جامعة الملك سعود
King Saud University

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MED437

7th Lecture | The Physiology Team

Physiology of the smell and taste

Objectives:

- Appreciate the physiology of olfaction & taste
- Describe the olfactory & taste pathways
- Appreciate some pathophysiological conditions related to olfaction & taste

Done by:

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Colour index:
- important
- ;)
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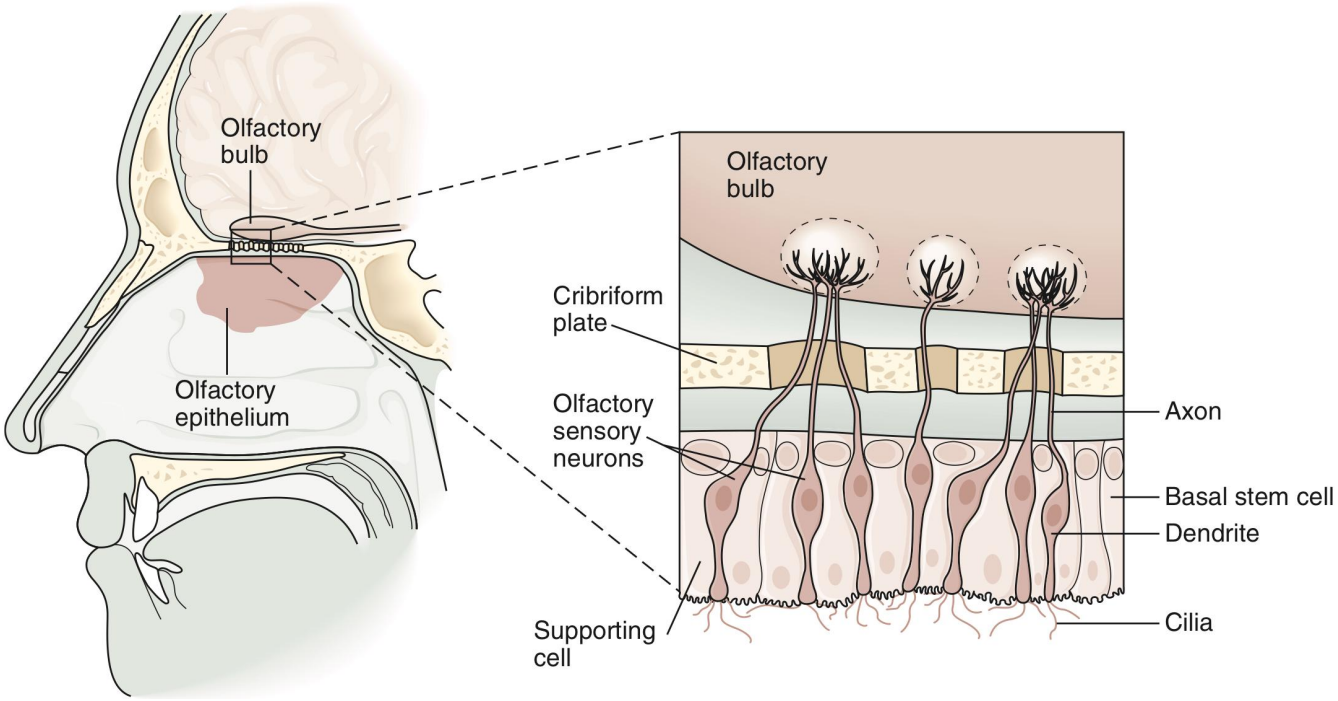
وَأَن لَّيْسَ لِلْإِنسَانِ إِلَّا مَا سَعَىٰ

Anatomy of olfaction

- **Olfactory epithelium** "mucus": in the roof of nasal cavity near the septum
  - Contain olfactory receptors (bipolar neurons)
  - Axons collected in bundles called **fila olfactoria**



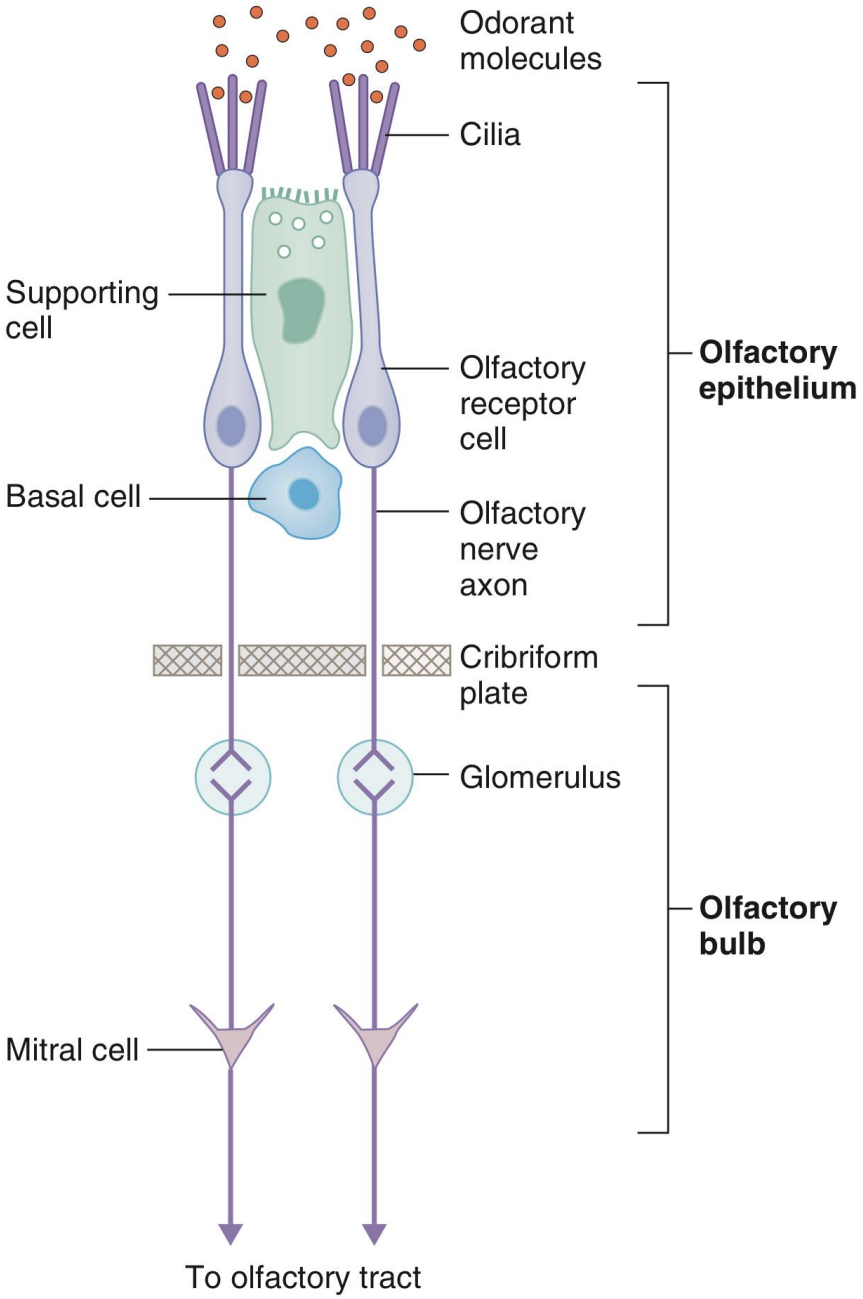
Physiology of olfaction

- ➔ Power of perceiving odors is called **smell**
- ➔ Olfactory receptors present in the **roof of nasal cavity**
- ➔ Neurons with long cilia (olfactory hairs)
- ➔ Chemicals must dissolved in mucus for detection
- ➔ Impulses transmitted via the **olfactory nerve**
- ➔ Interpretation of smells is made in the **olfactory cortex of the brain**

- ★ Human can differentiate between 2000-4000 odours
- ★ Adaptation can occur to pleasant and nasty smells due to changes both in receptors and central connections

Olfactory Transduction

Molecules dissolve in mucus layer ➡ combine with receptors on cilia ➡ stimulate adenylate cyclase ➡increase intracellular cAMP ➡opening of Na channels ➡receptors potential ➡AP in olfactory pathway



Olfactory pathway

- Fila olfactoria enter olfactory bulb ➡ synapse with mitral and tufted cells ➡ from mitral cells lateral and intermediate stria start ➡ end on ipsilateral cortex

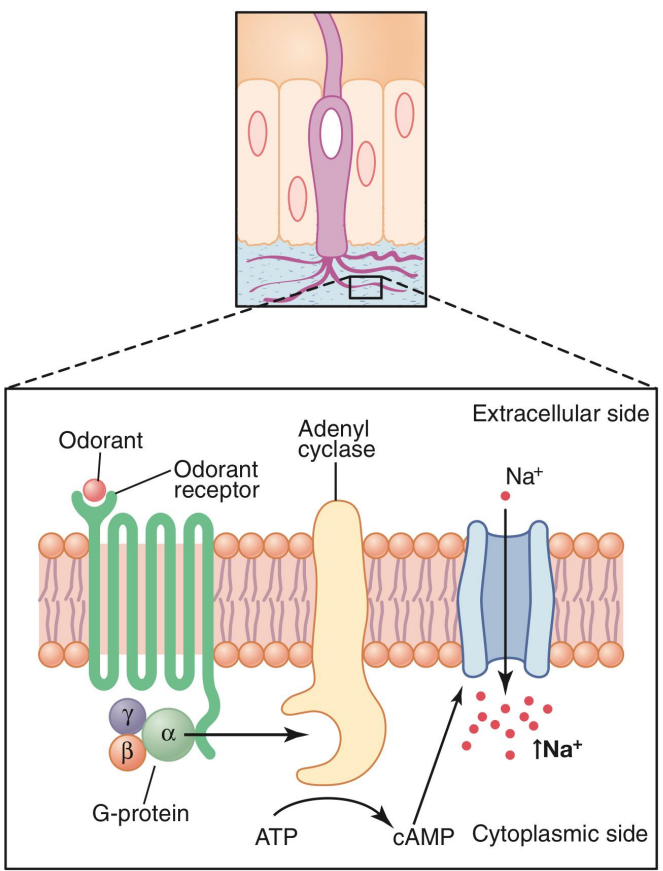
from tufted cells medial stria start then cross the midline & end on granular cells in opposite side (contralateral)

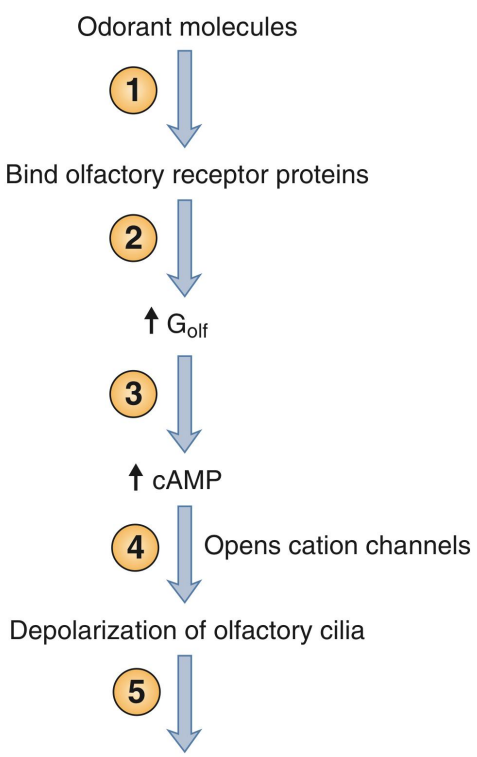
★ Impulses travel along the olfactory tracts to **the limbic system** – (also involved in emotions and memory)

★ Impulses are interpreted in **olfactory cortex** – Deep in temporal lobe and base of frontal lobe

Mechanism of olfactory cell stimulation:

Oduran + receptor protein ➡ Activation of G protein ➡ Activation of adenylate cyclase ➡ ATP to cAMP ➡ Opening of Na+ channels ➡ Na+ influx ➡ depolarization



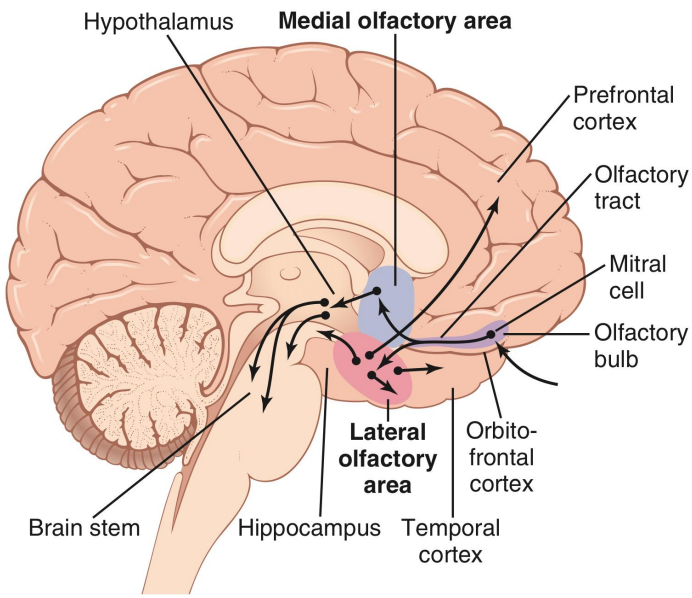


The Olfactory Pathway

Olfactory receptor cell ➡ olfactory nerve ➡ olfactory bulb ➡ olfactory tract

- **Medial olfactory area**
  - **Septal Nuclei**
    - Hypothalamus
      Limbic system
      (primitive parts)
      Primitive olfactory system
      - Primitive reflexes, such as licking the lips, salivation, and other feeding responses caused by the smell of food or by basic emotional drives associated with smell.
- **Lateral olfactory area**
  - **Prepyriform cortex**
    Pyriform cortex
    Amygdala
    - Limbic System
      (hippocampus)
      (Less old olfactory system)
      - important for learning to like or dislike certain foods depending on one's experiences with them.
  - **Thalamus**
    - Orbitofrontal Cortex
      (Newer system)
      - helps in the conscious analysis of odor.

An important feature of the lateral olfactory area is that many signal pathways from this area also feed directly into an older part of the cerebral cortex called the paleocortex in the anteromedial portion of the temporal lobe. **this area is the only area of the entire cerebral cortex where sensory signals pass directly to the cortex without passing first through the thalamus.**



Pathophysiology

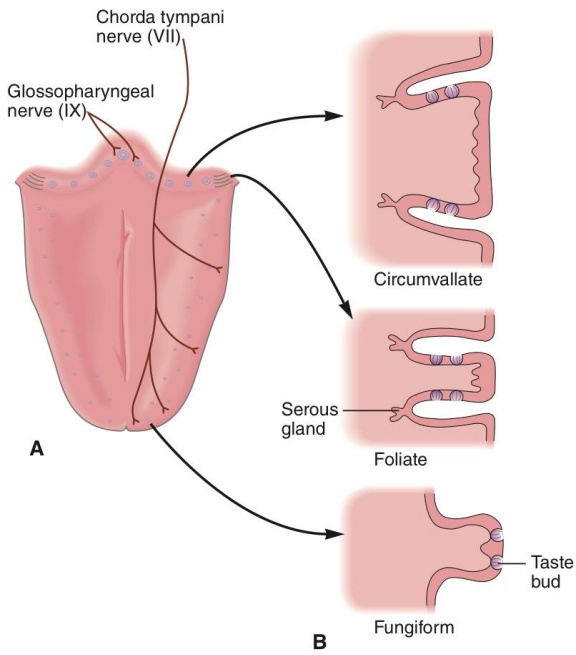
<table>
<tr><th>Disorder</th><th>Description</th></tr>
<tr><td>Anosmia</td><td>• loss of smell sensation
○ Due to damage to olfactory Epithelium</td></tr>
<tr><td>Dysosmia</td><td>• Distorted sense of smell
<table><tr><th>Parosmia</th><th>Phantosmia</th><th>Agnosia</th></tr><tr><td>Alteration in smell sensation</td><td>Perception of smell without an odor present</td><td>Inability to classify or contrast odors, although able to detect odors</td></tr></table></td></tr>
<tr><td>Hyperosmia</td><td>• increase in smell Sensation
○ Adrenal insufficiency</td></tr>
<tr><td>Hyposomia</td><td>• decreased smell Sensation
○ Vitamin A deficiency</td></tr>
</table>

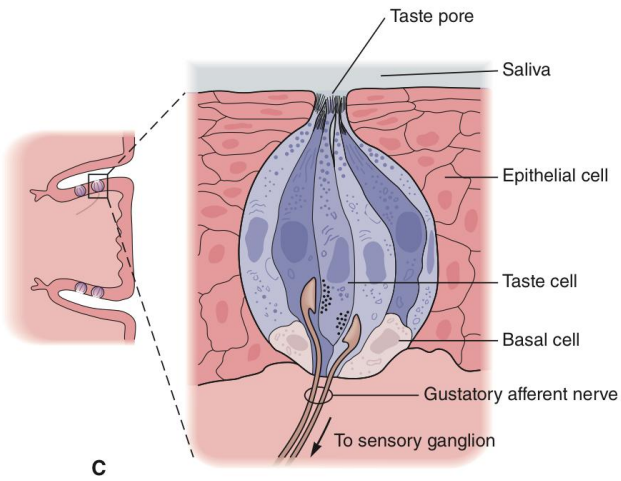
- **Taste** is the sensation produced when a substance in the mouth reacts chemically with taste receptors.
- Taste buds are specialized receptors widely scattered throughout the oral cavity:
  - Tongue
  - Soft palate
  - Inner surface of cheeks

Types of Papillae:

- The tongue is covered with 3 types of projections called papillae:
  - **Filiform:** Sharp – no taste buds
  - **Fungiform:** Rounded with moderate number of taste buds
  - **Circumvallate:** Large papillae with numerous number of taste buds
  - **Foliate:** located in the folds along the lateral surfaces of the tongue.

★ No taste buds on the mid dorsum of the tongue





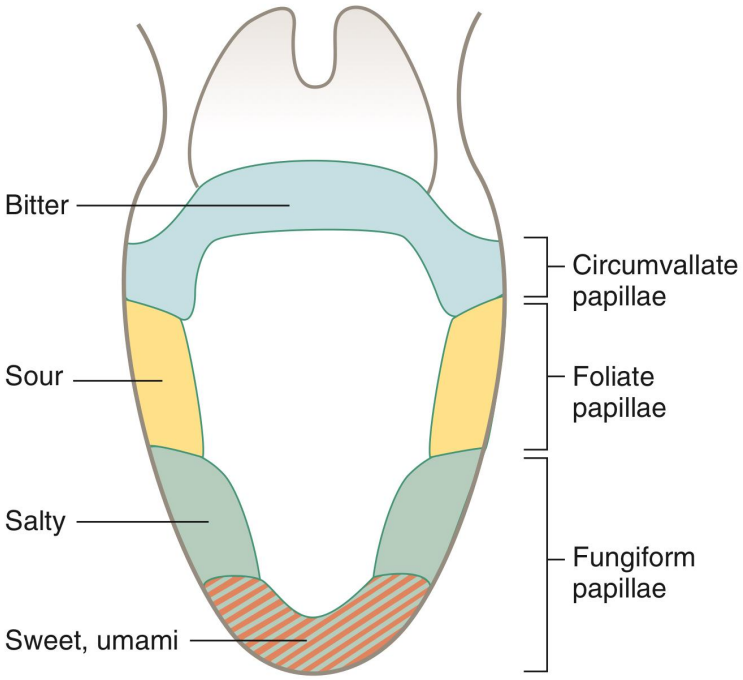
Structure of taste buds:

- Gustatory "Taste" cells with long microvilli (gustatory hair cells).
  - They are receptor cells with cilia projected through taste pore between the supporting cells.
- Hairs are stimulated by chemicals dissolved with saliva and transmit impulses to the brain.
- Impulses are carried to the gustatory complex by cranial nerves as taste buds are found in different areas:
  - Facial nerve (VII)
  - Glossopharyngeal nerve (IX)
  - Vagus nerve (X)

Distribution of taste buds:

➔ Distribution of taste buds on the tongue is not uniform:

- Sweet - tongue tip
- Sour - tongue margins
- Bitter - back of tongue
- Salty - widely distributed



Taste sensations:

5 established tastes:

1. Sweet receptors respond to:
   a. Sugars
   b. Saccharine
   c. Some amino acids
2. Sour receptors respond to:
   a. H+ ions
   b. Acids
3. Bitter receptors respond to:
   a. Alkaloids
4. Salty receptors respond to:
   a. Salt, ions, metal
5. Umami receptors respond to:
   a. Glutamate - "beef taste" of steak

Umami, a Japanese word meaning "**delicious**,"

❖ Molecules dissolve in the saliva » attach to receptors on cillia of gustatory cells » receptors potential » action potential.

❖ Combination between molecules and receptors are weak (since taste can be easily abolished by washing mouth with water).

★ When stimulated produce nerve impulse to specific brain area through:

- Anterior 2/3 of the tongue » **VII**
- Posterior 1/3 of the tongue » **IX**
- Palate, pharynx, epiglottis » **X**

Taste pathway:

➔ *First order neuron:*

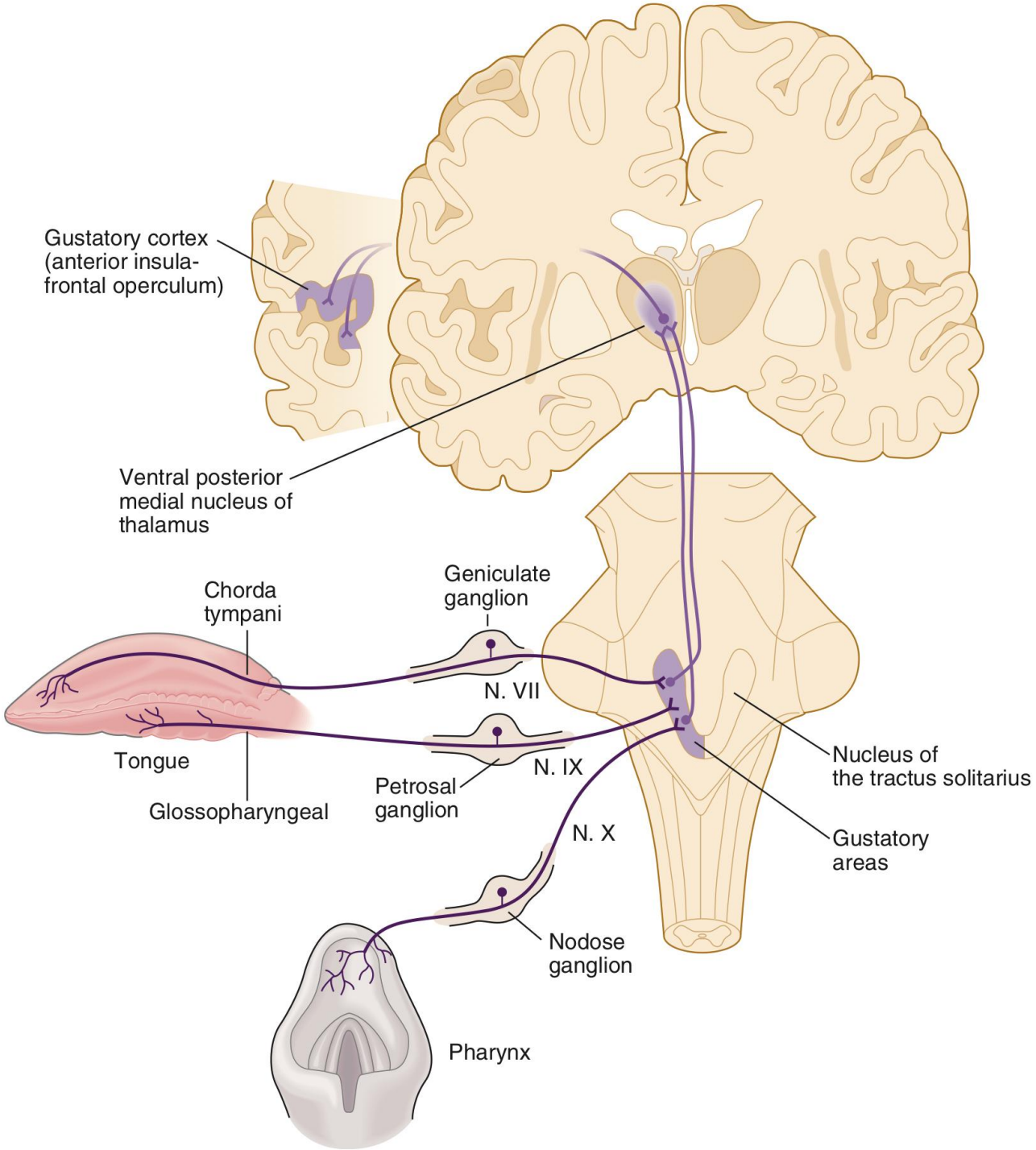
- Taste fibres from the three cranial nerves form "*tractus solitarius*" end in the nucleus of *tractus solitarius* "TS" (medulla).

➔ *Second order neuron:*

- From *TS* cross the midline to ascend in the medial lemniscus to the ventral posterior medial nucleus of the thalamus.

➔ *Third order neuron:*

- From thalamus project the cerebral cortex through thalamic radiation.



Pathophysiology:

- ➔ Ageusia (complete loss of taste).
- ➔ **D**ysgeusia (**d**isturbed taste).
  - ◆ Caused by a damage to cranial nerves VII, IX, X.
- ➔ Hypergeusia
  - ◆ Caused by adrenal insufficiency
- ➔ Hypogeusia
  - ◆ Many diseases can produce hypogeusia. In addition, drugs such as captopril and penicillamine—which contain sulfhydryl groups—cause temporary loss of taste sensation.

1. medial stria starts from
A. . mitral cells
B. . tufted cells
C. . basal cells
D. . taste receptors

2. Vitamin A Deficiency causes
A. . Ageusia
B. . Dysgeusia
C. . Anosmia
D. . Hyposomia

3. Which of the following described as Primitive olfactory system?
A. .Thalamus
B. . Pyriform cortex
C. .Hypothalamus
D. .Amygdala

4. "Perception of smell without an odor present"; is a definition of which of the following?
A. .Phantosmia
B. .Parosmia
C. .Hyperosmia
D. .Agnosia

5. Each of the following is part of Lateral olfactory area except:
A. .Septal Nuclei
B. .Amygdala
C. .Thalamus
D. .Prepyriform cortex

6. Taste buds can be found on all of the following except?
A. Tongue
B. Soft palate
C. Hard palate
D. Inner surface of the cheek

7. Umami receptors respond to:
A. Alkaloids
B. Glutamate
C. Some amino acids
D. H+ ions

8. Taste from the posterior ⅓ of the tongue is sensed by:
A. Glossopharyngeal nerve
B. Vagus nerve
C. Hypoglossal nerve
D. Facial nerve

9. Tractus Solitarius is formed by the _, _, and _ cranial nerves.
A. IX, X,XI
B. VII, IX, X
C. VIII, X, XI
D. VIII, IX, X

10. Which of the following is a pathophysiological manifestation caused by adrenal insufficiency?
A. Ageusia
B. Hypogeusia
C. Dysgeusia
D. Hypergeusia

Answers:
1.B
2.D
3.C
4.A
5.A
6C
7B
8A
9B
10D