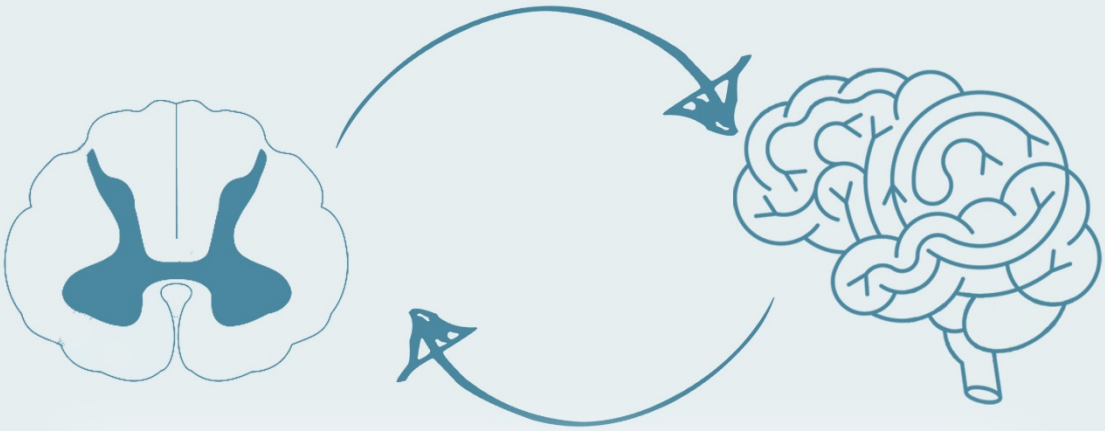

CNS

physiology

0 slides 0 sheets

number	7
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***Note : first 10 min fromthe record of lec 7 were writen in sheet 6**

Please refer to the slides for figures

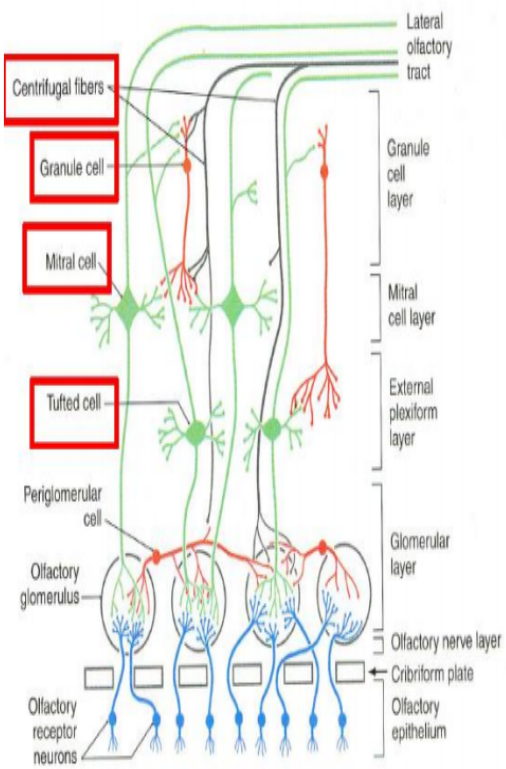
Speical sensations:

1) **Olfacation and taste (the topics of this sheet)** : we call them chemical sensations because they start when chemical receptors detect chemical substrates, then initiate neuronal signals.
2) **Visual system**
3) **Auditory system**

Olfacation (smell)

The olfactory system starts in the nasal cavity, in the roof of nasal cavity there is a specialized type of epithelium known as olfactory epithelium.

The olfactory epithelium is constituted of three main cell types, which are:



1. ***Receptors***: olfactory receptor neurons are bipolar cells. The first pole has cilia with receptors on them(chemical receptors) and the other end is formed by axons which will enter the CNS to carry the olfactory information.

2. ***Supporting cells***: they provide mechanical, chemical, and nutritional support to the neurons, because these neurons cannot survive on their own. Their function is similar to the function of astrocytes in CNS.
   • The previously mentioned cells are exposed to the external environment therefore they are at risk of either being damaged or destroyed so a regeneration process is needed. Regeneration could also provide a physiological function allowing for the renewal of the neurons and receptors, and this is the function of the next cell type.

3. ***Basal cells:*** are undifferentiated cells that are responsible for the regeneration of both the neuronal and supporting cells. These cells may be a potential source of stem cells for research purposes and possible promising treatment**.**

THE PROCESS OF OLFACTION

Olfaction is a chemical sensation ,the chemicals detected should bind to receptors, the chemicals must be dissolved in a media and this is the function of the Bowman cells/glands; which secrete the fluid that the chemical substances dissolve into, allowing them to bind to their receptors.

Next, the central axon of the olfactory cell will enter the skull to reach the CNS, through the cribriform plate (which forms the roof of the nasal cavity and has many pores through which the axons pass) and there in the plate they will synapse with the second-order neurons in the olfactory bulb **,**the synapsing will occur at the rostral end of the first cranial nerve (olfactory nerve).The olfactory bulb is the enlargement at the end of the olfactory nerve and tract.

usually in neuronal pathways there is **divergence (one single neuron synapses with two or more second order neurons) or **convergence** (two or more axons converge to one second order neuron)

The olfactory system has a special type of connection (synapsing), there is both convergence and divergence, which form the olfactory glomerulus.In the glomeruli, three or four receptors will gather at one second order neuron (convergence) and a single receptor is going to send impulses to more than one second order neuron (divergence); this property is what makes's the olfactory system so complex .

According to the labeled line theory, each receptor receives a different stimulus and leads to a different sensation, so if you have 10 receptors each one leads to a single cascade (without any synapsing) and so you would only be able to recognise 10 scents .

However, the glomerulus formation allows for the combination of impulses from different receptors, for example if receptors 1, 2 and 5 are activated they will give a specific smell and if receptors 1, 2 and 7 are activated they will give a different smell, therefore the amount of scents detected is based on the glomerulus and their second order neurons rather than the number of the receptors .

One of the most important structures found in the olfactory bulb are the **centrifugal fibers** , they extend from cortex to the olfactory bulb allowing for direct feedback between them, they have two functions :

1) Sensitization of some smells, certain scents smell stronger due to a desicion from the cortex or subcortex
2) Adaptation

** almost 90% of olfactory adaptation is done at a central level (central adaptation) rather than through its receptors (receptor adaptation). why ?? because most of the receptors in the olfactory system work through a 2nd messenger type receptor and one of the most important characteristics of the 2ndmessenger type receptor is that it initiates a cascade of signals through cAMP or others which leads to signal amplification.

i.e: the receptor is way more potent because it amplifies the signal and so the receptor is less likely to adapt easily.

Now, after detection and processing, the information should move to the CNS, the sensation travels from olfactory bulb toward the olfactory tract, then goes to the CNS.

In the ALS pathway, part of the tract goes to the thalamus then to the cortex (conscious). There is also another part that stops at the brainstem, hypothalamus and numerous other places (unconscious). And there is yet another part that goes to the cortex directly without passing through the thalamus, it ends in the cingulate gyrus, we will study in more detail later on in this course the 2 types of cortex; the neocortex and the paleocortex, as a general rule nothing can pass to the neocortex without first passing through the thalamus and it usually conveys conscious information as for the paleocortex the information doesn't pass through the thalamus and it's usually associated with unconscious information.

The same principle applies here, two thirds of the olfactory system will pass through the thalamus and from the thalamus to the neocortical areas "to the dorsomedial thalamus then to the primary olfactory cortex which is located in the medial part of the temporal lobes" and this is very important in giving meaning and allowing processing of olfaction. **Conscious**.

While the other third will go to the other areas that are associated with reflexes related to olfaction; internal regulation, emotion, feeding, hunger(like how smelling food makes you hungry) and anger. **Unconscious**.

Examples of these other areas that represent the last third are the;amygdala,olfactory tubercle, piriform cortex, anterioramygdala, periamygdaloid and entorhinal cortex,

DISORDER OF OLFACTORY SYSTEM

- ***Anosmia***: complete loss of olfaction
- ***Hyposmia*** : decrease in olfaction

<u>The causes:</u>

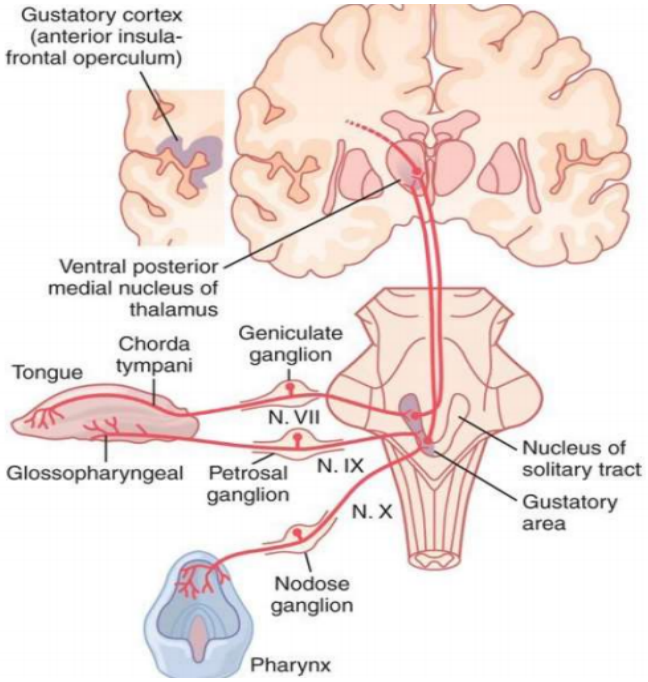
1) Damage to the ***tract***: A cut in the tract can occur due to trauma, mostly trauma to the face, the first and the most common part to be broken is the cribriform plate causing a cut in the first order neuron axons. In the case of a minor cut or one with no resultant inflammation, the basal cells will regenerate within a few months and the axon will reach its destination again →temporary loss of sensation. But in cases of inflammation, inflammation damages the 'guidance queue' so no correction can take place →permanent loss
2) ***Receptors*** unable to detect the chemicals, the most common cause, this happens in cases of edema and/or inflammation of the nasal cavity, colds, flus and sinusitis.
3) Damage to the ***cortex***

** decrease of olfactory sensation is among the first symptoms detected in *Alzheimer's* disease and other *degenerative* diseases, unfortunatley most people and doctors will assume the decrease in olfaction is simply due to old age (natrual process), however it could be the sign of a serious disease.

Gustatory Sensation (Taste)

Taste sensation starts on the tongue, on the tongue there are groups of taste receptor cells known as taste buds. Most of the taste receptors on the tongue are found in special structures called papillae on the outer surface of the tongue. Food particles have to enter the papillae in order to bind to the receptors, therefore we need saliva (a media) for this process to take place. We have different types of receptors to differentiate different flavors. There are 5 types of taste receptors that distinguish the 5 type's sensations of taste. They are: bitter, sweet, sour, salty, and umami(delicious).Umami receptors recognize the savory tastes of meats, amino acid, proteins, and particularly foods that contain monoamine sodium glutamate(الملح الصيني).

<u>THE PROCESS OFGUSTATION</u>



- The sensation is detected in the receptor by certain mechanisms some of them metabotropic and others ionotropic (details are not important).
- After detection of the signals on the tongue the signal is conductedto the CNS through three cranial nerves: 7(facial), 9(glossopharyngeal) and 10 (vagus).
- Then the axons of these three nerves deliver the sensations to the brain stem which will enter a special nucleus called the gustatory nucleus (solitary).
- The axons of the second order neuron will continue on to the thalamus.
- After synapsing in the thalamus, the impulse will be taken to the primary taste cortex, which is located at the lower end of the postcentral gyrus and insular lobe.

** note that the taste fibers remain ipsilateral throughout the pathway.

1st order neuron: from the receptor →gustatory nucleus
2nd order neuron: from the gustatory nucleus →the thalamus
3rd order neuron: from the thalamus →primary taste cortex

DISORDERS OF GUSTATORY SYSTEM

- **Aguseia** : complete loss of taste
- **Hypogeusia**: partial loss of taste

The causes:

The most important cause is decreased fluid (saliva) in the oral cavity, preventing food particles from reaching the papillae and binding to the receptors, so detection and activation will not occur. Situations that reduce saliva secretion are :cancer therapy, radiation, medications and certain diseases such as xerostomia (which means decrease in saliva).

Flavor

We said that we have only 5 types of receptors for taste, and we saw there isn' tmuch complexity in this pathway, such as lateral inhibition and glomerulus formation, they almost run in a single

line path however, we can distinguish millions of flavors, we have many different types of foods and many different flavors. So how can we distinguish so many different flavors with only 5 receptors?
The answer is that flavor is not simply detected through taste! It is detected through smell for two reasons: it has more divergence and is more potent; evidence supporting this is that when we get sick (common cold) we lose our sensation of taste because of the absence of smell.

Association cortex

The association areas are the parts of the cerebral cortex that are located in the lower parts of the brain, in the orbitofrontal areas and they are multisensory cortexes.
The association areas do not belong to the primary regions ,primary regions are parts of cerebral cortex that receives one sensation and where processing takes place according to memories of the information ,for example if receptor X gets activated, according to memories and past experiences, we will have Y type of sensation .

The association cortex receives more than one sensation and develops memories about complex experiences from more than one sensation ,for example if we took some ice-cream and allowed it to melt, it will no longer be appetizing, why is that? It has the same smell, taste and ingredients, we only changed its state, so your experience has changed and thus the flavor appears to change too.
So, flavor is an experience that depends on olfaction, taste, somatosensation, vision, and other areas of the cortex. Olfaction being the most important one because of its diversity and complexity.

*People who have olfactory problems will not go to doctor because they cannot smell, they usually visit doctor because of feelings of dysgeusia, unpleasant experiences with food that used to be pleasant.

Special thanks for Somaya AlKiswani<3

The end

Best of luck

The beginning of wisdom is: Acquire wisdom; And with all your acquiring, get understanding.
Proverbs4:7