CHAPTER 1: STIMULI & RESPONSE (ENGLISH)

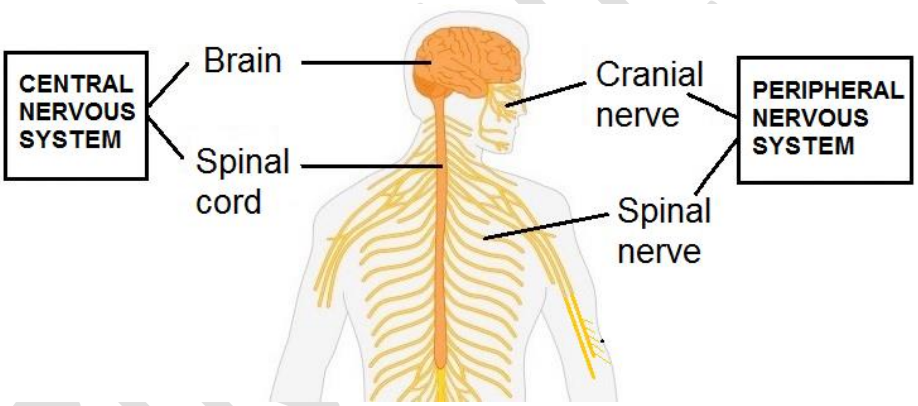
1.1 HUMAN NERVOUS SYSTEM

A. Structure of the Human Nervous System

1. Human NS consists of **central nervous system (CNS) & peripheral nervous system (PNS)**

a. CNS: brain & spinal cord in the middle
b. PNS:
- **cranial nerves** connect brain & sensory organs
- **spinal nerves** connect spinal cord with skeletal muscles

2. Diagram:



B. Function of the Human Nervous System

4 functions:

a. detect stimuli (changes in environment)
b. send impulse to the CNS
c. brain interprets impulse
d. produce appropriate response

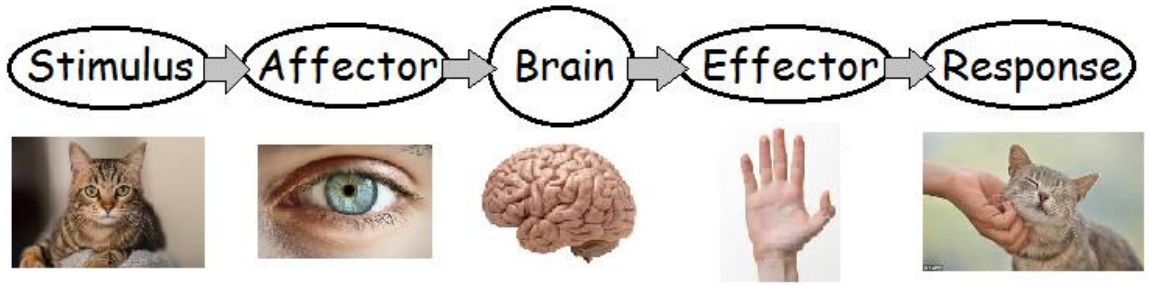
C. Voluntary and Involuntary Actions

1. **Voluntary actions** = actions which our conciousness can control

2. Examples of voluntary actions – reading, writing, walking, running

3. Impulse pathway for voluntary action:

Stimulus →	Affector →	Brain (CNS) →	Effector →	Response



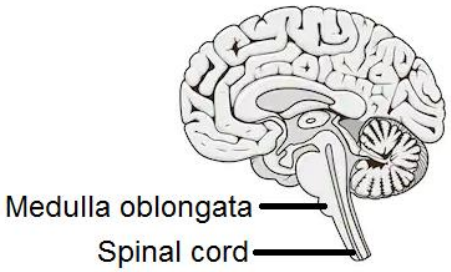
4. So, if brain is damaged → cannot control voluntary actions (ex.: cannot walk properly)

5**. Involuntary actions** = actions which our consciousness cannot control

6. 2 types of involuntary actions & examples:

Type	*Example*
a. Use **medulla oblongata (brainstem)** for continous involuntary actions	Heartbeat, breathing, peristalsis, pupil dilation/constriction
b. Use **spinal cord** for short & rapid one (reflex actions)	Sneezing, vomiting, withdraw hand from hot/sharp object

- Diagram showing **medulla oblongata** & **spinal cord:**



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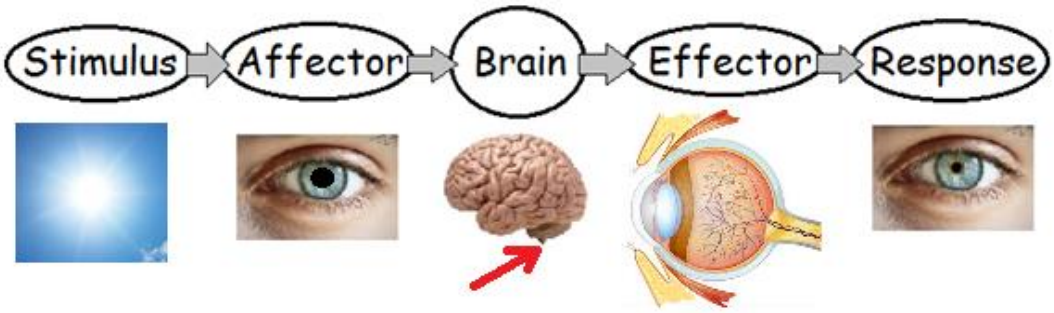
7. Impulse pathway for involuntary action (pupil constriction):

Stimulus →	Affector →	CNS →	Effector →	Response
Bright light	Eye retina	Medulla oblongata	Eye muscle	Pupil constriction



D. Importance of Human Nervous System in Daily Life

2 importance:

a. Prevent danger/ avoid injury
b. Adapt to the environment

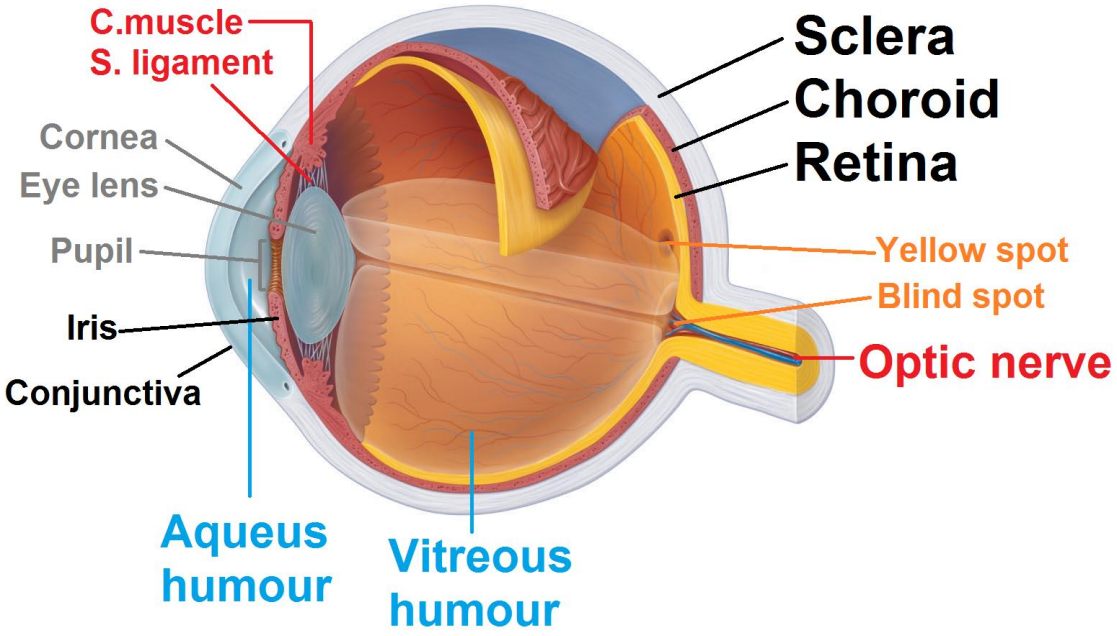
1.2 STIMULI & RESPONSES IN HUMANS

We detect stimuli using five sensory organs:

Sensory organs	*Type of sense*	*Stimulus*
Eye	Sight	Light
Ear	Hearing	Sound wave
Nose	Smell	Chemical substance
Tongue	Taste	Chemical substance
Skin	Touch	Physical surface

A. Eye

1. Labels of eye parts:



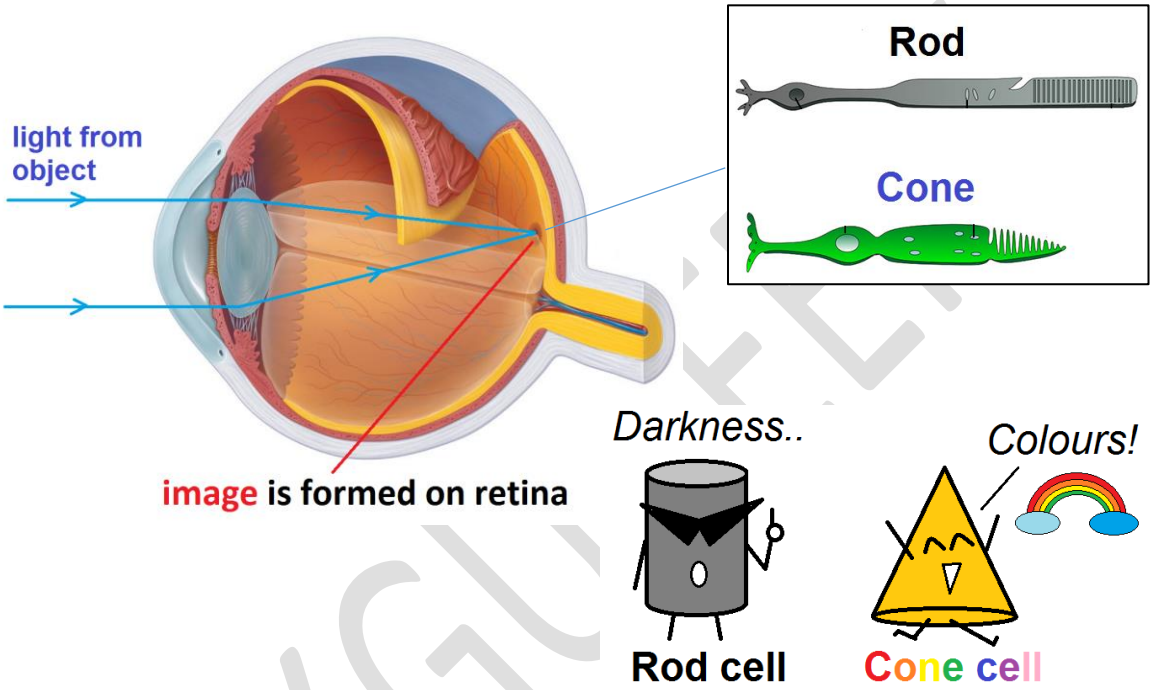
2. Function of parts:

15 Parts of eye	*Function/ description*
Sclera	Protect eye
Choroid	Prevent light reflection
Retina	Detect light stimulus & change to impulse
Blind spot	Not sensitive to light
Yellow spot	Most sensitive to light
Optic nerve	Send impulse to brain
Aqueous humour	Maintain eyeball shape
Vitreous humour	Maintain eyeball shape
Ciliary muscle	Change lens thickness
Suspensory ligament	Holds eye lens
Eye lens	Focus light on retina
Cornea	Focus light on retina
Conjunctiva	Protect cornea
Pupil	Allow light to enter eye
Iris	Control pupil size

3. Mechanism of sight – light pathway:

Conjunctiva	Cornea	Aqueous humour	Pupil	Lens	Vitreous humour	Retina	Optic nerve

4. In order to see, light from object needs to form **image** on the retina:



5. Retina contains 2 **photoreceptors:**

a. **Rod cells** – sensitive in faint light but not colours
b. **Cone cells** – sensitive in bright light & colours

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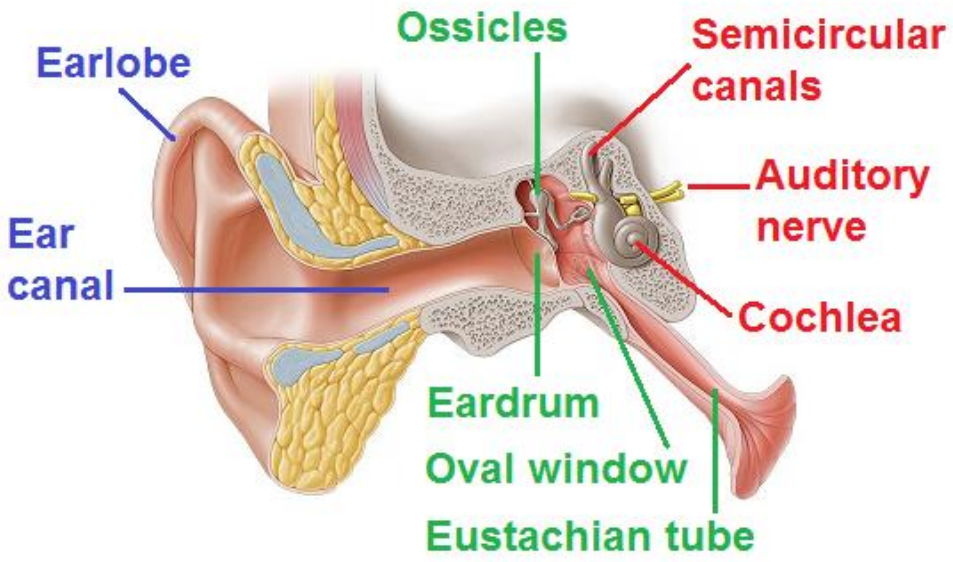
B. Ear

1. Label of ear parts:



2. Function of parts:

	Part of ear	*Function/ description*
Outer ear	**Earlobe**	Collect sound wave
	Ear canal	Channel sound to eardrum
Middle ear	**Eardrum**	Vibrate according to sound frequency
	Ossicle bones	Amplify sound vibration
	Oval window	Channel sound from ossicles to cochlea
	Eustachian tube	Balance air pressure in ear
Inner ear	**Semicircular canals**	Balance the body
	Cochlea	Detect sound stimulus & change to impulse
	Auditory nerve	Send impulse to brain

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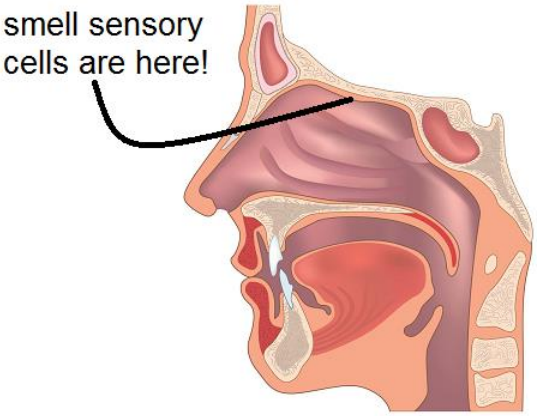
3. Mechanism of hearing:

Earlobe	Ear canal	Eardrum	Ossicles	Oval window	Cochlea	Auditory nerve

4. Eustachian tube & semicircular canals are <u>not involved in hearing</u>

C. Nose

1. Location of smell sensory cells:



2. **Smell sensory cells** are located at the roof of nasal cavity & covered with **mucus**

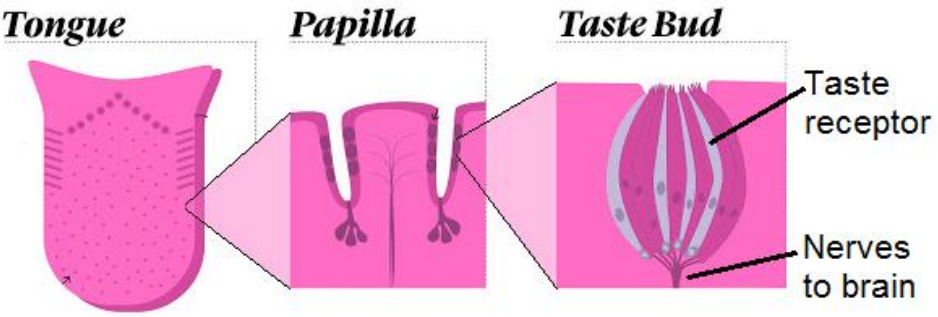
3. During fever/flu:

Too mucus is secreted → mucus block the sensory cells → cannot smell properly → food has bland taste

D. Tongue

1. Tongue detects 5 basic tastes:
Sweet, salty, sour, bitter, and umami

2. Tongue structure:



3. Tongue surface has **tastes buds** which detect the five tastes

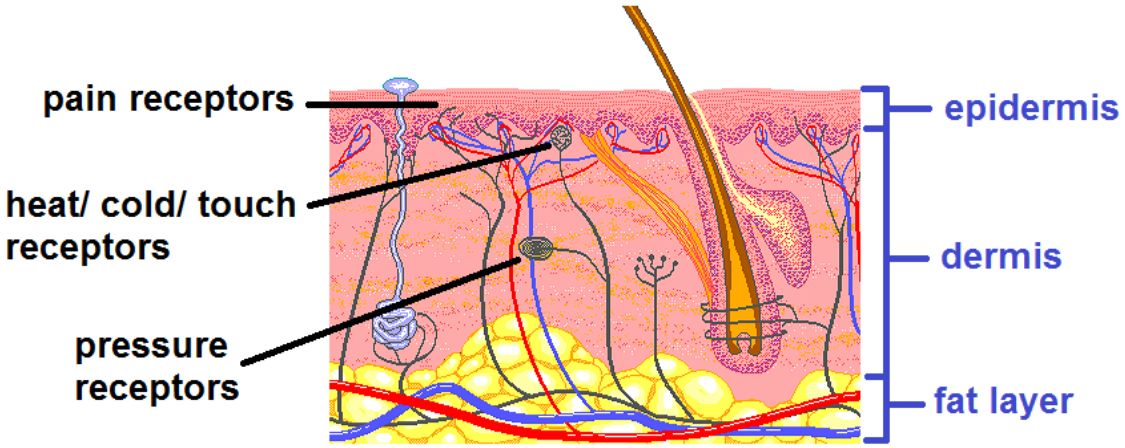
4. To detect the taste, chemical substances in food need to dissolve in **saliva**

5. Taste is influenced by smell. During fever which nose is blocked, we cannot taste food properly

6. Taste is not influenced by sight. That's why we still can taste food with eyes closed

E. Skin

1. Label of skin receptors:



2. Skin sensitivity is influenced by **number of receptors & thickness of epidermis.**

a. The more receptors → the more sensitive the skin
b. The thicker the epidermis → the less sensitive the skin

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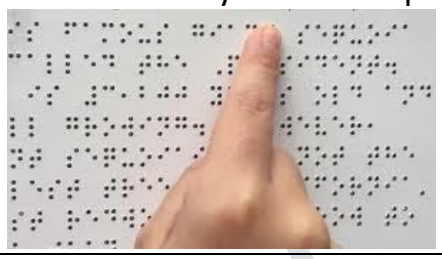
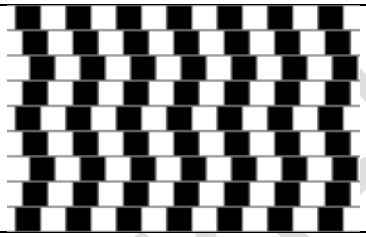
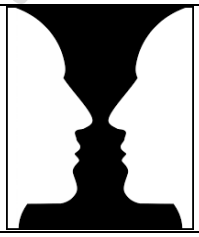
3. Application:	
Injection on shoulder due to less pain receptors	Reading Braille using fingertips because have many touch receptors 

F. Limitation of the Sense of Sight

1. Our eyes are wonderful, but they have **3 limitations:**

a. we cannot see <u>very tiny or faraway objects</u>

b. we cannot interprete certain things due to distractions (**optical illusion**):

	
Parallel lines or not?	A vase or two faces?

c. we cannot see if image falls on **blind spot** instead of retina:

2. How to overcome limitations of sight:

Binoculars/ telescope to see faraway objects	Microscope to see very small objects	X-ray machine to observe structure in body

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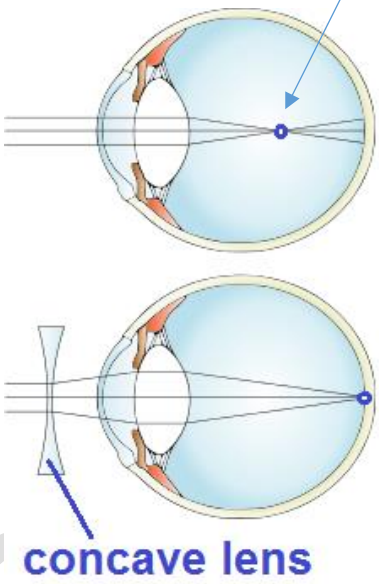
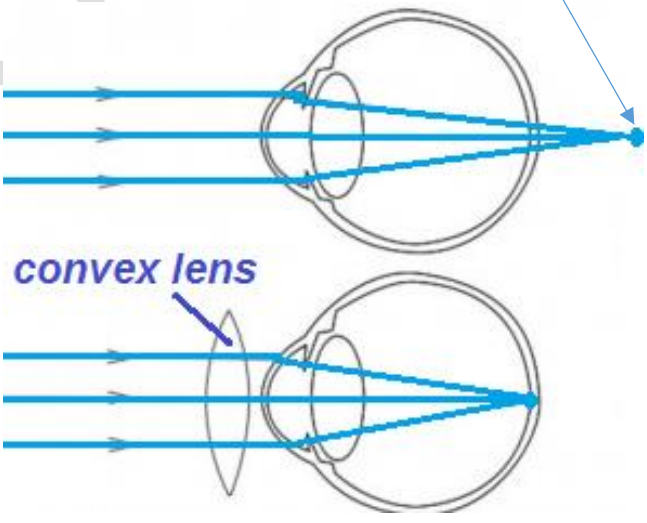
G. Defects of the Sense of Sight

3 defects – **short-sightedness, long-sightedness, & astigmatism**

1. **Short-sightedness:**
- Cannot see distant objects clearly (<u>image in front of retina</u>)
- caused by <u>thick eye lens</u> or <u>long eyeball</u>
- can be corrected using **concave lens**



2. **Long-sightedness:**
- cannot see near objects clearly (<u>image behind retina</u>)
- caused by <u>thin eye lens</u> or <u>short eyeball</u>
- can be corrected using **convex lens**



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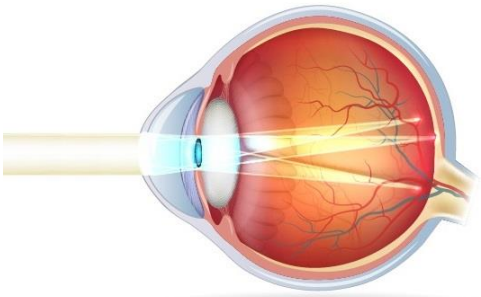
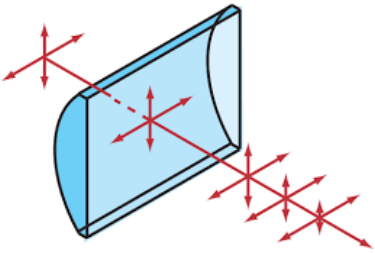
3. **Astigmatism:**
- objects seen – some clear, some blurry
- caused by <u>uneven surface of cornea or eye lens</u>
- this will form <u>many overlapping images</u>
- can be corrected using **cylindrical lens**

 Eye with Astigmatism	 cylindrical lens (kanta silinder)

H. Limitation of Hearing

1. Our ears are wonderful, and they also have limitations:

a. we cannot hear very faint sound or from faraway objects
b. we can only hear sound frequency between range **20Hz - 20,000Hz**

2. How to overcome limitations of hearing:

Stethoscope to hear heartbeat	Loudspeaker to amplify sound

I. Defect of the Sense of Hearing

Defect can be caused by damages to outer, middle, & inner ear

1. **Damage to outer or middle ear**
- can be corrected easily by clearing ear canal, medicine, or surgery

2. **Damage to inner ear**
- more difficult to be corrected
- damage cochlea can be corrected by using **cochlear implant** or hearing aid

1.3 STIMULI & RESPONSES IN PLANTS

2 types of plants responses – **tropism & nastic movement**

A. Tropism

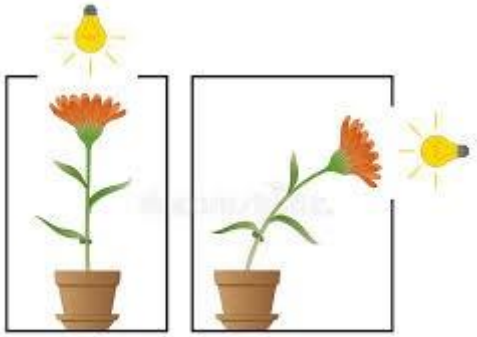
1. **Tropism** = plant response that depends on stimulus direction

2. 4 types – **phototropism, hydrotropism, geotropism, thigmotropism**

3. **Phototropism:**

a. Definition = plant response to **light**

b. Shoot shows **positive phototropism (towards light)**



c. Importance – shoot & leaves can obtain sunlight to do photosynthesis

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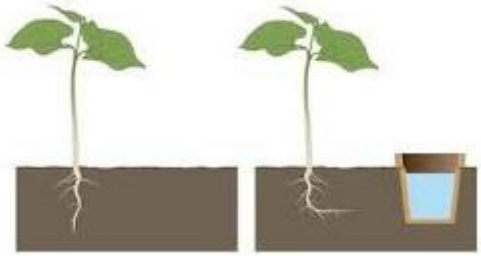
4. **Hydrotropism:**

a. Definition = plant response to **water**
b. Root shows **positive hydrotropism (towards water)** 
c. Importance – root can obtain water & mineral salts for survival

5. **Geotropism:**

a. Definition = plant response to **gravity**
b. Shoot (negative geotropism) & root (positive geotropism):
c. Importance: - shoots grows upward towards sunlight - root grows downward into ground to grip soil & become stable

6. **Thigmotropism:**

a. Definition = plant response to **touch**

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b. Tendrils & twining stems show positive thigmotropism:

c. Importance – to grip & grow upwards towards sunlight

B. Nastic Movement

1. **Nastic** = plant response that does not depend on stimulus direction

Example: *Mimosa pudica:*

2. Importance – protect plants from enemies & weather (strong winds)

C. Comparing Tropism & Nastic Movement:

TROPISM	*NASTIC MOVEMENT*
Depend on stimuli direction	Does not depend on stim. direction
Slow response	Rapid response
Show positive (move towards) or negative (move away) responses	No specific response
4 types: phototropism, hydrotropism, geotropism, thigmotropism	No type

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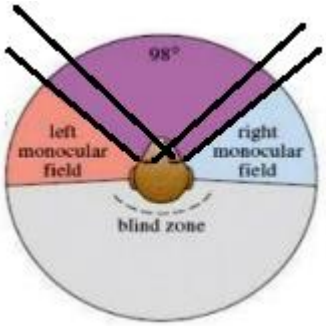
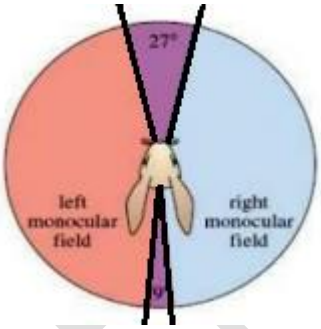
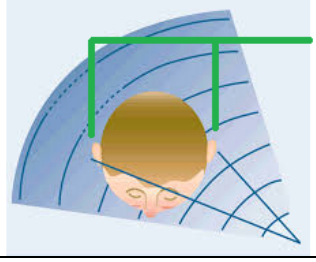
1.4 IMPORTANCE OF RESPONSES TO STIMULI IN ANIMALS

A. Stereoscopic & Monocular Vision

STEREOSCOPIC	***MONOCULAR***
	
Eyes in front of head (in most **predators**):	Eyes at the sides of head (in most **prey**):
Overlapping FOV → **3D images** → can estimate distance/depth	No overlapping FOV → **2D images** → can't estimate distance/depth
Advantage: can catch accurately Disadvantage: narrow FOV (can't see behind)	Advantage: wide FOV to detect predators Disadvantage: can't estimate image depth

B. Stereophonic Hearing & Hearing Frequencies

1. **Stereophonic hearing**:
- definition: hearing using both ears
- mechanism: both ears receive sound wave at **different time & loudness**
- importance: we can <u>detect the source of sound</u>



Both ears receive sound wave at **different time & loudness**

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2. **Hearing frequencies**
- Human can hear at frequency range of 20Hz – 20,000Hz
- Dogs can hear at higher frequency → dogs can hear sound that we can't:

C. Sensory Organs Ensure the Survival of Animals on Earth

Animal	*Sensory organ & its importance*
Cape porcupine, cat	**Whiskers** – to sense surrounding in the dark
Electric eel	**Skin generates electric field** – to navigate & find prey in dark water
Melolontha beetle	**Gland secretes pheromone** – to find mates & reproduce
Snake, lizard, cat	**Jacobson organ** – detect the smell of prey and pheromone in the air
Jumping spider	**Have many sets of eyes** - front eyes to catch prey - side eyes to detect predators
Fish	**Lateral line on abdomen** – to detect movement, pressure, & vibration in water

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BAB 1: RANGSANGAN DAN GERAK BALAS (BAHASA)

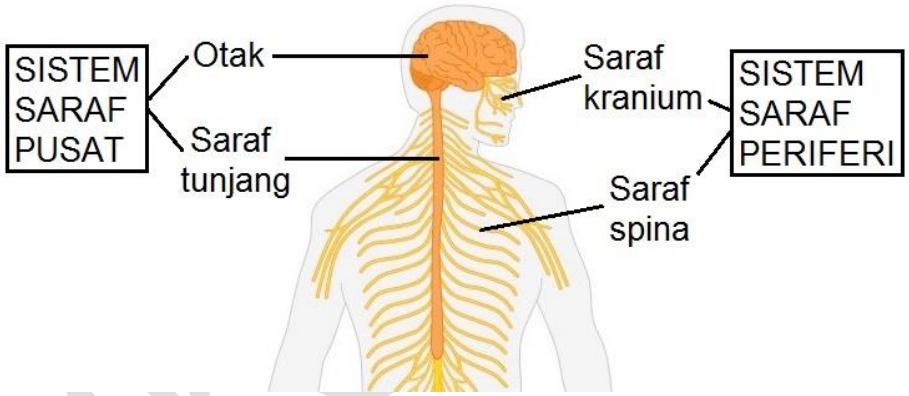
1.1 SISTEM SARAF MANUSIA

A. Struktur Sistem Saraf (SS) Manusia

1. NS manusia terdiri daripada **sistem saraf pusat** & **sistem saraf periferi**

a. SS pusat: otak & saraf tunjang di tengah
b. SS periferi:
- **saraf kranium** menghubungkan otak & organ deria
- **saraf spina** menghubungkan saraf tunjang dengan otot rangka

2. Rajah:



B. Fungsi Sistem Saraf Manusia

4 fungsi:

a. mengesan rangsangan (perubahan persekitaran)
b. menghantar impul ke SS pusat
c. otak menafsirkan impuls
d. menghasilkan gerak balas yang sesuai

C. Tindakan Terkawal dan Tindakan Luar Kawal

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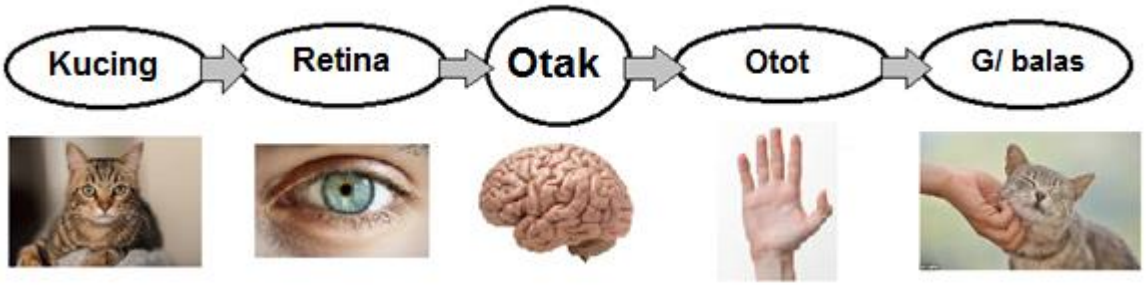
1. **Tindakan terkawal** = tindakan yang boleh dikawal oleh minda sedar

2. Contoh tindakan terkawal – membaca, menulis, berjalan, berlari

3. Laluan impuls untuk tindakan terkawal:

Rangsangan →	Reseptor →	SS Pusat →	Efektor →	Gerak balas



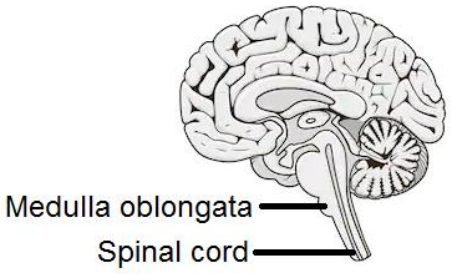
4. Jadi, jika otak cedera → tidak dapat kawal tindakan terkawal (tidak dapat berjalan dengan baik)

5. **Tindakan luar kawal** = tindakan yang tidak dapat dikawal oleh minda sedar

6. 2 jenis tindakan luar kawal & contoh:

Jenis	*Contoh*
a. Dikawal oleh **medulla oblongata (MO)** untuk tindakan luar kawal berterusan	Denyutan jantung, pernafasan, peristalsis, anak mata mengecil/ membesar
b. Dikawal oleh **saraf tunjang** utk tindakan luar kawal sekejap & cepat (tindakan refleks)	Bersin, muntah, menarik tangan daripada objek panas / tajam

- Rajah menunjukkan medula oblongata & saraf tunjang:



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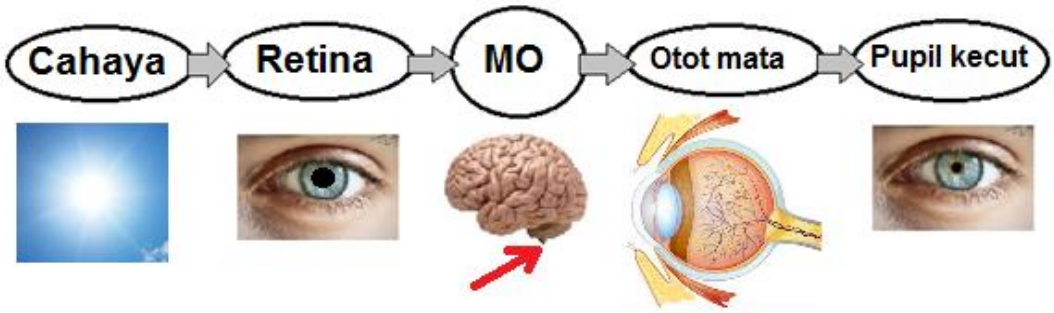
7. Laluan impuls untuk tindakan luar kawal (anak mata mengecil):

Rangsangan	Reseptor	SS Pusat	Efektor	Gerak balas
Cahaya yang terang	Retina mata	Medulla oblongata	Otot mata	Anak mata mengecil



D. Kepentingan Sistem Saraf Manusia dalam Kehidupan Harian

2 kepentingan:

a. Mencegah bahaya / mengelakkan kecederaan
b. Menyesuaikan diri dengan persekitaran

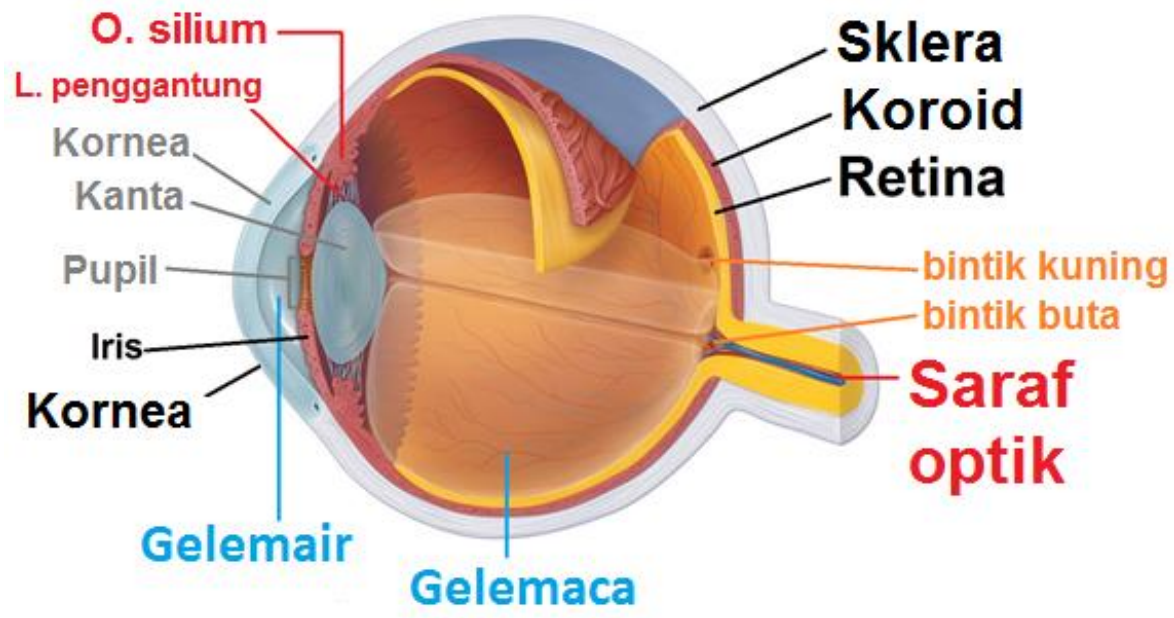
1.2 RANGSANGAN & GERAK BALAS DALAM MANUSIA

Kita mengesan rangsangan menggunakan lima organ deria:

Organ deria	*Deria*	*Rangsangan*
Mata	Penglihatan	Cahaya
Telinga	Pendengaran	Gelombang bunyi
Hidung	Bau	Bahan kimia
Lidah	Rasa	Bahan kimia
Kulit	Sentuh	Sentuhan, tekanan, sakit, panas, sejuk

A. Mata

1. Label bahagian mata:



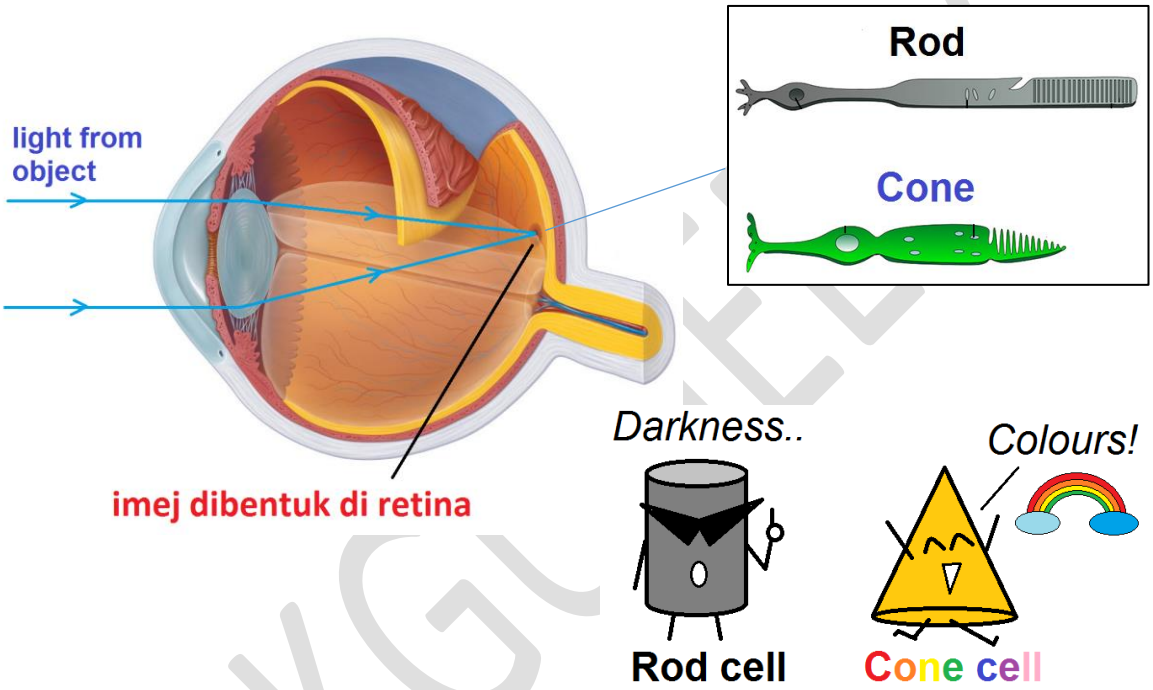
2. Fungsi bahagian:

15 bahagian mata	*Fungsi / keterangan*
Sklera	Melindungi mata
Koroid	Elakkan pantulan cahaya dalam bola mata
Retina	Mengesan cahaya & ubah menjadi impuls
Bintik buta	Tidak peka kpd cahaya
Bintik kuning	Paling peka kpd cahaya
Saraf optik	Hantar impuls ke otak
Gelemaca	Mengekalkan bentuk bola mata
Gelemair	Mengekalkan bentuk bola mata
Otot silium	Ubah ketebalan kanta
Ligamen penggantung	Memegang kanta
Kanta mata	Fokus cahaya pada retina
Kornea	Fokus cahaya pada retina
Konjunktiva	Lindungi kornea
Anak mata (pupil)	Kawal jumlah cahaya masuk ke mata
Iris	Kawal saiz pupil

3. Mekanisme penglihatan - laluan cahaya:

Konjunktiva	Kornea	Gelemair	Pupil	Kanta	Gelemaca	Retina	Saraf optik

4. Untuk melihat, cahaya dari objek perlu membentuk **imej** di retina:



5. Retina mengandungi 2 **fotoreseptor:**

a. **Sel rod** – berfungsi dlm cahaya malap → menghasilkan imej hitam/putih
b. **Sel kon** – berfungsi dlm cahaya terang & warna → hasilkan imej warna

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B. Telinga

1. Label bahagian telinga:

2. Fungsi bahagian:

	Bahagian telinga	*Fungsi / keterangan*
Telinga luar	**Cuping telinga**	Kumpul gelombang bunyi
	Salur telinga	Salurkan bunyi ke gegendang
Telinga tengah	**Gegendang telinga**	Bergetar mengikut frekuensi bunyi
	Tulang osikel	Menguatkan getaran bunyi
	Tingkap bujur	Salurkan bunyi dari osikel ke koklea
	Tiub Eustachio	Seimbangkan tekanan udara dlm telinga
Telinga dalam	**Salur separuh bulat**	Keseimbangan badan
	Koklea	Mengesan bunyi & ubah menjadi impuls
	Saraf auditori	Hantar impuls ke otak

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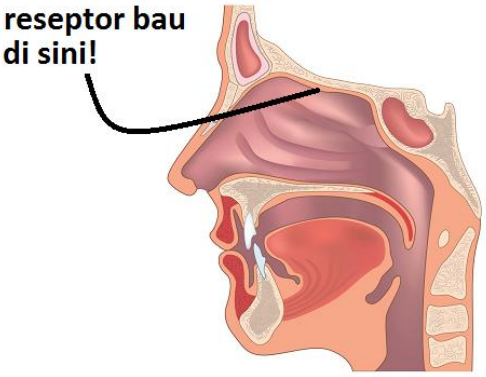
3. Mekanisme pendengaran:

Cuping telinga	Salur telinga	Gegendang telinga	Osikel	Tingkap bujur	Koklea	Saraf auditori

4. Tiub Eustachio & salur separuh bulat <u>tidak terlibat dalam pendengaran</u>

C. Hidung

1. Lokasi sel-sel reseptor bau:



2. **Sel reseptor bau** terletak di bumbung rongga hidung & dilitupi dengan **mukus**

3. Semasa demam / selesema:

Terlalu banyak mukus dirembeskan → mukus menyekat sel reseptor → tidak dapat menghidu dengan baik → makanan terasa hambar

D. Lidah

1. Lidah mengesan 5 rasa:
Manis, masin, masam, pahit, dan umami

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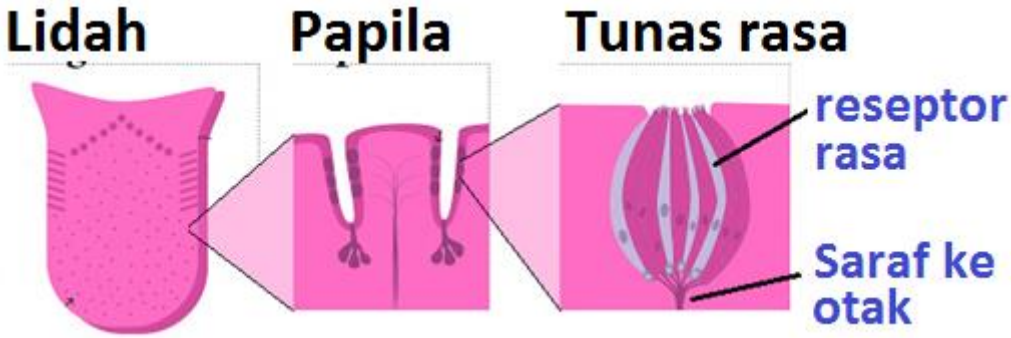
2. Struktur lidah:



3. Permukaan lidah mempunyai **tunas rasa** yang mengesan lima rasa

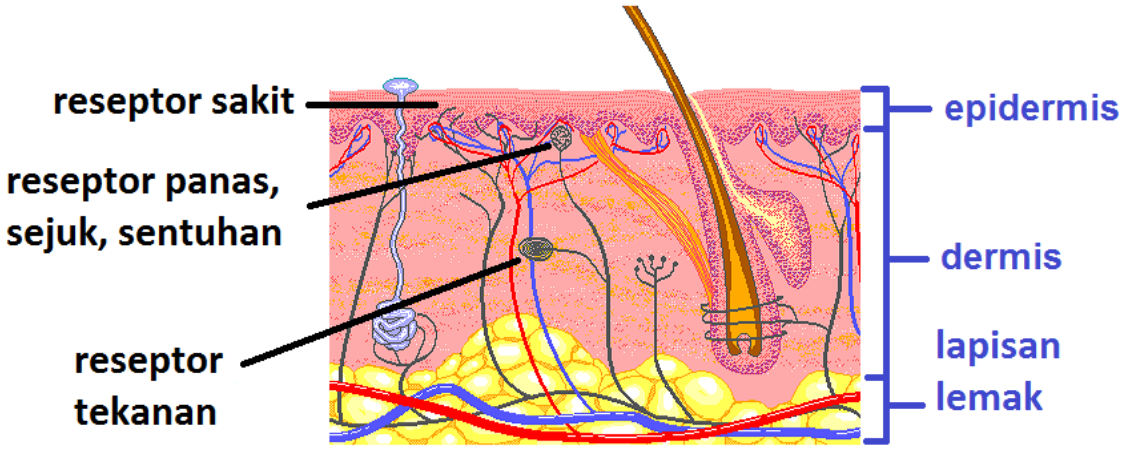
4. Untuk mengesan rasa, bahan kimia dlm makanan perlu larut dalam **air liur**

5. Deria rasa dipengaruhi oleh deria bau. Semasa demam (hidung tersumbat), kita tidak dapat rasa makanan dengan betul

6. Rasa tidak dipengaruhi oleh penglihatan → kita masih dapat rasa makanan dengan mata tertutup

E. Kulit

1. Label reseptor kulit:



2. Kepekaan kulit dipengaruhi oleh **bilangan reseptor** & **ketebalan epidermis**.

a. Semakin banyak reseptor → kulit makin peka
b. Semakin tebal epidermis → kulit kurang peka

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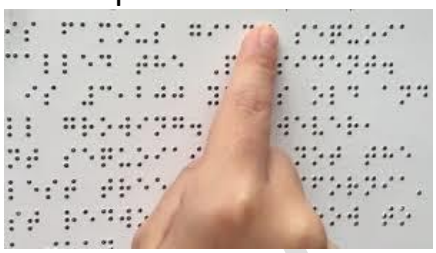
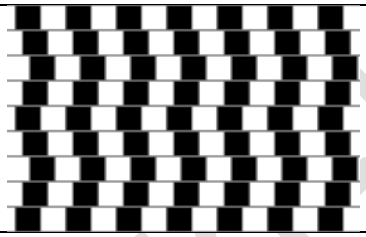
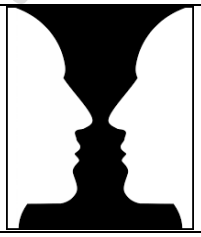
3. Aplikasi:	
Suntikan di bahu kerana kurang reseptor sakit	Baca Braille guna hujung jari yg banyak reseptor sentuhan 

F. Had Deria Penglihatan

1. Mata kita mempunyai 3 had:

a. kita tidak dapat melihat objek yang <u>sangat kecil atau sangat jauh</u>

b. kita tidak dapat menafsirkan objek tertentu (**ilusi optik**):

	
Garis selari atau tidak?	Pasu atau dua muka?

c. kita tidak dapat lihat jika imej jatuh pada **titik buta** dan bukannya retina:

2. Cara mengatasi had penglihatan:

Binokular/teleskop utk lihat objek jauh	Mikroskop utk lihat objek sgt kecil	Mesin sinar-X untuk memerhati struktur dlm badan

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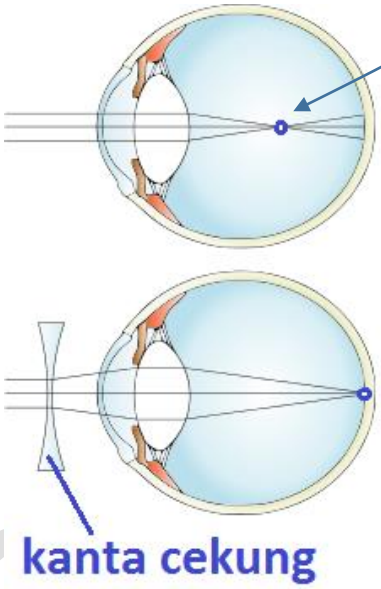
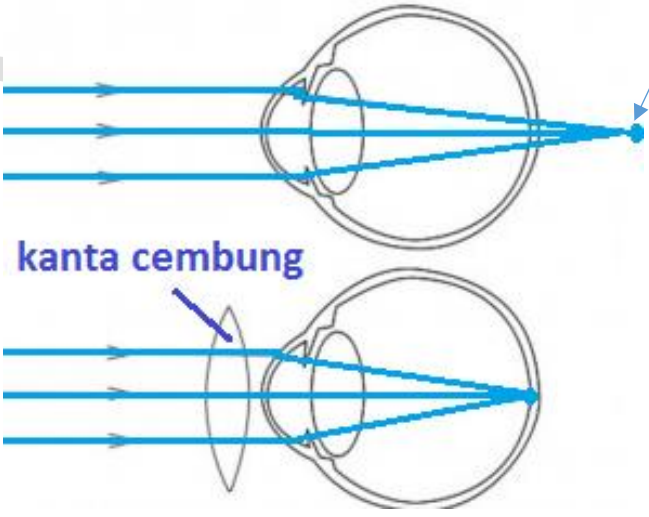
G. Kecacatan Penglihatan

3 kecacatan – **rabun dekat, rabun jauh, & astigmatisme**

1. **Rabun dekat:**
- Tidak dapat melihat objek jauh dengan jelas (imej di hadapan retina)
- disebabkan oleh kanta mata tebal atau bola mata panjang
- boleh diperbetulkan dengan menggunakan **kanta cekung**



2. **Rabun jauh:**
- tidak dapat melihat objek dekat dengan jelas (imej di belakang retina)
- disebabkan oleh kanta mata nipis atau bola mata pendek
- boleh diperbetulkan dengan menggunakan **kanta cembung**



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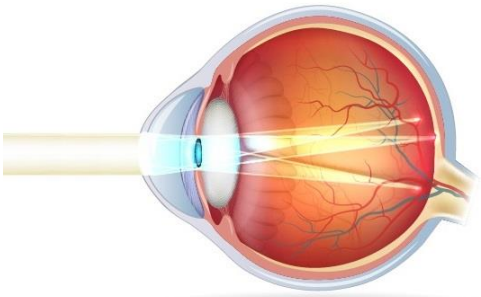
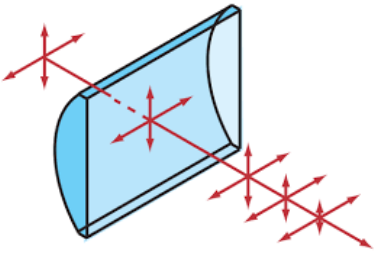
3. **Astigmatisme:**
- objek dilihat – ada yg jelas, ada yg kabur
- disebabkan oleh <u>permukaan kornea atau kanta tidak rata</u>
- ini menyebabkan pembentukan <u>banyak imej bertindih</u>
- boleh diperbetulkan dengan menggunakan **kanta silinder**

 Eye with Astigmatism	 cylindrical lens (kanta silinder)

H. Had Deria Pendengaran

1. Telinga kita mempunyai 2 had:

a. kita tidak dpt dengar bunyi yang sangat halus atau jauh
b. kita hanya dapat dengar frekuensi bunyi antara julat **20Hz - 20,000Hz**

2. Cara mengatasi had pendengaran:

Stetoskop – dengar degupan jantung	Pembesar suara – menguatkan bunyi

I. Kecacatan Pendengaran

Kecacatan → disebabkan oleh kerosakan pada telinga luar, tengah, & dalam

1. Kerosakan pada **telinga luar atau tengah**
- dapat diperbaiki dngn bersihkan saluran telinga, ubat, atau pembedahan

2. Kerosakan pada **telinga dalam** - lebih sukar untuk diperbetulkan - koklea rosak dapat diperbaiki dengan menggunakan **implan koklea** atau alat bantu pendengaran

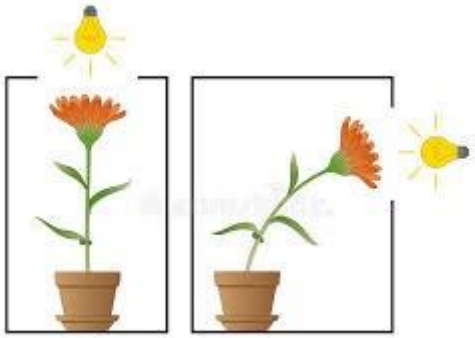
1.3 RANGSANGAN DAN GERAK BALAS DALAM TUMBUHAN

2 jenis tindak balas tanaman – **tropisme & gerak balas nastik**

A. Tropisme

1. **Tropisme** = gerak balas tumbuhan yg bergantung kpd <u>arah rangsangan</u>
2. 4 jenis – **fototropisme, hidrotropisme, geotropisme, tigmotropisme**

3. **Fototropisme:**

a. Definisi = gerak balas tumbuhan terhadap **cahaya**
b. Pucuk menunjukkan **fototropisme positif (ke arah cahaya)** 
c. Kepentingan - pucuk & daun dapat memperoleh cahaya matahari untuk melakukan fotosintesis

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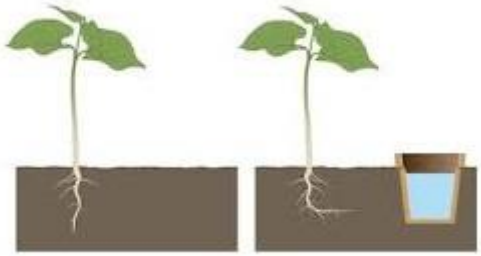
4. **Hidrotropisme:**

a. Definisi = gerak balas tumbuhan terhadap **air**
b. Akar menunjukkan **hidrotropisme positif (ke arah air)** 
c. Kepentingan – akar memperoleh garam air & mineral untuk hidup

5. **Geotropisme:**

a. Definisi = tindak balas tumbuhan terhadap **graviti**
b. Pucuk (geotropisme negatif) & akar (geotropisme positif):
c. Kepentingan: - pucuk tumbuh ke atas ke arah cahaya matahari - akar tumbuh ke bawah ke tanah utk cengkam tanah & tumbuhan jadi stabil

6. **Tigmotropisme:**

a. Definisi = gerak balas tumbuhan terhadap **sentuhan**

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b. Sulur paut & batang lembut menunjukkan tigmotropisme positif:

c. Kepentingan – utk cengkam & tumbuh ke arah cahaya matahari

B. Gerak Balas Nastik

1. **Nastik** = gerak balas tumbuhan yg tidak bergantung pada arah rangsangan

Contoh: *Mimosa pudica:*

2. Kepentingan – melindungi tumbuhan drpd musuh & cuaca (angin kencang)

C. Membandingkan Gerak Balas Tropisme & Nastik:

TROPISME	*G/B NASTIK*
Bergantung pada arah rangsangan	Tidak bergantung pada arah
Gerak balas perlahan	Pantas
Menunjukkan gerak balas positif (mendekati) atau negatif (menjauhi)	Tiada gerak balas positif/negatif
4 jenis: fototropisme, hidrotropisme, geotropisme, tigmotropisme	Tiada jenis

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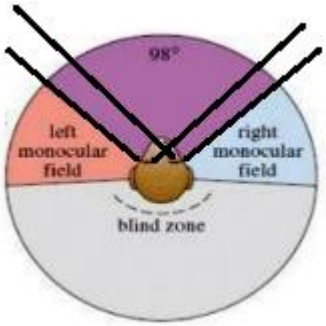
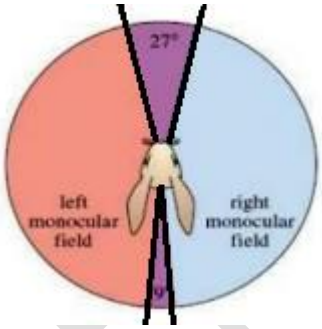
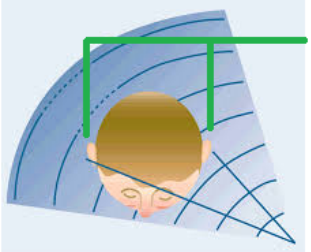
1.4 KEPENTINGAN GERAK BALAS DALAM HAIWAN LAIN

A. Penglihatan Stereoskopik & Monokular

STEREOSKOPIK	***MONOKULAR***
	
Mata di hadapan kepala (kebanyakan **pemangsa**):	Mata di sisi kepala (kebanyakan **mangsa**):
Medan penglihatan bertindih → **imej 3D** → dapat menganggar jarak	Medan penglihatan tidak bertindih → **imej 2D** → tak dpt anggar
Kelebihan: dpt tangkap dengan tepat Kekurangan: Medan penglihatan tidak luas	Kelebihan: Medan penglihatan luas utk mengesan pemangsa Kekurangan: tak dpt anggar jarak

B. Pendengaran Stereofonik & Frekuensi Pendengaran

1. **Pendengaran stereofonik:**
- definisi: pendengaran menggunakan kedua-dua belah telinga
- mekanisme: kedua-dua telinga **terima gelombang bunyi pada masa & kekuatan bunyi yang berbeza**
- kepentingan: kita dapat mengesan sumber bunyi



Kedua-dua telinga **terima gelombang bunyi pada masa & kekuatan bunyi yang berbeza**

2. **Frekuensi pendengaran:**
- Manusia boleh mendengar pada julat frekuensi 20Hz - 20,000Hz
- Anjing dapat mendengar pada frekuensi yang lebih tinggi → anjing boleh mendengar bunyi yang kita tidak dapat dengar:

C. Organ Deria Menjamin Kesinambungan Haiwan di Bumi

Haiwan	*Organ deria & kepentingannya*
Landak, kucing	**Misai** – mengesan persekitaran dlm kegelapan
Belut elektrik	**Kulit menghasilkan medan elektrik** - untuk mengemudi & memburu mangsa dlm air gelap
Kumbang *Melolontha*	**Kelenjar merembeskan feromon** - untuk mencari pasangan & membiak
Ular, cicak, kucing	**Organ Jacobson** - mengesan bau mangsa dan feromon di udara
Labah-labah melompat	**Mempunyai banyak set mata** - mata hadapan untuk menangkap mangsa - mata sisi untuk mengesan pemangsa
Ikan	**Garis lateral pada abdomen** - untuk mengesan pergerakan, tekanan, & getaran di dalam air

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