS (GUSTATORY NUCLEUS)
SOMATOSENSORY AND FRONTAL CORTEX
(Conscious perception of taste)
AMYGDALA HYPOTHALAMUS
(Emotional quality of taste)
HIPPOCAMPUS
(Memories of taste)

Ascending Taste Pathways

Posterior frontal lobe; buried in roof of the Sylvian fissure



Primary Taste Cortex

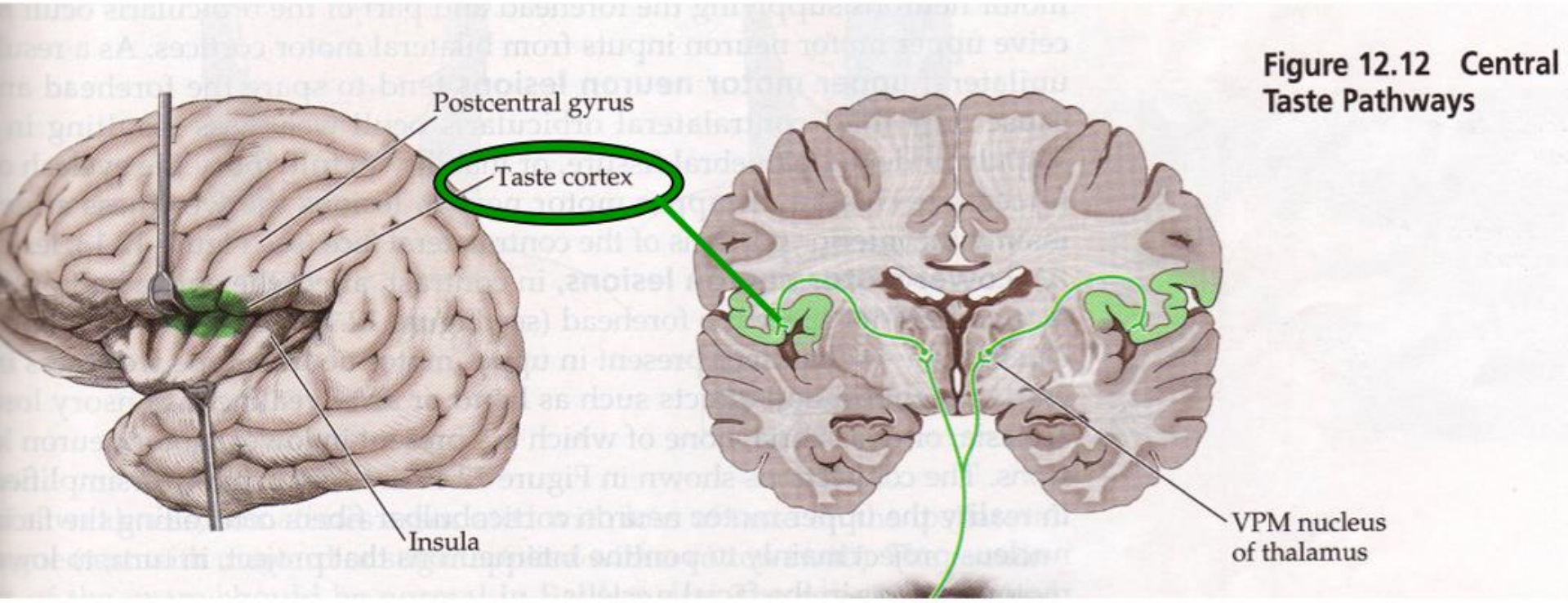
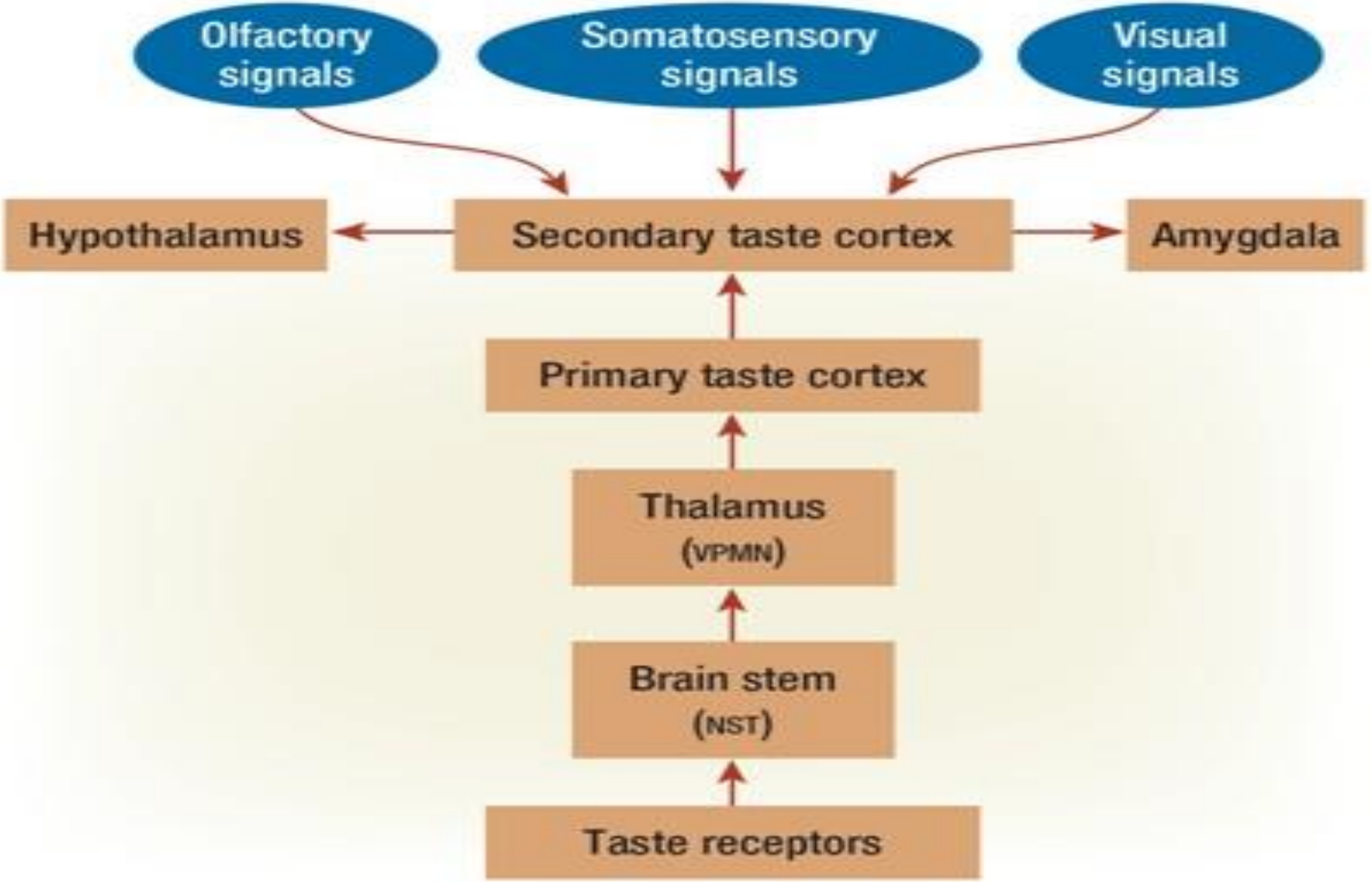
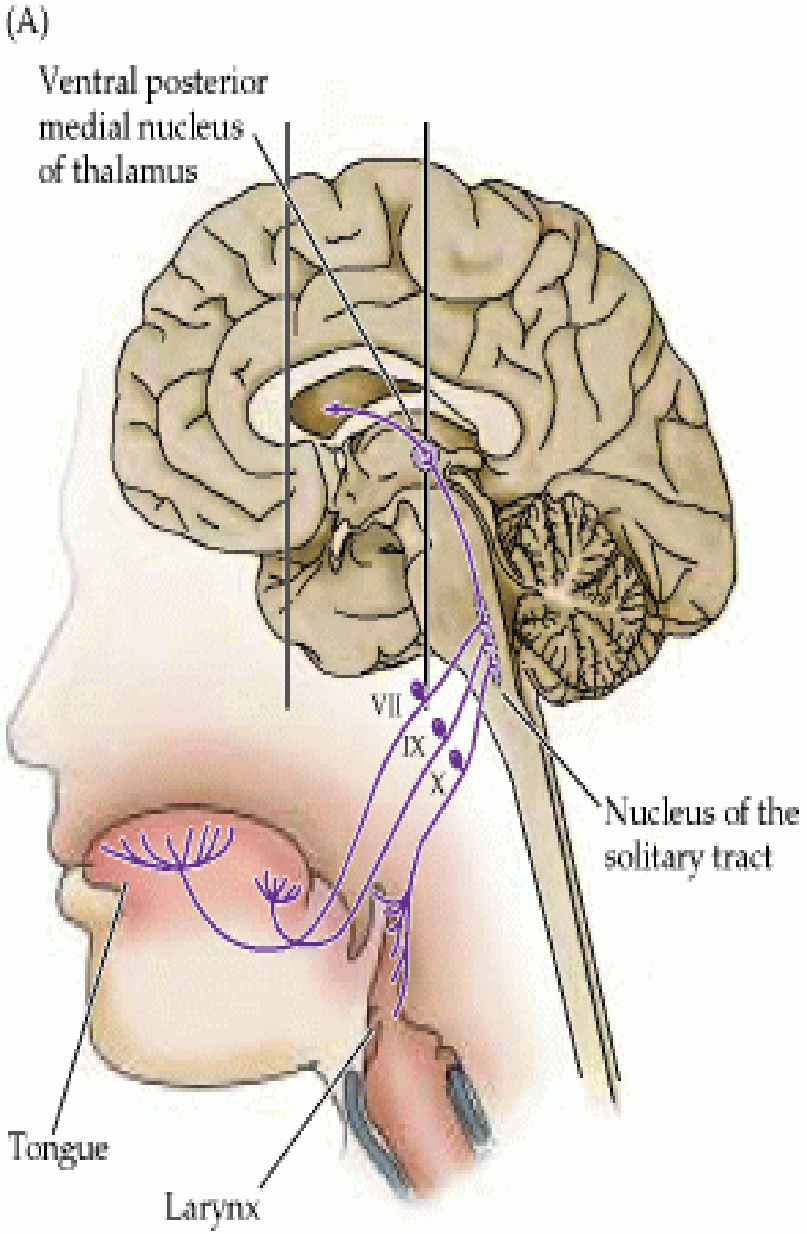


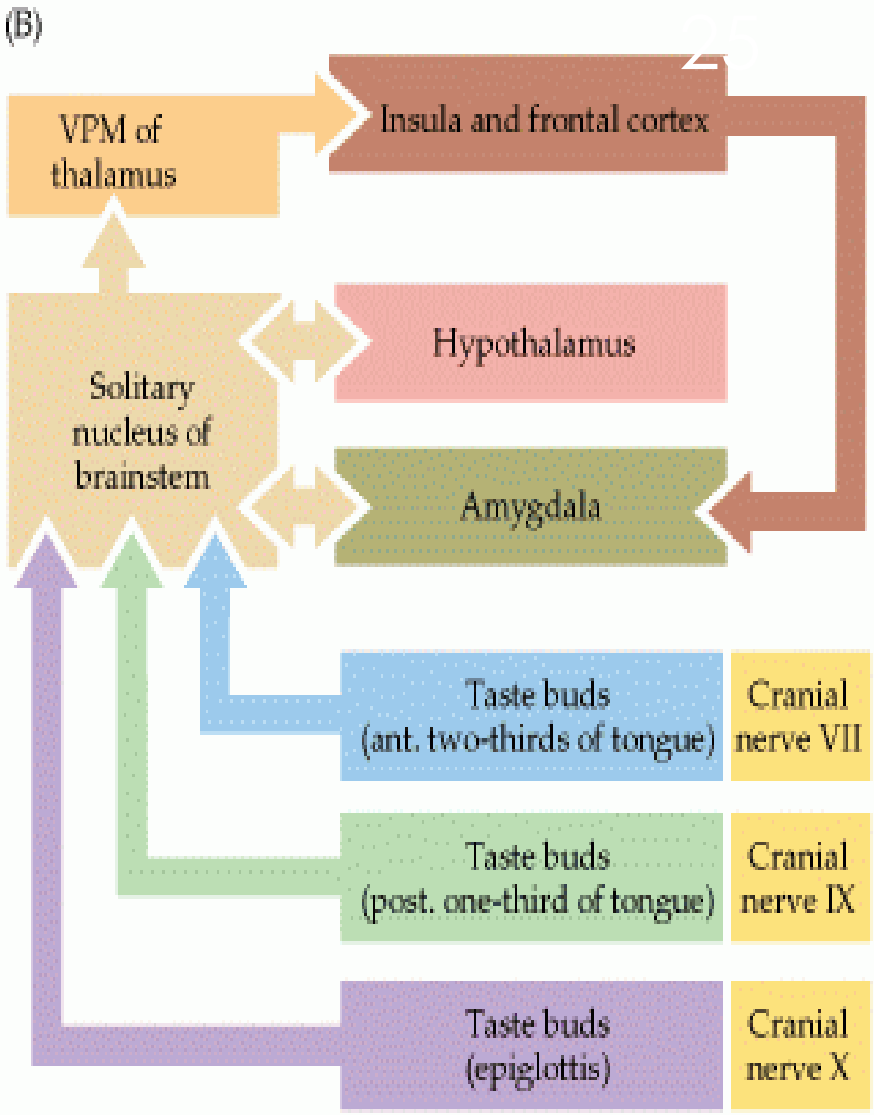
Figure 12.12 Central Taste Pathways

In Parietal lobes…posterior to central sulcus in lateral sulcus

Integration Of Flavour




(A)
Ventral posterior medial nucleus of thalamus
VII
IX
X
Nucleus of the solitary tract
Tongue
Larynx


(B)
VPM of thalamus
Insula and frontal cortex
Hypothalamus
Solitary nucleus of brainstem
Amygdala
Taste buds (ant. two-thirds of tongue)
Cranial nerve VII
Taste buds (post. one-third of tongue)
Cranial nerve IX
Taste buds (epiglottis)
Cranial nerve X

Taste Preference & Adaptation

Taste Adaptation

- Taste sensations adapt rapidly, often almost completely within a minute or so of continuous stimulation
- Adaptation of the taste buds themselves usually accounts for no more than about half of this
- Final adaptation in taste sensation occurs in the central nervous system
- mechanism and site of this are not known

Taste Preference and Control of Diet

Taste preferences change according to **body's need** for certain specific substances

An animal will **choose** certain types of food in preference to others→ automatically uses this to help control diet it eats

Salt-depleted animals select drinking water with a high sodium chloride content in preference to pure water

An animal given **excessive insulin** → ↓ blood sugar → animal chooses sweetest food

calcium depleted animals choose drinking water with a ↑ content of calcium chloride

Taste Preference….

- Human beings reject any food with an unpleasant sensation → protects our bodies from undesirable substances

- Taste preference is mainly a central nervous system phenomenon because previous experience with unpleasant or pleasant tastes plays a major role in determining one's taste preferences

Abnormalities of Taste

Abnormalities Of Taste

- *Ageusia*

  Loss of the sense of taste.

- *Hypogeusia*

  Diminished taste sensitivity.

- *Dysgeusia*

  Disturbed sense of taste.

- *Taste blindness*

  Rare genetic diorder in which there is inability to recognize taste

Causes Of Taste Disorder

Upper respiratory and middle ear infections

Radiation therapy for head and neck cancer patients

Exposure to certain chemicals like insecticides, some medicines including common antibiotics and antihistamines

Head injury

Some surgeries to ear, nose and throat

Poor oral hygiene and dental problems

Effects Of Taste Disorder

Can **remove** early warning system--- that helps in detection of spoiled food or liquids/ presence of ingredients to which a person is allergic

Can create **serious health issues**, distorted taste sense can be a risk factor for diabetes, heart disease, stroke … that require sticking to a specific diet

Some may eat too little or too much

Can be a sign of degenerative diseases like alzheimers, parkinsons disease

Recommended Books

- Principles of Human Physiology

  -Lauralee Sherwood
- Guyton & Hall
- Ganong's review of Medical Physiology

https://www.youtube.com/watch?v=K9JSBzEEA0o

https://www.youtube.com/watch?v=XCPzPFLn3so


That's all Folks!

THIS IS TASTE OF EVEN MORE TO COME,.


Questions,
Comments,
Feedback?