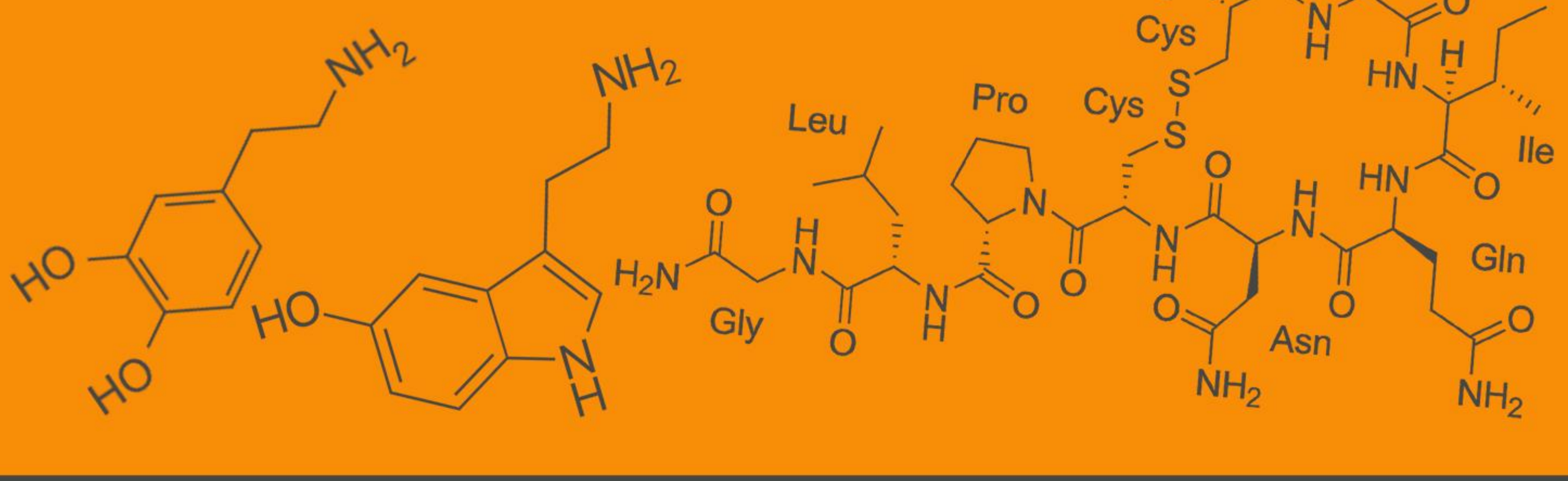


MEDICINE438's CNS PHYSIOLOGY

LECTURE X: Physiology of the Smell and Taste

EDITING FILE GSLIDES

IMPORTANT | MALE SLIDES | EXTRA | FEMALE SLIDES | LECTURER'S NOTES

1 Physiology of the Smell and Taste

Lecture Ten

OBJECTIVES

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

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

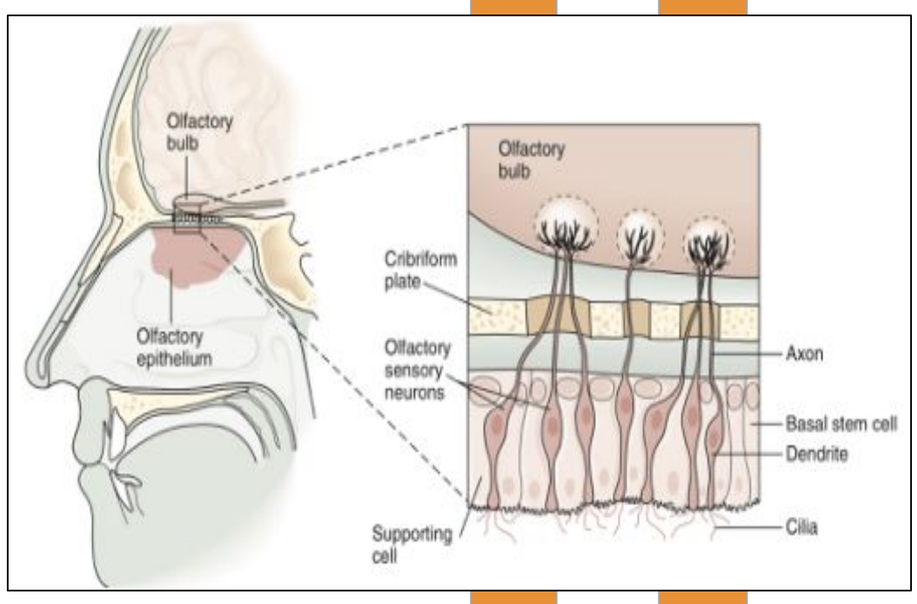


Figure 10-1

PHYSIOLOGY OF OLFACTION

- Power of perceiving odours is called **smell**
- 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

1. Molecules dissolve in mucus layer
2. Combine with receptors on cilia
3. Stimulate adenylate cyclase[1]
4. Increase intracellular cAMP[1]
5. Opening of Na channels
6. Receptor potential
7. AP in olfactory pathway

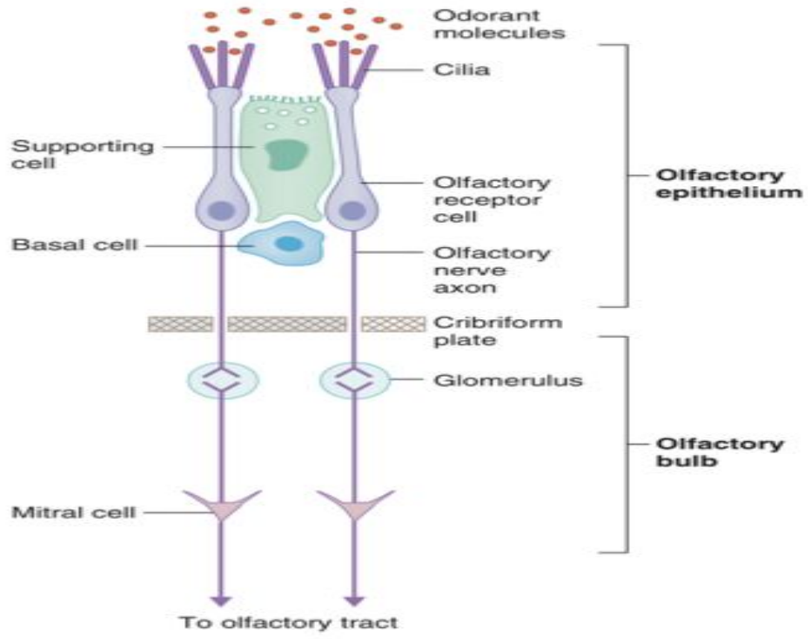


Figure 10-2

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 (BOX 10-1)** – (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

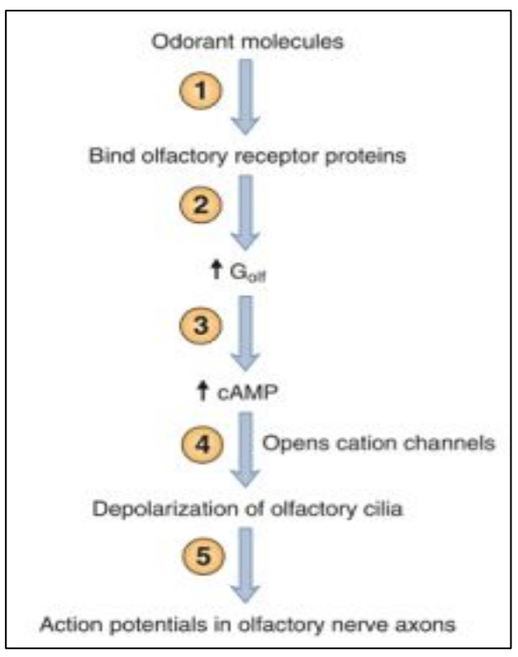


Figure 10-4

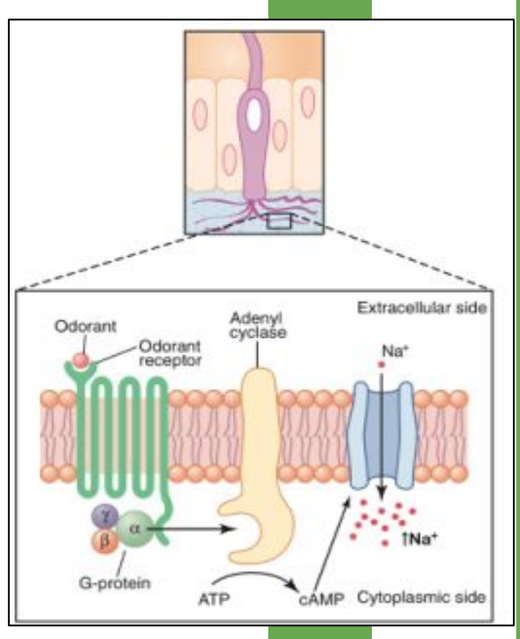


Figure 10-3

FOOTNOTES

1. Adenylate cyclase is an enzyme that is activated by alpha unit of G-proteins, it functions to convert ATP into cAMP. cAMP is an important intracellular messenger that can function to open Na channels. It's involved in the pharmacology for treating asthma and anaphylactic shocks.

BOX 10-1: GUYTON AND HALL

THE LIMBIC SYSTEM

Olfaction, in terms of evolution is one of the oldest senses. Different olfactory systems can be seen in different animals, some are intermingled.

- The very old olfactory system contains the septal nuclei, which are midline nuclei that feed into the hypothalamus and other primitive portions of the brain's limbic system. The limbic system is a part of the brain that originally served olfaction, however it later on evolved into the basal brain structures that control emotions and other aspects of human behaviour. It is an older core of the brain consisting of the areas anterior and lateral to the thalamus such as hypothalamus, hippocampus, septal region, amygdala, and even the old regions of the thalamus and the cortex themselves.
- The very old olfactory system is responsible for primitive responses of olfaction, such as licking the lips, salivation, and other feeding responses concerned with smell of food.
- The less old is responsible for learning to like and dislike certain foods based on smell, and to develop an aversion to foods that cause vomiting and nausea for example. The newer system has now been found, it is thought to be involved in conscious analysis of smell.

OLFACTORY RECEPTOR CELL

↓

OLFACTORY NERVE

↓

OLFACTORY BULB

↓

OLFACTORY TRACT

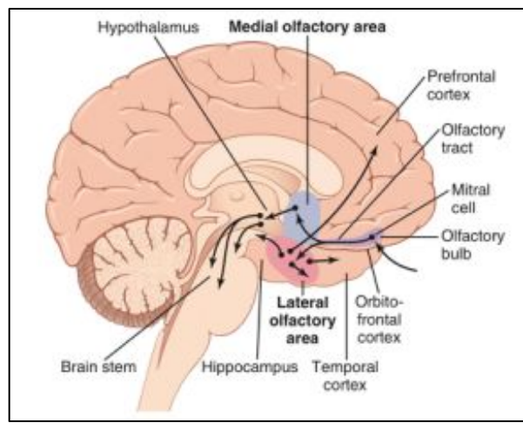


Figure 10-5

- Medial olfactory stria
  - Septal nuclei
    - Hypothalamus
      Limbic system (primitive parts)
      Primitive olfactory system
- Lateral olfactory stria
  - Prepyriform cortex
    Pyriform cortex
    Amygdala
    - Limbic System (hippocampus) (Less old olfactory system)
  - Thalamus
    - Orbitofrontal Cortex (Newer system)

PATHOPHYSIOLOGY

Disorder	Description
Anosmia	• loss of smell sensation Due to damage to olfactory Epithelium - Anosmia is one of the earliest symptoms of Alzheimer's, Parkinson's, and some other neurodegenerative diseases.
Parosmia	Alteration in smell sensation e.g. pregnant women, they are easily irritated by odors
Hyperosmia	• increase in smell Sensation Adrenal insufficiency
Hyposomia	• Decreased smell sensation Vitamin A deficiency

PHYSIOLOGY OF TASTE

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[1]

The tongue is covered with 3 types of projections called papillae:

- Filiform: Sharp – no taste buds their main function is for friction (e.g. licking ice cream)
- Fungiform: Rounded with moderate number of taste buds
- Circumvallate: Large papillae with numerous number of taste buds
- No taste buds on the mid dorsum of the tongue

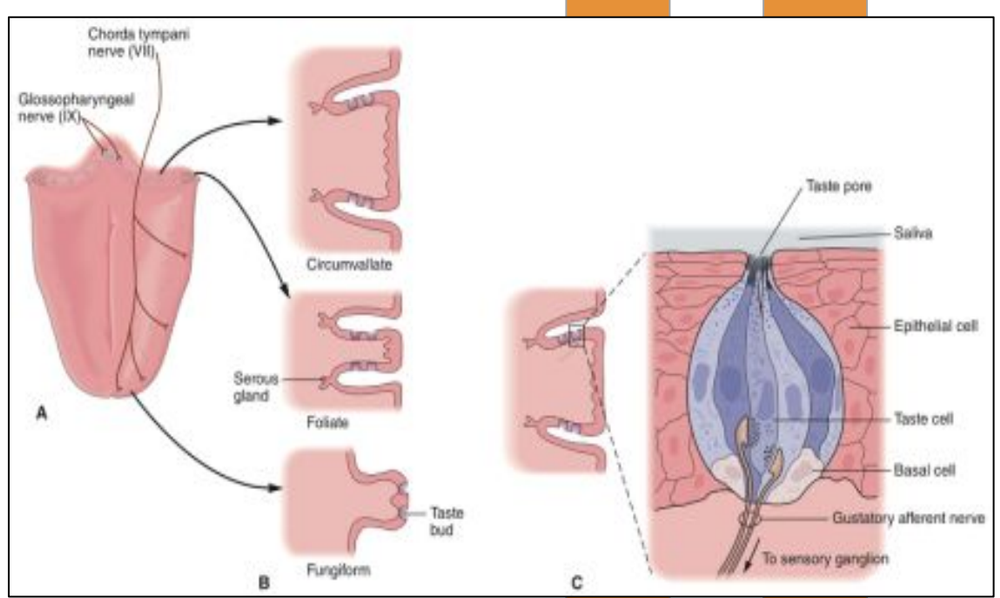


Figure 10-6

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:
  - Anterior 2/3 of the tongue »**VII** (Facial nerve)
  - Posterior 1/3 of the tongue »**IX** (Glossopharyngeal nerve)
  - Palate, pharynx, epiglottis » **X** (Vagus nerve)

FOOTNOTES

1. Are the small, nipple-like structures on the upper surface of the **tongue** that give it its characteristic rough texture.

TASTE SENSATION AND PATHWAY

- **Distribution of taste buds:**
- Sweet – tongue tip
- Sour – tongue margins
- Bitter – back of tongue
- Salty – widely distributed
- Umami – widely distributed[1]

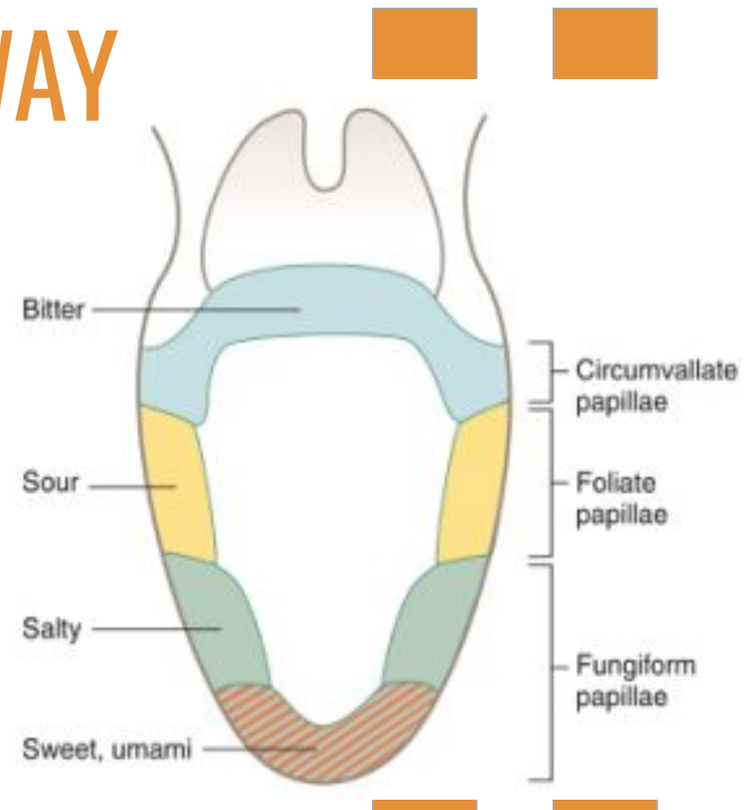


Figure 10-7

TASTE SENSATION

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:
Alkaloids

4.Salty receptors respond to:
Salt, ions, metal

5.Umami receptors respond to:
Monosodium Glutamate - "beef taste" of steak

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

FOOTNOTES

1. Guyton and Hall: Umami is a Japanese word, meaning "delicious", it is a dominant taste of foods containing L-glutamate, an amino acid, such as meat extracts and aging cheese. Some physiologists consider it a separate, fifth category of primary taste stimuli. The precise molecular mechanisms for umami taste is still unclear.

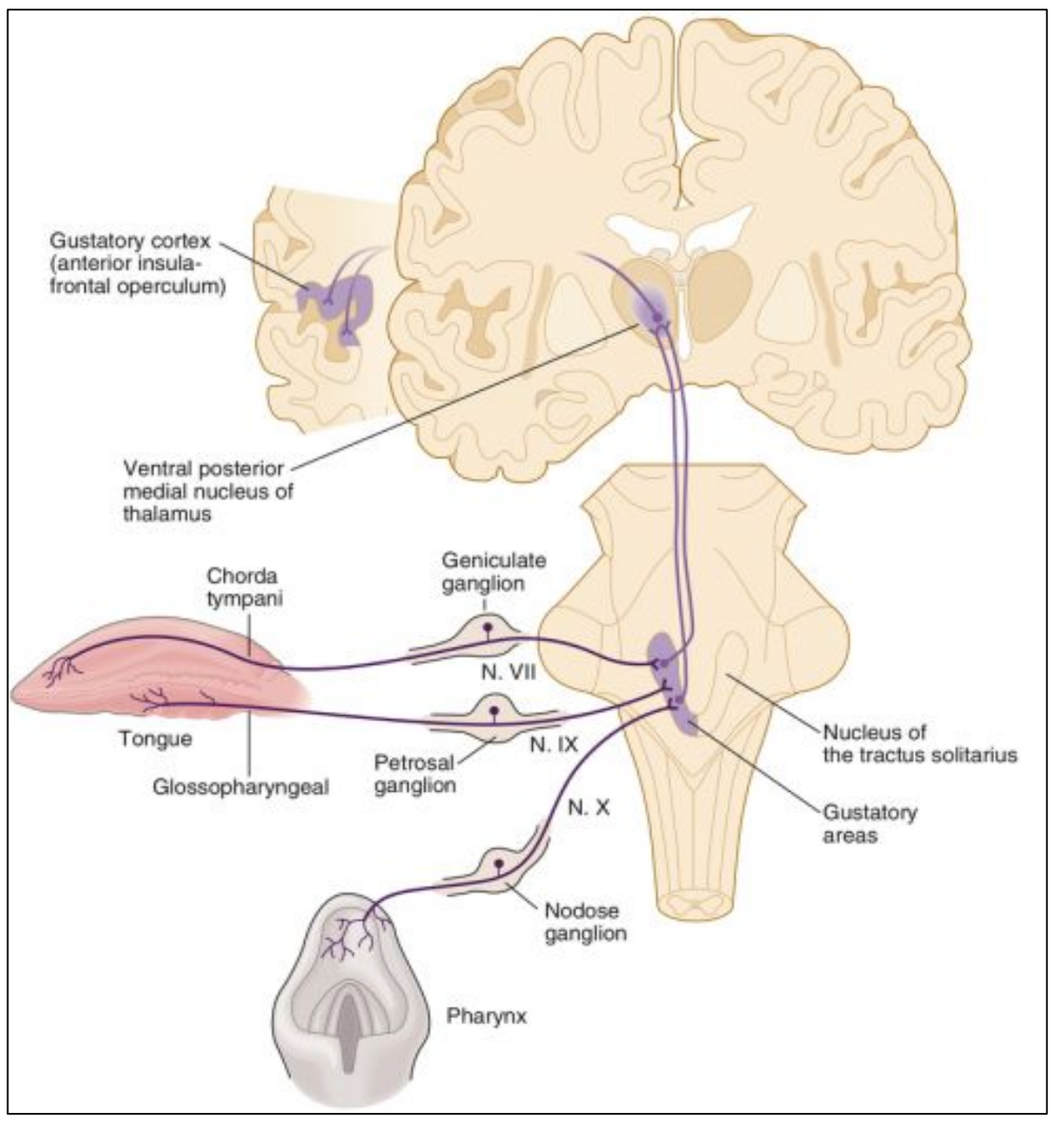


Figure 10-8

- 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).

PATHOPHYSIOLOGY

- Ageusia (complete loss of taste).

- Hypergeusia

Caused by adrenal insufficiency.

- Dysgeusia (Disturbed taste).

Caused by a damage to cranial nerves VII, IX, X.

- Hypogeusia

Many diseases can produce hypogeusia. In addition, drugs such as captopril and penicillamine—which contain sulfhydryl groups—cause temporary loss of taste sensation.

-Tooth extraction

QUIZ

MEDICINE438's
CNSPHYSIOLOGY

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

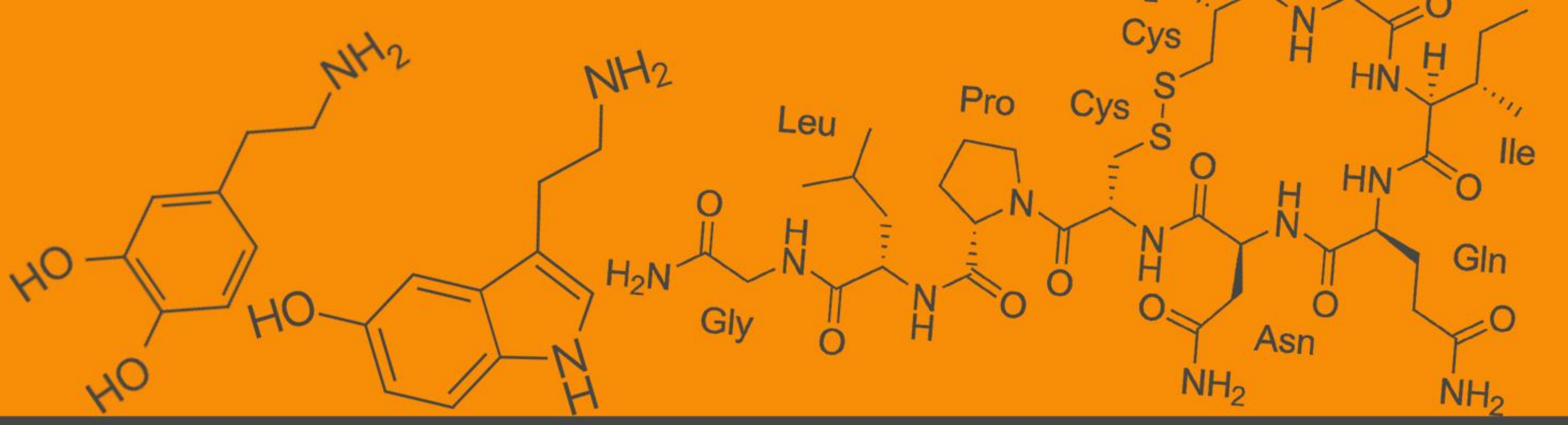
2. Which of the following described as Primitive olfactory system?
A) Thalamus
B) Pyriform cortex
C) Hypothalamus
D) Amygdala

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

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

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

ANSWER KEY: A, C, D, B, D



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