

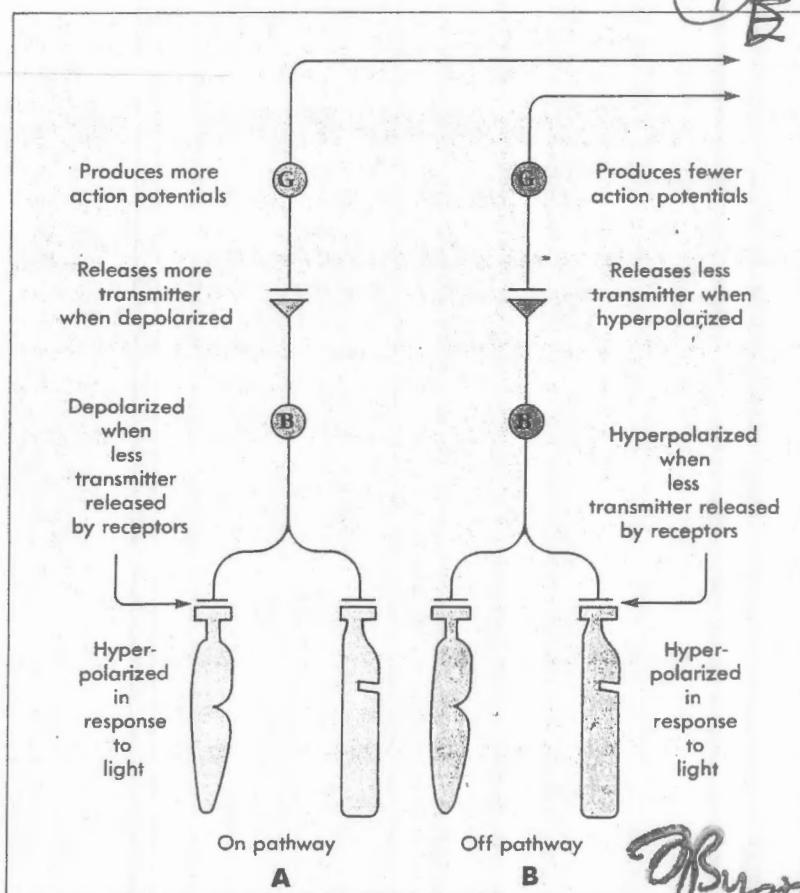
Obstetra

(4) B (5)

FIGURE 10-25

The response of the photoreceptors (both rods and cones) to light is always hyperpolarization. A The bipolar cell (B) in this pathway is excited by the decrease in transmitter release from the photoreceptors, that is, the transmitter had an inhibitory effect that was turned off. The bipolar excitation increases the number of action potentials in the ganglion cell (G) and therefore this is known as the ON pathway.

B Hyperpolarization of the photoreceptors decreases transmitter release, which inhibits the bipolar cell. This effect indicates that receptor cell transmitter has an excitatory effect on this class of bipolar cells. The inhibited bipolar cell releases less transmitter at its terminals on the ganglion cell, and this results in a decreased number of action potentials from ganglion cells in this pathway. This is therefore the OFF pathway.



Obstetra

In the DARK → ganglion cells produce a low steady baseline rate of action potentials

In response to Illumination ↑ the activity of any particular ganglion cell either INCREASES (an ON response) or decreases (an off response)

The ON and Off pathways from receptor cells to ganglion cells are mediated by separate type of bipolar cells (bipolar neurons either depolarizing or hyperpolarizing) THESE DIFFER IN THEIR RESPONSE TO THE TRANSMITTER THAT IS CONTINUOUSLY RELEASED BY PHOTORECEPTORS IN THE DARK → the transmitter causes hyperpolarization in one type of bipolar cell and depolarization in the other → ① Bipolar cells that are hyperpolarized by the photoreceptor transmitter in the dark becomes relatively depolarized when light excites the receptors → these constitute the ON pathway ② Those bipolar cells that are depolarized by the photoreceptor transmitter in the dark become relatively hyperpolarized when light excites the receptors and constitute the OFF pathway

Observation

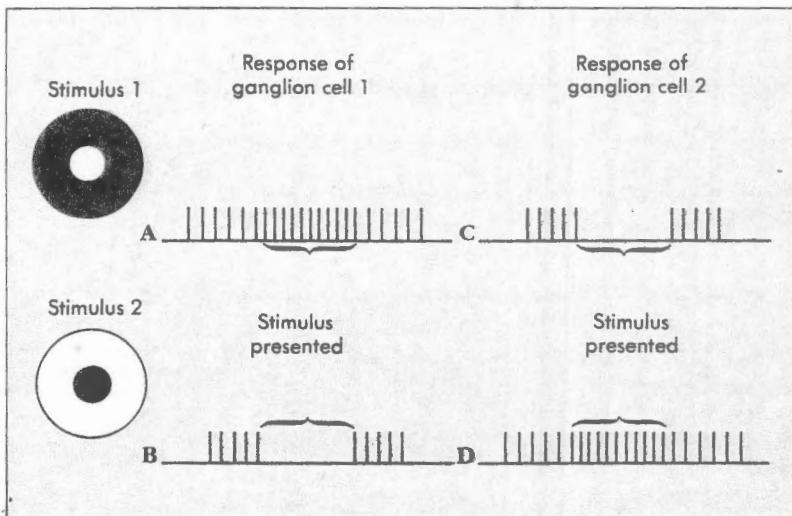


FIGURE 10-26

Electrical recordings from two categories of retinal ganglion cells that are responding to two stimuli. The traces show the rate of action potentials (indicated by vertical spikes) over time.

A Ganglion cell 1 is turned on (the frequency of action potentials increases) by a stimulus (1) consisting of a bright spot (the "center") surrounded by a dark background (the "surround").

B Ganglion cell 1 is turned off by a stimulus (2) consisting of a dark center surrounded by a bright background. It is therefore called an "ON center/OFF surround" cell. C Ganglion cell 2 is turned off by stimulus 1 and turned on (D) by stimulus 2. It is therefore called an "OFF center/ON surround" cell.

Typically ganglion cells have Receptive fields with Central regions in which a Stimulus results either in A burst of action Potentials OR a decrease in the Steady low rate of action potentials → These are called ON centre and OFF centre ganglion cells

Most Receptive fields combine excitation & inhibition so that if light in the centre of the receptive field excites a ganglion cell → the same cell will be inhibited by light in a circular area around the centre (the Surround) → these are ON centre/OFF surround cells

In other ganglion cell → a spot of light falling on the centre is inhibitory while in the surrounding region it is excitatory these are OFF centre/ON Surround cells

The opposite effects of stimulating the centre and surround of a ganglion cell's receptive field are probably due to lateral connections of horizontal cell which block output from the centre pathway when a contrasting illumination falls on the surround. !!!

Obstacles

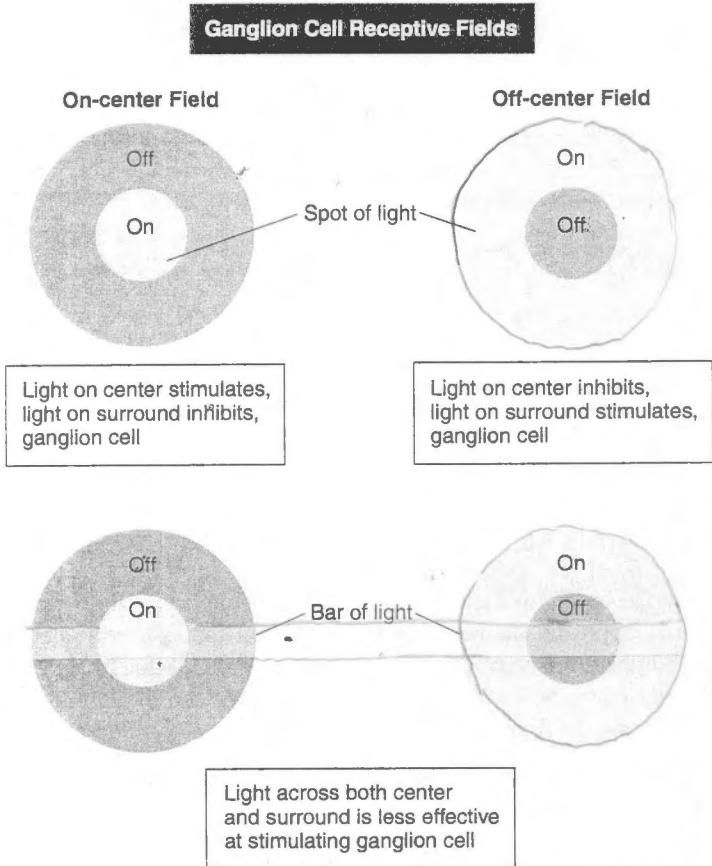


Figure 10.46 Ganglion cell receptive fields. Each ganglion cell receives input from photoreceptors in the retina that are part of the ganglion cell's "receptive field." Because of the antagonism between the field's center and its surround, an image that falls across the entire field has less effect than one that only excites just the center or surround. Because of this, edges of an image are enhanced, improving the clarity of vision.

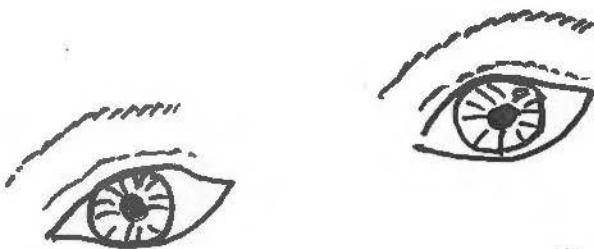
What the Retina Tells the Brain

Ganglion cells are the retinal cells whose axons form the optic nerve, so their output is the final product of the information processing that occurs in the retina. The optimum stimulus for an ON center/OFF surround cell is a spot of light of the right size on a dark background. The optimum stimulus for an OFF center/ON surround cell is a dark spot on a white background. In some cases, the basic receptive field organization incorporates selectivity for colors. For example, a ganglion cell may be excited by a spot of green light on a red background but inhibited by a spot of red on a green background.

Each ganglion cell may send three different messages to the brain (Figure 10-27). A burst of action potentials constitutes a signal to the brain that most of the light falling on the cell's receptive field is on the excitatory part of the field. A decrease in the rate of action potentials means that most of the light falling on the receptive field is on the inhibitory part of the field. No change in the rate of action potentials means that light, if present, does not vary in intensity over its receptive field. In sum, the effect of lateral inhibition in the retina is to favor response to contrast in the visual field and to suppress response to uniformity, so the retina informs the brain of the locations of spots in the image where there is contrast, either of light intensity or of color.

Rt.

Lt.

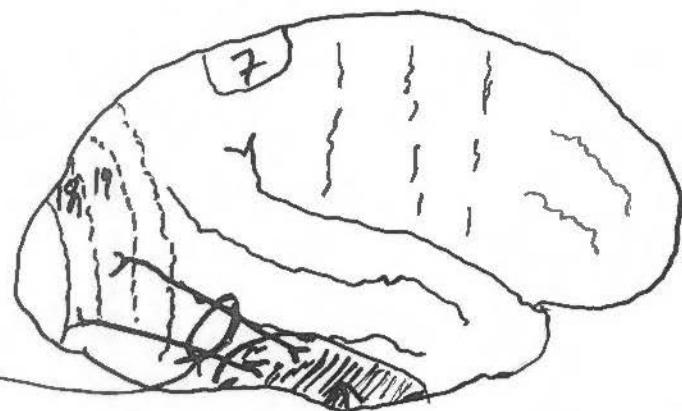


Left trochlear nerve Paralysis

the Patient tilts the head to compensate
for the slightly skewed gaze

inferior longitudinal
fasciculus

Bilateral lesions
visual agnosia



inferotemporal area

highest visual
association area

area 7 (serving visual
attention)

It receives input from 18, 19

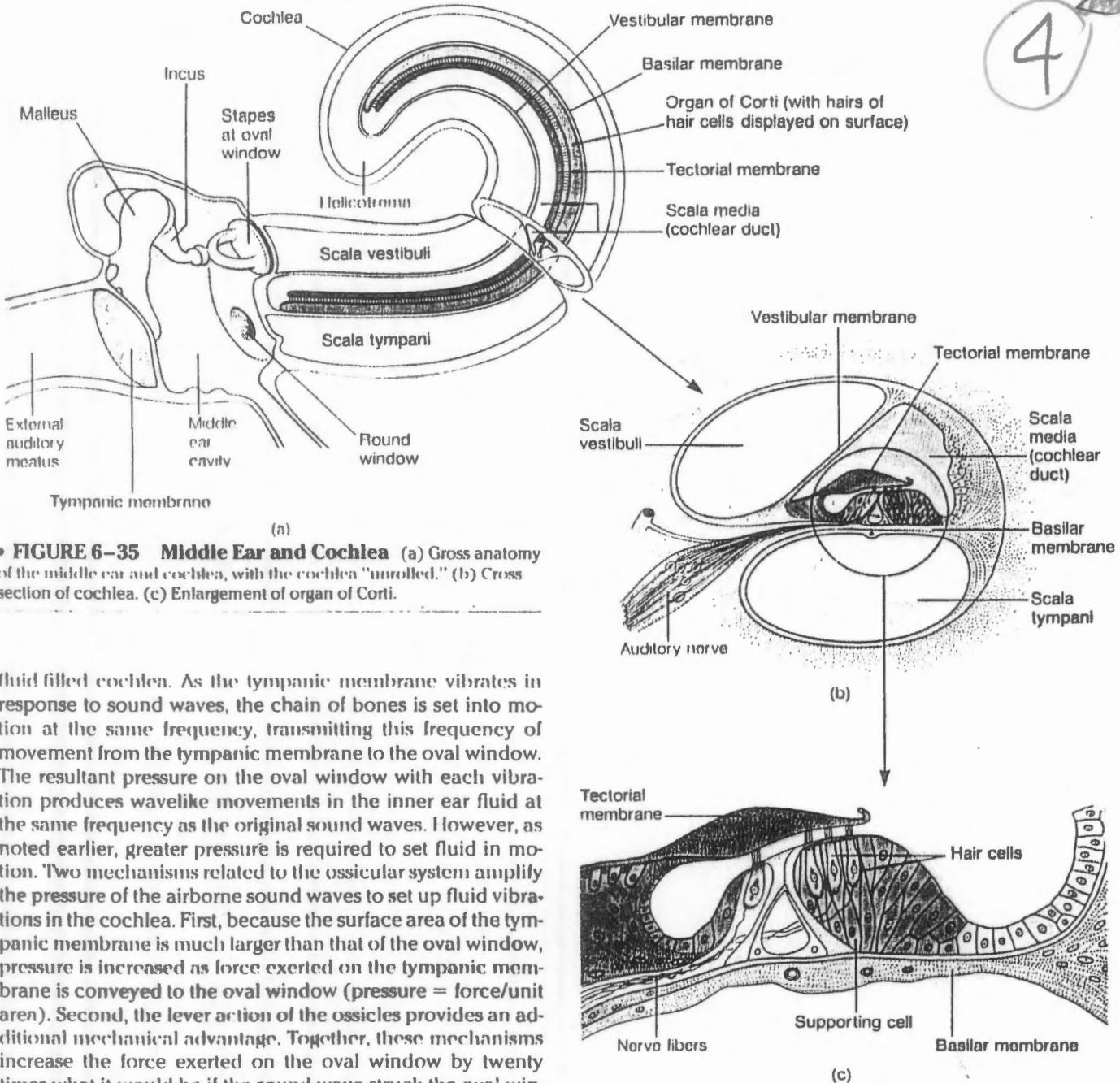


FIGURE 6-35 Middle Ear and Cochlea (a) Gross anatomy of the middle ear and cochlea, with the cochlea "unrolled." (b) Cross section of cochlea. (c) Enlargement of organ of Corti.

fluid-filled cochlea. As the tympanic membrane vibrates in response to sound waves, the chain of bones is set into motion at the same frequency, transmitting this frequency of movement from the tympanic membrane to the oval window. The resultant pressure on the oval window with each vibration produces wavelike movements in the inner ear fluid at the same frequency as the original sound waves. However, as noted earlier, greater pressure is required to set fluid in motion. Two mechanisms related to the ossicular system amplify the pressure of the airborne sound waves to set up fluid vibrations in the cochlea. First, because the surface area of the tympanic membrane is much larger than that of the oval window, pressure is increased as force exerted on the tympanic membrane is conveyed to the oval window (pressure = force/unit area). Second, the lever action of the ossicles provides an additional mechanical advantage. Together, these mechanisms increase the force exerted on the oval window by twenty times what it would be if the sound wave struck the oval window directly. This additional pressure is sufficient to set the cochlear fluid in motion.

Several tiny muscles in the middle ear contract reflexly in response to loud sounds (over 70 dB), causing the tympanic membrane to tighten and limit movement of the ossicular chain. This reduced movement of middle ear structures diminishes the transmission of loud sound waves to the inner ear to protect the delicate sensory apparatus from damage. This reflex response is relatively slow, however, happening at least 40 msec after exposure to a loud sound. It thus provides protection only from prolonged loud sounds, not from sudden loud sounds like an explosion.

Hair cells in the organ of Corti transduce fluid movements into neural signals.

The snail-shaped cochlear portion of the inner ear is a coiled tubular system lying deep within the temporal bone (Fig. 6-32). It is easier to understand the functional components of the cochlea by "unrolling" it, as shown in Figure 6-35a. The cochlea is divided throughout most of its length into three fluid-filled longitudinal compartments. A blind-ended **cochlear duct**, which is also known as the **scala media**, constitutes the middle compartment. It tunnels lengthwise

Receptors for Hearing

↓
Sensory Hair cells of the spiral organ (of Corti) disposed as:

- 1) single row of inner hair cells
- 2) 3 rows of outer hair cells

- 2 types of neurons in the spiral ganglion

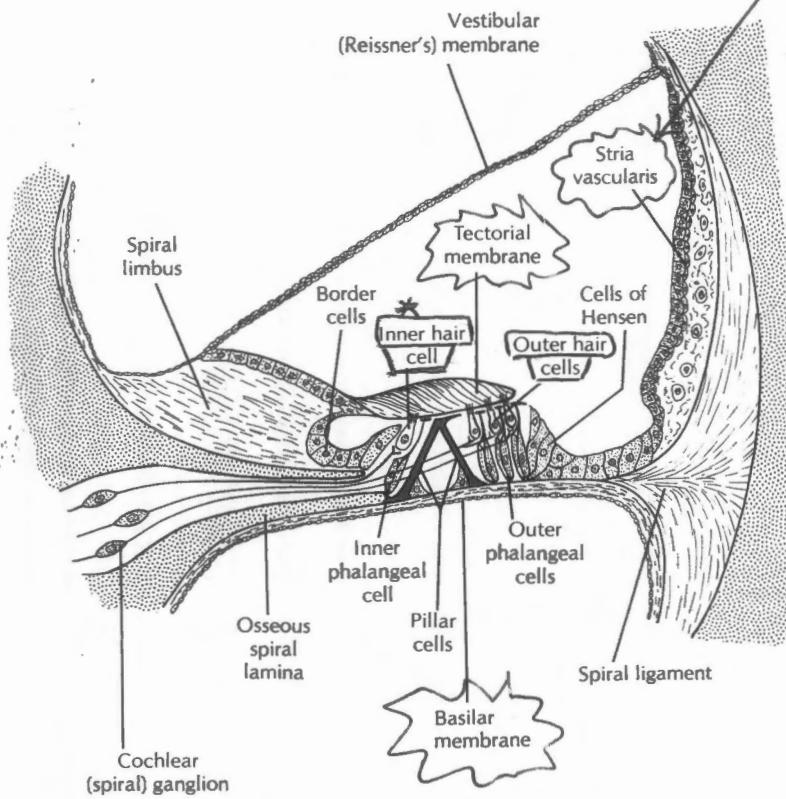
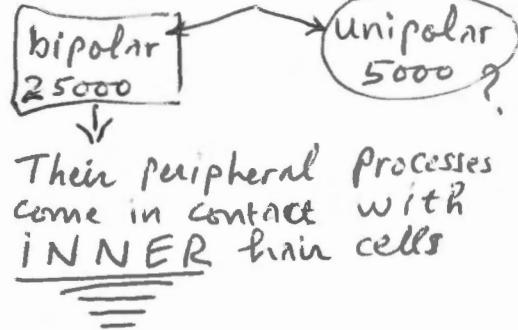
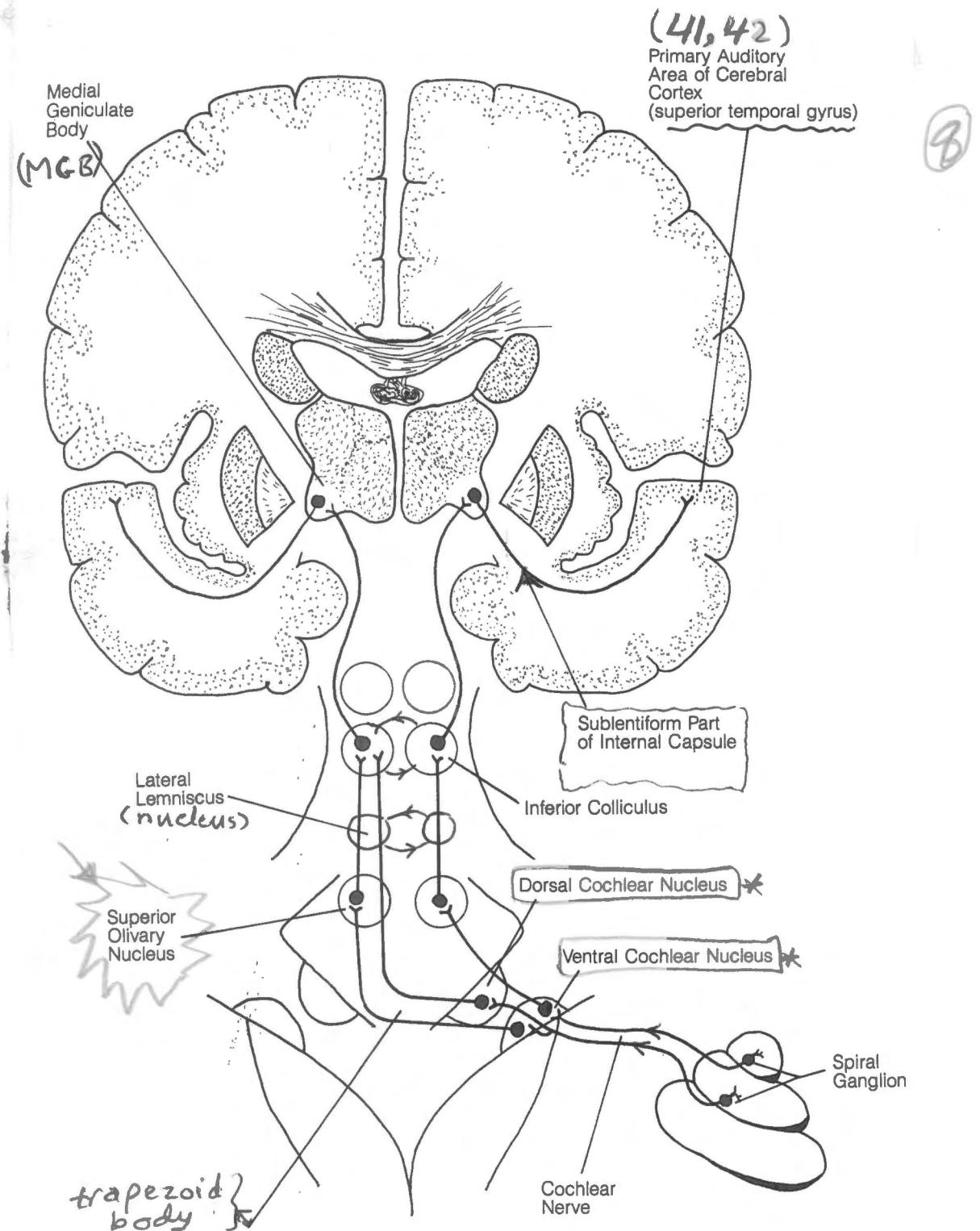


Figure 21-5. Structure of the cochlear duct and spiral organ (organ of Corti).

- Action potential recorded from the main cochlear nerve appear to be derived from neurons supplying inner hair cells
- Endolymph has a high concentration of K^+
- In contrast perilymph has high concentration of Na^+
- ion Pumps in the hair cell membrane produce a resting membrane potential of about -70 mV
- As the basilar membrane is displaced UP in response to fluid movement in the scala tympani → the taller Stereocilia are displaced against the tectorial membrane
- This causes ion channels at the tips of the Stereocilia to open allowing K^+ flow along electrical gradient to DEPOLARIZE the cell → When a hair cell depolarizes → voltage-gated Ca^{2+} channels at the base of the cell open and the resulting influx of Ca^{2+} causes release of neurotransmitter → depolarize afferent fibres of Cochlear nerve → action Potential transmitted along the >> " fibres



- Cochlear Nerve (Central Processes of spiral ganglion cells) bifurcates at ponto medullary junction & enters cochlear nuclei (dorsal (posterior) ventral (anterior))

* Fibres from VENTRAL cochlear nucleus → ipsilateral superior olivary nucleus → Lateral Lemniscus → trapezoid body

* Fibres from DORSAL cochlear nucleus → majority contralateral superior olivary nuc. → lateral lemniscus

contralateral sup. oliv. nucleus → lateral lemniscus

Notice the following:

(9)

Informations from both ears converges on each superior olive & AT ALL HIGHER LEVELS most of the neurons respond to inputs from both sides

- **Cochlear nuclei** → the only auditory nuclei that do not receive binaural input (ie input from both ears)
damage results in unilateral deafness
- **Dorsal cochlear nucleus** → receives input from the cochlear nerve
projects contralaterally to the lateral lemniscus
- **Ventral cochlear nucleus** → receives input from the cochlear nerve
projects bilaterally to the superior olivary nuclei
contralaterally to the lateral lemniscus through the trapezoid body
- **Superior olivary nucleus** → located in the pons at the level of the facial nucleus
receives input from Ventral cochlear nuclei
projects bilaterally to the lateral lemniscus
plays a role in sound localization & binaural hearing
gives rise to the efferent Olivocochlear bundle
which suppresses auditory activity when stimulated
- **Lateral lemniscus** → receives input from superior olivary nuclei (both ears)
projects to the nucleus of the inferior colliculus
connected to the contralateral lateral lemniscus via commissural fibres
- **Nucleus of inferior colliculus** → receives input from the lateral lemniscus
projects via the brachium of the inferior colliculus to the medial geniculate body (MGB) which is the thalamic centre for hearing

MGB → receives input from the nucleus of the inferior colliculus
 Projects via the auditory radiation (in the sublentiform part of internal capsule) to the Primary auditory cortex → the transverse gyri of Heschl (area 41 & 42 in the depth of the lateral sulcus) → Projects to the auditory association cortex (area 22)

* Although fibres conveying auditory input decussate at several levels → the sound is carried out by 2 ways:

① Monaural information i.e. information about sounds at a single ear
 conducted to the contralateral side

② Binaural information i.e. information about differences between sounds to both ears
 is handled by central pathways that receive compare & transmit this input.

* Unilateral damage to Cochlea (Receptors), Fa-cochlear nerve, >> nucleus } Results in monaural i.e. Unilateral deafness

* In contrast Unilateral damage AT or ABOVE the Superior olivary complex leaves intact fibres from either ear so monaural deafness DOES NOT occur

The auditory decussations, particularly the trapezoid body are functionally similar to the optic chiasma

* Unilateral lesion at or above the superior olive
 → impaired hearing especially on contralateral ear
 → inattention to stimuli on the " " "