

MUNI
MED

Electrooculography

Physiology I – practice
Autumn, weeks 7-9

Electrooculography

- A method of assessment of the eye movements employing the measurement of potential difference between cornea and retina
- This potential difference generates an electric dipole oriented in parallel with the optical axis of the eye
- The main goal of eye movements is to maintain and stabilize the object of interest at the point of sharpest vision (yellow spot)

Types of eye movements

- **Reflex stabilizing movements** (fixation) – while looking to the distance, the eyes are not moving aimlessly, but they are automatically focusing on an object in the visual field
- **Smooth pursuit movements** – ensure focusing of the observed object onto the yellow spot, as well as the focusing of the moving object
- **Saccadic movements** – the eye makes jerky movements during viewing of the object or while reading – the eye changes rapidly the points it fixes – it moves the focus to the new object of interest (e.g. a large saccade – changing the focus from the end of the read line to the beginning of the newly read line)

Types of eye movements

- **Nystagmus** – rhythmic eye-bulb movements, 2 components: slow deviation to one side and fast twitch to the opposite side.
- **Vestibulo-ocular reflex** – stabilization of image on the retina during sudden irregular head movements
- **Optokinetic nystagmus** – regular eye movements stabilizing the view during slight movement of the head (for example while looking out of the window in a moving vehicle) or when the object changes its position while the head is motionless

Nystagmus

- Rhythmic spontaneous and oscillating eye-bulb movements
- It consists of two alternating components – slow deviation to one side and fast twitch to the opposite side (slow is vestibular, fast from brainstem structures).
 - The direction of nystagmus is determined by the direction of the fast component.
- Nystagmus at rest – vestibular system or cerebellum is affected by some pathological process



Optokinetic nystagmus

- Physiological
- Present to ensure image stability on the retina
- Induced spontaneously or experimentally
- Combination of slow movements in one direction and fast movements in the opposite direction
 - Slow component – tracking motion
 - Fast component (saccade) – fixation on a new target
- Objective proof of preserved eye function

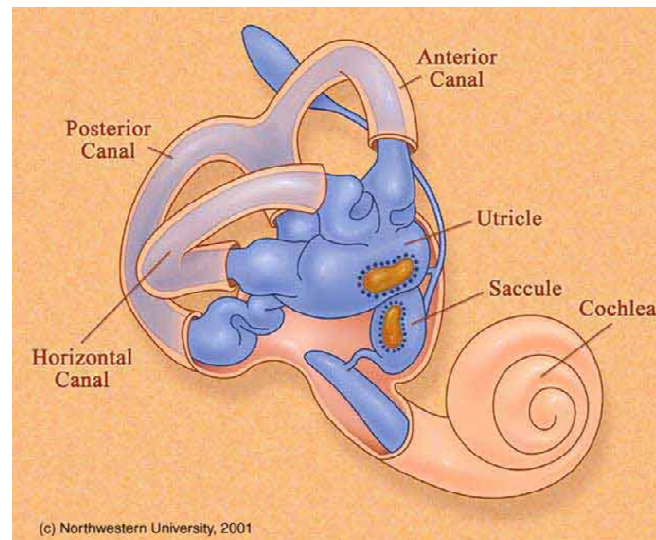


Vertigo

- Vertigo (dizziness) – subjective loss of stability in space, feeling of a rotation of surrounding space or rotation of the body in space
- It is connected with objective symptoms – disturbances of equilibrium and nystagmus – by stimulation of the labyrinths

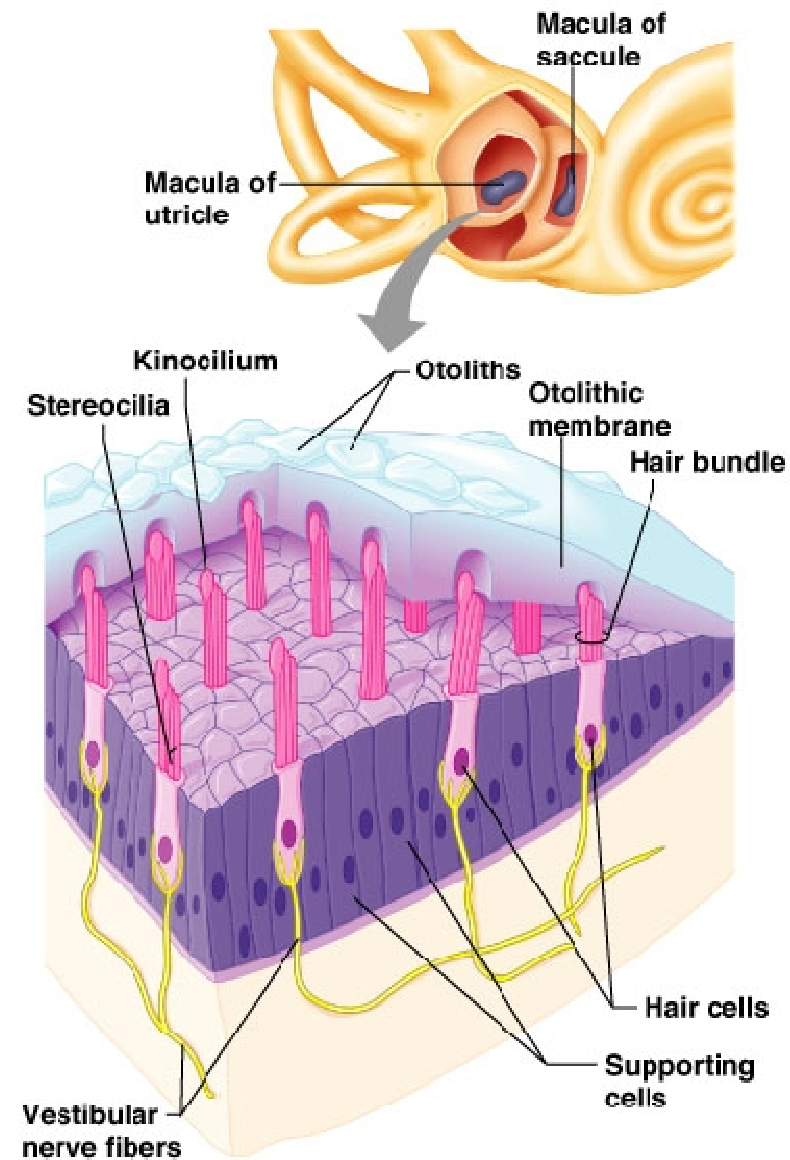
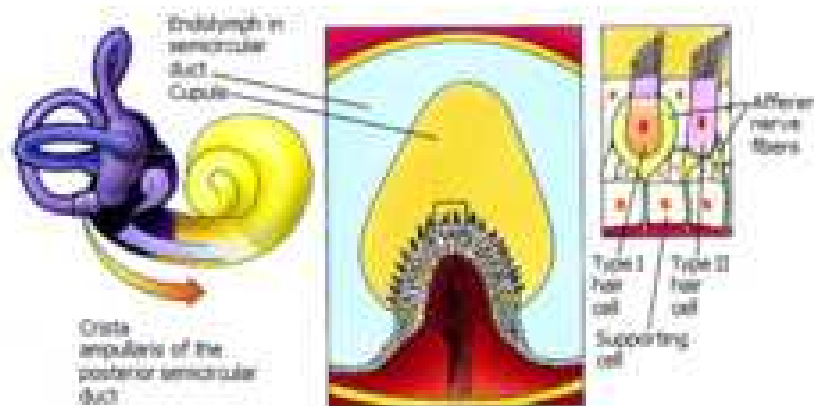
Vestibular system

- Function: stabilization of the retinal image and maintaining of visual acuity while moving
- Vestibulo-ocular reflexes



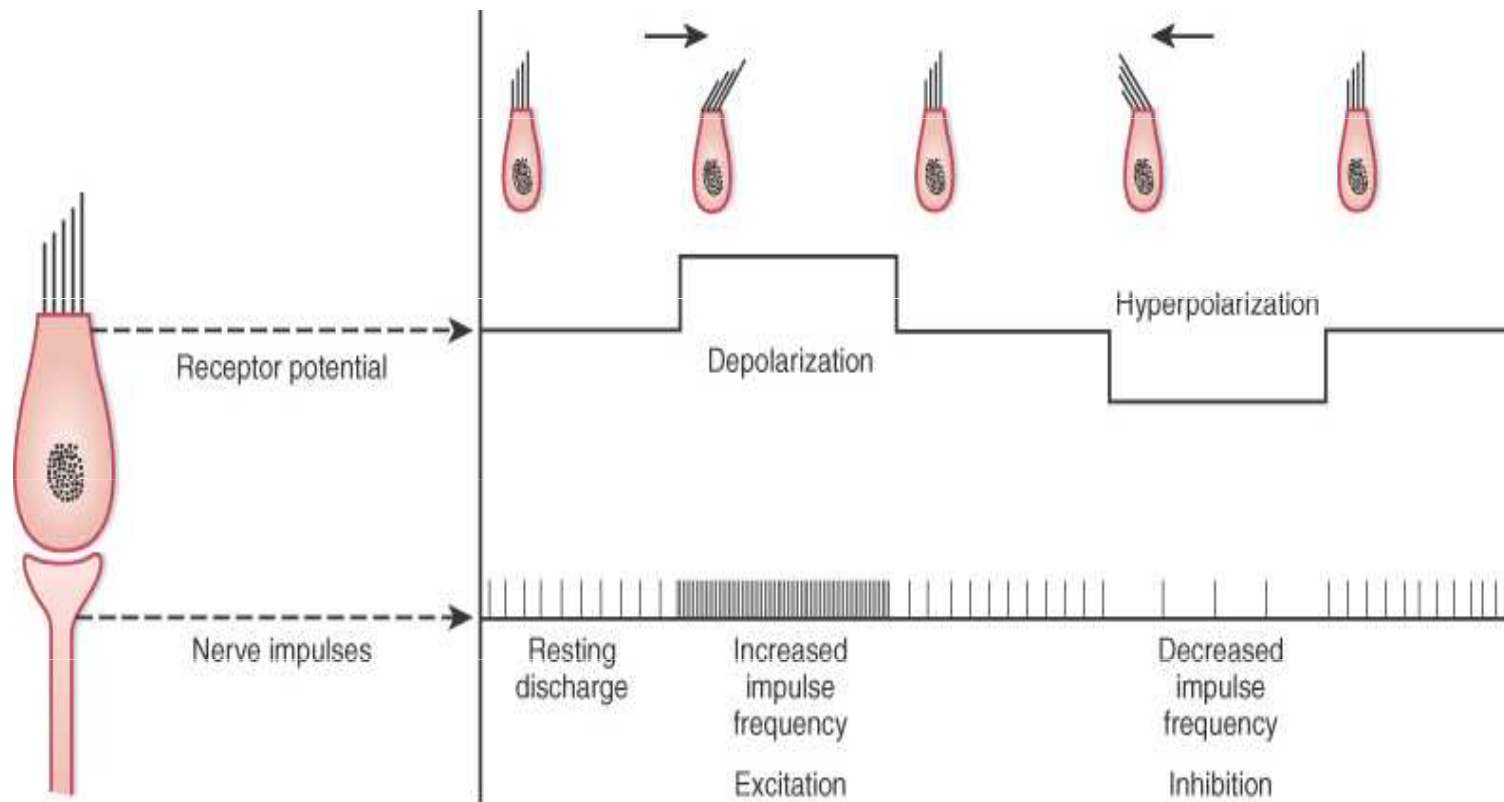
Vestibular apparatus

- Semicircular canals – cristae ampullares, reaction to angular acceleration
 - Kinetic sensor
- Utriculus, sacculus – maculae staticae, linear acceleration, head position in a gravitational field
 - Static sensor



Vestibular apparatus

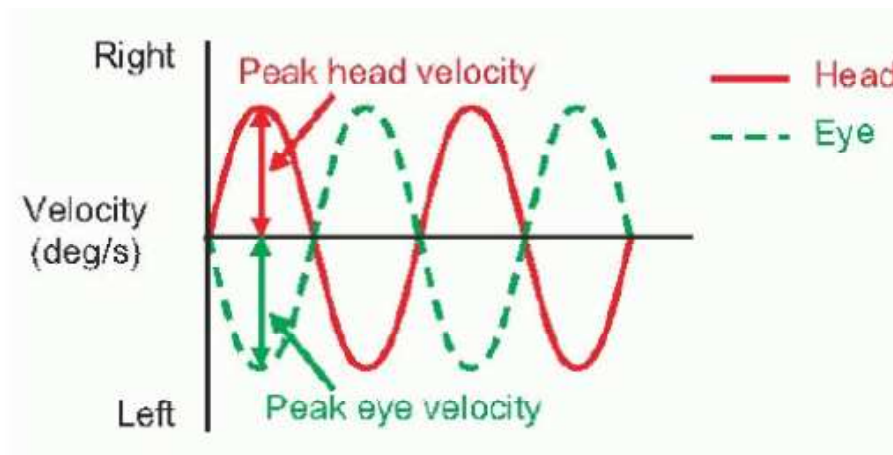
- Bending of stereocilia towards the kinocilia – stimulation, depolarization (more K^+ in)
- Bending of stereocilia in the opposite direction – inhibition, hyperpolarization (less K^+ in)
- This bending is caused by the flow of endolymph
 - Ampullopetal (towards the ampulla) – bending towards the kinocilia
 - Ampullofugal (away from the ampulla) – bending away from kinocilia
- The three semicircular canals are perpendicular to each other, so they provide information about the movement of the head in all three dimensions

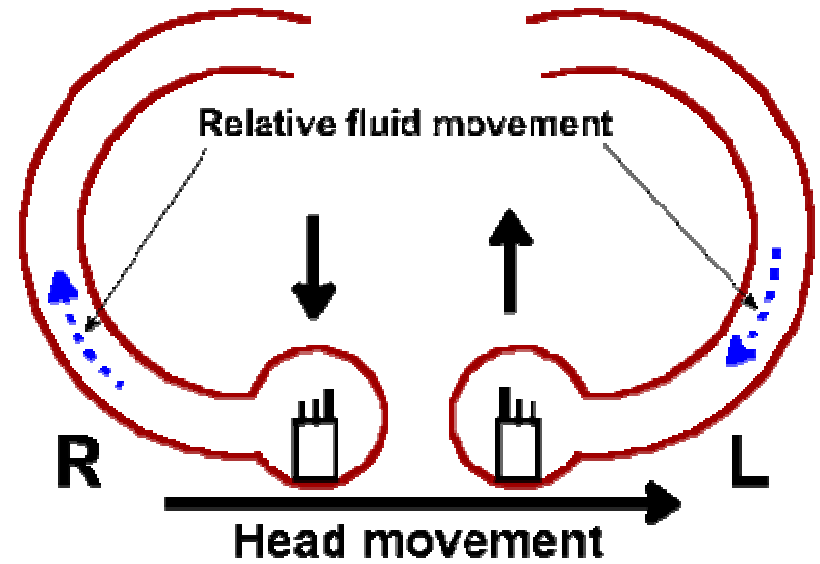
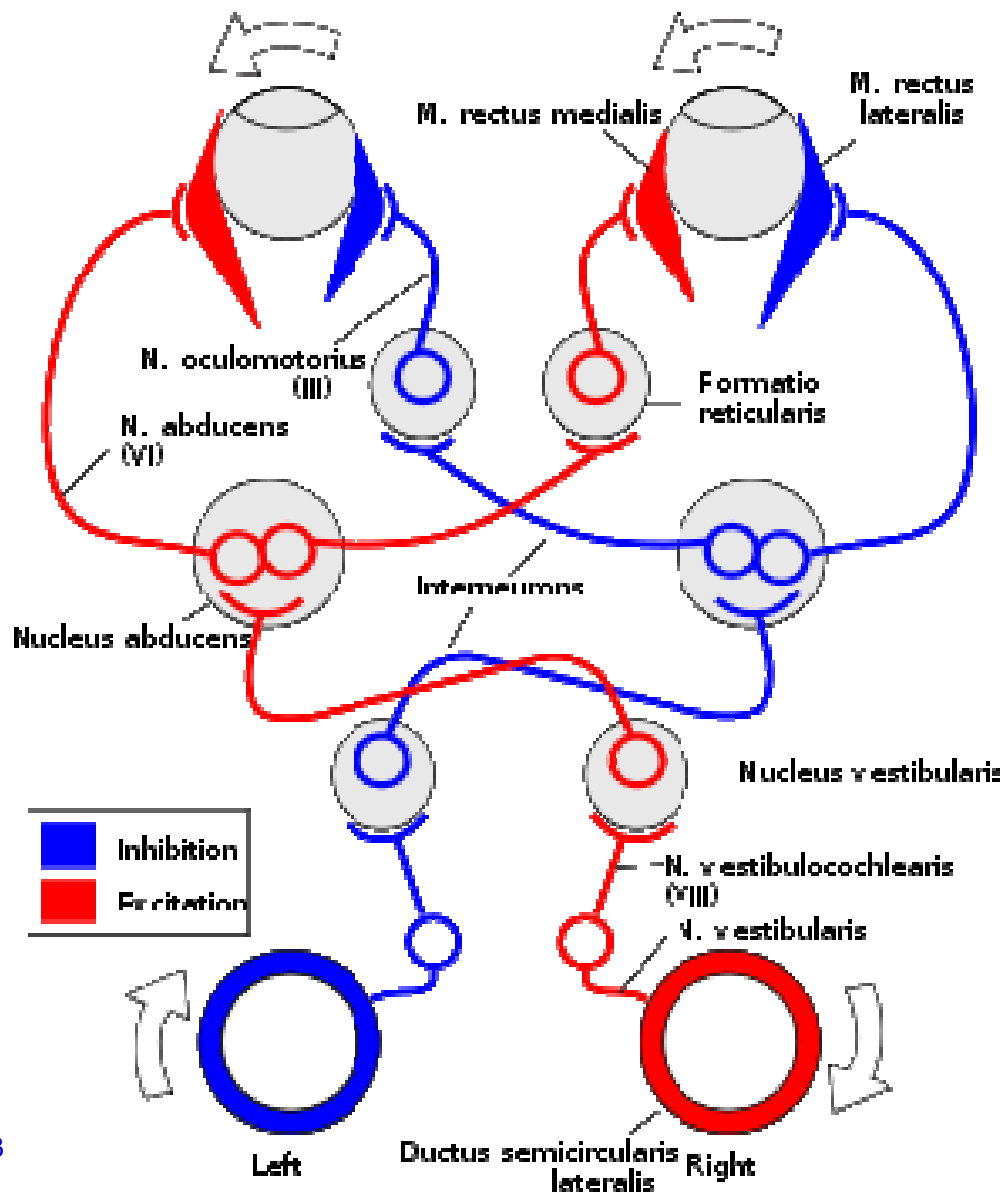


Stereocilia bending in the opposite direction creates a hyperpolarization by closing those channels that are constantly open, even in the resting state, thus further obstructing K^+ flow down the electrochemical gradient.

Vestibulo-ocular reflex

- The vestibulo-ocular and optokinetic reflexes are the earliest eye movements to appear phylogenetically
- The vestibulo-ocular reflex (VOR) stabilizes retinal images during head motion by counter-rotating the eyes at the same speed as the head but in the opposite direction





Each canal is connected to that pair of oculomotor muscles that cause the coupling of eye movements in its plane

Provocative test for nystagmus

– Rotation test

- Seated, leaning forward 30°- the lateral canal is in a horizontal plane
- Examination of both canals at once
- Rotation – 10 turns
- After 10 turns we stop abruptly
- We watch for the **post-rotational nystagmus** – the fast component "beats" in the opposite direction than was the direction of rotation

- Slow component – initiation from the vestibular system, direction of endolymph flow
- Fast component – induction from the brain stem, returns the eye to the starting position

Evaluation of nystagmus

- Direction (horizontal, vertical, diagonal, rotational)
- Amplitude (in degrees)
- Frequency (per s)
- Duration (s, min)

Provocative test for nystagmus

– Test: **caloric nystagmus**

- Performed with water (27°C or 44°C)
 - The patient is lying bent forward 30°, the lateral canal is in a vertical position
 - Frenzel's surveillance glasses
 - Cold / hot water
 - Cold water – decreased response, ampullofugal flow, nystagmus “beats” to the other side
 - Warm water – irritation, ampullopetal, nystagmus “beats” to the same side
 - Pros: one-sided testing
 - **Cons: non-physiological testing**
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- **It can also happen while applying fluids (e.g. ear drops) to the external ear canal if these fluids are not at human body temperature**

Spontaneous nystagmus

- Always pathological
- Vestibular/vestibulocerebellar lesions

Sources

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