BUKU PANDUAN

PRAKTIKUM

BLOK 1.3 Biomedik 2

Anatomi

Histologi

Fisiologi

Biokimia

FAKULTAS KEDOKTERAN

Tahun Ajaran 2021/2022

BLOK 1.3

Anatomi

Histologi

Fisiologi

Biokimia

PENUNTUN PRAKTIKUM

EDISI 4

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KATA PENGANTAR

Assalamualaikum Warahmatullahi Wabarokatuh

Alhamdulillah, Puji dan syukur kita panjatkan kehadirat Allah SWT, serta salawat dan salam kepada Rasul tercinta Muhammad SAW, dimana atas inayah-Nya dan berkah-Nya kami dapat menyelesaikan buku ini. Buku panduan laboratorium ini berisikan panduan-panduan untuk mengikuti aktivitas pembelajaran laboratorium di blok biomedis 2.

Tema pembahasan pada blok ini adalah 'genetika dan biomolekuler' yang akan memberikan bekal bagi mahasiswa tentang ilmu dasar yang diperlukan sebagai landasan untuk menjadi seorang dokter. Adapun aktivitas pembelajaran laboratorium di blok ini di dukung oleh tiga mata kuliah praktikum yaitu Histologi, Fisiologi dan Biokimia.

Kegiatan pembelajaran laboratorium di blok ini akan berlangsung selama lima minggu. Pada minggu pertama mahasiswa akan mengamati tentang model DNA, karyotype kromosom dan bentuk DNA di laboratorium biokimia. Di minggu kedua mahasiswa akan mengamati anatomi system genitalia, fisiologi sistem saraf, jaringan dan lapisan-lapisannya pada sistem reproduksi pria dan wanita di laboratorium histologi. Di minggu ketiga mahasiswa akan mengamati anatomi sistem saraf,histologi sistem endokrin dan sistem syaraf. Di minggu keempat mahasiswa akan mengamati tentang anatomi system indera, histologi sistem indera dan fisiologi sensorik. Pada minggu terakhir mahasiswa akan melakukan ujian laboratorium.

Terima kasih sebesar-besarnya kami sampaikan kepada semua pihak yang terlibat dalam penyelesaian buku panduan ini. Kami menyadari buku ini masih banyak kekurangan, kami sangat mengharapkan masukan dan saran agar kedepannya lebih baik. Semoga buku blok ini dapat memberikan kemanfaatan yang sebesar-besarnya.

Wassalamualaikum Warahmatullahi Wabarokatuh

Jakarta, November 2021

DAFTAR ISI

TATA TERTIB LABORATORIUM

I.1 KEHADIRAN MAHASISWA

a. Mahasiswa diwajibkan untuk mengikuti semua kegiatan Praktikum 100%.
b. Apabila mahasiswa tidak dapat memenuhi ketentuan tersebut di atas, maka mahasiwa yang bersangkutan tidak diperkenankan mengikuti ujian laboratorium
c. Mahasiswa diwajibkan hadir sedikitnya 15 menit sebelum kegiatan laboratorium dimulai. Terlambat lebih dari 15 menit mahasiswa tidak diperkenankan mengikuti kegiatan akademik.

I.2 PROSES PEMBELAJARAN LABORATORIUM

1. Mahasiswa diwajibkan mengikuti semua kegiatan Laboratorium yaitu :
    a. Menggunakan jas laboratorium
    b. Mengikuti kegiatan laboratorium sesuai yang di jadwalkan
    c. Mengerjakan dan mengumpulkan laporan laboratorium maksimal setiap hari senin setelah kegiatan laboratorium
    d. Ujian Laboratorium setiap akhir blok
2. Kegiatan laboratorium dibagi menjadi 2 kelompok mahasiswa, dan kegiatan di adakan sesuai dengan tema pembelajaran setiap minggu
3. Mahasiswa akan di berikan pre-test setiap sesi laboratorium. Penilaian pre-test akan mempengaruhi nilai akhir mahasiswa
4. Mahasiswa mengikuti kegiatan laboratorium sesuai arahan dosen pembimbing.
5. Mahasiswa tidak deperkenankan membawa makanan/minuman ke dalam ruang laboratorium
6. Mahasiswa tidak diperkenankan menggunakan *handphone* selama proses aktivitas laboratorium berlangsung
7. Mahasiswa akan di berikan tugas laporan yang harus dikumpulkan maksimal pada hari senin setiap minggu berikutnya
8. Penilaian dan *feedback* dicatat dalam *logbook* dan ditandatangani

oleh dosen/instruktur.

9. Nilai latihan diperinci sebagai berikut :
    - < 70% : Belum terampil
    - 70% – 85% : Terampil
    - > 85% : Sangat terampil
10. Sopan santun dan etika
    a. Mengucapkan salam
    b. Disiplin dan tepat waktu
    c. Jujur dan bertanggung jawab
    d. Tidak merokok dan mengkonsumsi NAPZA
    e. Tidak diperbolehkan membawa alat-alat yang membahayakan diri sendiri dan orang lain (misalnya: senjata tajam, senjata api, dan lain-lain)
    f. Tidak diperbolehkan membuat kegaduhan, perundungan (*bulying*), SARA (Suku, Agama, Ras, Antar golongan).
    g. Dilarang memalsukan tanda tangan para dosen dan/atau instruktur, teman.
    h. Dilarang memalsukan dokumen dan plagiasi.
    i. Dilarang melakukan kecurangan dalam bentuk apapun.
    j. Dilarang merusak atau menghilangkan properti CSL FK UHAMKA selama kegiatan pembelajaran.
11. Mentaati peraturan akademik Fakultas Kedokteran UHAMKA dan peraturan akademik UHAMKA

I.3 ETIKA BERPAKAIAN

Selama berada di lingkungan kampus UHAMKA dan setiap kegiatan yang mengatas namakan Fakultas Kedokteran UHAMKA baik di dalam maupun di luar lingkungan kampus, mahasiswa diwajibkan:

1. **Mahasiswa** : berpakaian sopan, **tidak memakai** pakaian dari bahan jeans dan sejenisnya, kaos/T-shirt, sandal/sepatu sandal, tato, tindik, anting, dan kuku panjang.
2. **Mahasiswi** : berpakaian muslimah/berjilbab dengan pakaian yang sopan dan rapih, **tidak memakai** pakaian dari bahan jeans dan

sejenisnya, sandal/selop, hak sepatu/sandal lebih 5cm, tato, kuku panjang dan menggunakan cat kuku.

3. Mahasiswa yang melanggar ketentuan berpakaian seperti diatas diharuskan menghadap Bagian Kemahasiswaan Fakultas Kedokteran UHAMKA dan akan dikenai sanksi dan dicatat sebagai pelanggaran tata tertib.

1.4 PERALATAN LABORATORIUM

1. Meja dan peralatan laboratorium harus selalu di bersihkan kembali setelah selesai menggunakan. Letakkan kembali peralatan yang telah digunakan ke tempat semula, tidak diperkenankan meninggalkan meja laboratorium dalam keadaan kotor.
2. Dilarang meminjam atau memindahkan peralatan laboratorium dari tempatnya tanpa seizin laboran/dosen penanggung jawab lab. Jika membutuhkan peralatan, harus mendapatkan izin dan persetujuan dari dosen pembimbing mata kuliah.
3. Peralatan-peralatan besar untuk pemakaian bersama tidak boleh di pindah letakkan. Penggunaan oleh mahasiswa harus dibawah pengawasan laboran/dosen penanggung jawab.
4. Harap berhati-hati dalam menggunakan peralatan laboratorium, kerusakan peralatan harus dilaporkan kepada laboran/dosen penanggung jawab dan mengganti kerusakan dengan barang yang sama dan kualitas yang sama. Sanksi lebih berat akan dikenakan jika tidak ada pelaporan terhadap kerusakan

1.5 BAHAN-BAHAN KIMIA

1. Harap di perhatikan karena anda akan bekerja dengan berbagai larutan dan peralatan yang berbahaya di laboratorium. Hindari segala aktivitas yang dapat membahayakan diri anda atau teman anda.
2. Hindari kontak langsung ataupun menghisap secara langsung uap bahan kimia. Gunakan alat perlindungan diri sesuai dengan instruksi dosen penanggung jawab

3. Dilarang mencicipi atau mencium bahan kimia kecuali ada perintah khusus dari dosen pembimbing
4. Baca label bahan kimia sekurang-kurangnya 2 kali untuk menghindari kesalahan.
5. Gunakan bahan-bahan kimia sesuai dengan jumlah yang diperlukan. Jangan menggunakan bahan kimia secara berlebihan.
6. Jangan mengembalikan bahan kimia yang sudah di gunakan ke dalam botol semula untuk mencegah terjadinya kontaminasi di dalam botol, dan jangan membuang sembarangan untuk menghindari dampak pada lingkungan. Tanyakan pada dosen pembimbing anda bagaimana membuang bahan kimia yang sudah digunakan.
7. Ketika membuka botol bahan kimia, jangan meletakkan tutup botol di atas meja karena kotoran pada meja dapat mengkontaminasi isi botol larutan kimia
8. Tutup botol dibuka dan dipegang dengan jari tangan sekaligus telapak tangan memegang botol tersebut.
9. Botol bahan yang telah dipakai harus dikembalikan ke rak-rak meja praktikum.

1.6 KESELAMATAN KERJA DI LABORATORIUM

1. Dilarang keras merokok di dalam laboratorium
2. Gunakan peralatan kerja seperti kacamata pengaman untuk melindungi mata, jas laboratorium untuk melindungi pakaian dan sepatu tertutup untuk melindungi kaki.
3. Biasakanlah mencuci tangan dengan sabun dan air bersih terutama selesai praktikum.
4. Bila kulit terkena bahan kimia, janganlah digaruk agar tidak tersebar. Segera cuci dengan air sebanyak-banyaknya.
5. Bila terjadi kecelakaan yang berkaitan yang berkaitan dengan bahan kimia, laporkan segera pada asisten atau petugas laboratorium. Segera pergi ke dokter untuk mendapatkan pertolongan secepatnya.
6. Mengetahui letak tabung pemadam kebakaran dan kotak P3K.

1.7 PENANGANAN LIMBAH

1. Limbah bahan kimia yang digunakan hendaknya dibuang pada tempat yang disediakan, jangan langsung dibuang ke pembuangan air kotor (wasbak).
2. Limbah cair yang tidak larut dalam air dan limbah beracun harus dikumpulkan dalam botol penampung. Botol ini harus tertutup dan diberi label yang jelas.
3. Limbah cair yang tidak berbahaya dapat langsung dibuang tetapi harus diencerkan dengan air secukupnya.
4. Sabun, detergen, dan cairan tidak berbahaya dalam air dapat dibuang langsung melalui saluran air kotor dan dibilas dengan air secukupnya.
5. Limbah zat organik harus dibuang secara terpisah pada tempat yang tersedia.
6. Limbah padat harus dibuang terpisah karena dapat menyebabkan penyumbatan.
7. Limbah padat seperti kertas saring, lakmus, korek api, dan pecahan kaca dibuang pada tempat sampah.

PENANGANAN LIMBAH ANATOMI

8. Potongan limbah jaringan *cadaver* dikumpulkan sesuai dengan identitas cadaver kedalam tempat yang sudah disediakan.
9. Cairan formalin yang masih mengalir dari tubuh cadaver dapat ditampung kedalam wadah yang sudah disediakan.
10. Limbah padat harus dibuang terpisah karena dapat menyebabkan penyumbatan.

I.8 TATA TERTIB UJIAN

Persyaratan Ujian

a. Mahasiswa yang dapat mengikuti ujian laboratorium adalah mahasiswa yang telah mengikuti semua kegiatan laboratorium 100% dan telah mengumpulkan semua tugas laboratorium
b. Mahasiswa sudah hadir di ruang ujian 10 menit sebelum ujian dimulai.
c. Berpenampilan rapih, sopan dan Islami:

i. **Mahasiswa** : Mengenakan kemeja putih lengan panjang, celana panjang hitam polos (tidak memakai bahan jeans dan sejenisnya), bersepatu, rambut rapih (tidak panjang) dan tidak mengenakan jaket.

ii. **Mahasiswi** : Mengenakan busana muslimah, kerudung/jilbab dan kemeja putih, rok hitam panjang polos sampai matakaki (tidak memakai bahan jeans dan sejenisnya), bersepatu dan tidak mengenakan jaket.

iii. Mahasiswa/i harus mengenakan jas lab putih dengan standar yang telah ditentukan oleh FK UHAMKA di dalam setiap aktivitas laboratorium

d. Tidak bekerjasama dengan teman dan atau membuka catatan/buku dalam menjawab dan mengerjakan soal
e. Tidak membantu atau memberitahu jawaban soal ujian kepada peserta lain
f. Tidak membuat keonaran dan atau tindakan lain yang dapat mengganggu pelaksanaan ujian
g. Selain alat tulis ujian, perlengkapan lain disimpan ditempat tersendiri, tidak diperkenankan meminjam alat tulis dari teman.
h. Tidak diperkenankan membawa HP, kamera, alpha link, komunikator dan alat elektronik lain pada saat ujian berlangsung, barang-barang tersebut disimpan diruang konsinyasi yang telah ditentukan.

SANKSI-SANKSI

II.1. Sanksi Akademik

Peserta ujian yang melanggar tatatertib ujian, akan dikenakan sanksi, sebagai berikut:

a. Terlambat lebih dari 15 menit diperkenankan tetap mengikuti ujian dengan sisa waktu yang tersedia, atas ijin dari koordinator tatatertib ujian, dengan catatan, belum ada peserta ujian lain yang telah menyelesaikan ujiannya.
b. Teguran lisan oleh pengawas ujian untuk satu kali pelanggaran tatatertib ujian
c. Teguran lisan dan dicatat dalam berita acara untuk dua kali pelenggaran tatatertib ujian
d. Bagi peserta ujian tidak mengenakan pakaian sesuai dengan tatatertib tidak diperkenankan mengikuti ujian
e. Bagi peserta ujian yang tidak membawa kartu ujian atau hilang diwajibkan melapor kepada koordinator tatatertib ujian sebelum ujian dimulai dan tidak diperkenankan ujian sebelum memperoleh kartu pengganti
f. Peserta ujian yang melanggar semua ketentuan persyaratan ujian akan dikenakan sanksi berupa pemotongan nilai ujian setinggi-tingginya 20% yang ditentukan berdasarkan rapat akademik
g. Peserta/kelompok yang melakukan pengrusakan/penghilangan properti laboratorium diwajibkan mengganti dengan barang yang sama dan kualitas yang sama.
h. Pelanggaran tatatertib ujian yang belum diatur, akan ditentukan kemudian berdasarkan Keputusan Dekan.

II.2. Sanksi Pelanggaran Hukum, Etika Moral, Etika Profesi, atau Etika Akademik

1. Apabila mahasiswa melakukan pelanggaran hukum, etika moral atau etika profesi, setelah dibicarakan dalam Senat Fakultas, akan dikenai sanksi khusus, sedangkan bila ada masalah pidana, penanganannya akan diserahkan kepada yang berwajib.
2. Jenis pelanggaran berupa tindak pidana maupun penyalahgunaan obat, narkotika dan sejenisnya serta penggunaan minuman keras dan sejenisnya, dan telah ditetapkan bersalah secara hukum oleh pengadilan, akan dikenai sanksi berupa skorsing sampai pemutusan hubungan studi oleh pimpinan universitas (dikeluarkan).
3. Mahasiswa yang melanggar etika moral, profesi (memeriksa pasien/klien tanpa supervisi, membuat resep, melakukan konsultasi tanpa supervisi, dsb.), memalsukan tanda tangan dan sejenisnya akan dikenakan sanksi akademik maupun administratif oleh pimpinan fakultas.

I. ANATOMI

PENGANTAR PRAKTIKUM

PRAKTIKUM I : SYSTEMA GENITALIA (REPRODUKSI)

PRAKTIKUM II: SYSTEMA NERVOSUM

PRAKTIKUM III : SYSTEMA INDERA dan OTOT WAJAH

A. SYSTEMA GENITALIA (REPRODUKSI)

Nama Organ	Tulis dengan huruf balok
• **MASCULINA**	……………………………………………………
○ **INTERNA**	……………………………………………………
▪ Testis (Orchis)	……………………………………………………
▪ Epididymis	……………………………………………………
♦ Caput epididymis	……………………………………………………
♦ Corpus epididymis	……………………………………………………
♦ Cauda epididymis	……………………………………………………
▪ Ductus deferens	……………………………………………………
▪ Vesicula seminalis	……………………………………………………
♦ Ductus excretorius	……………………………………………………
▪ Ductus ejaculatorius	……………………………………………………
▪ Vesicula seminalis	……………………………………………………
♦ Ductus excretorius	……………………………………………………
▪ M.cremaster	……………………………………………………
▪ Prostata (Glandula prostatica)	……………………………………………………
♦ Lobus (dexter/sinister)	……………………………………………………
♦ Lobus medius (isthmus prostatae)	……………………………………………………
▪ Glandula bulbo-urethralis	……………………………………………………
	……………………………………………………
○ **EXTERNA**	……………………………………………………
▪ Penis	……………………………………………………
♦ Glans penis	……………………………………………………
♦ Preputium penis	……………………………………………………
♦ Raphe penis	……………………………………………………
♦ Corpus cavernosum penis	……………………………………………………
♦ Corpus spongiosum penis	……………………………………………………
♦ Bulbus penis	……………………………………………………
♦ Tunica albuginea corporum cavernosum	……………………………………………………
♦ Tunica albuginea corporis spongiosi	……………………………………………………
♦ Septum penis	……………………………………………………
♦ Fascia penis superficialis	……………………………………………………
♦ Fascia penis profunda (Fascia Buck)	……………………………………………………
▪ Scrotum	……………………………………………………
♦ M.dartos	……………………………………………………
• **FEMININA**	……………………………………………………
○ **INTERNA**	……………………………………………………
▪ Ovarium	……………………………………………………
♦ Ligamentum ovarii proprium	……………………………………………………
▪ Tuba uterina (Salpinx)	……………………………………………………

♦ Infundibulum tubae uterinae ♦ Fimbriae tubae ♦ Ampulla tubae uterinae ♦ Isthmus tubae uterinae ♦ Ostium uterinum tubae ▪ Uterus ♦ Fundus uteri ♦ Corpus uteri ♦ Cervix uteri ✶ Portio supravaginalis cervicis ✶ Portio vaginalis cervicis ♦ Ostium uteri ▪ Vagina ♦ Fornix vaginae pars anterior dan posterior ♦ Paries anterior ♦ Paries posterior ♦ Rugae vaginales ♦ Carina urethralis vaginae ○ **EXTERNA** ▪ Mons pubis ▪ Labium majus pudendi ▪ Labium minus pudendi ▪ Vestibulum vaginae ▪ Clitoris ▪ Urethra feminine ▪ Perineum	....

Paraf

(.....)

B. SYSTEMA NERVOSUM

Nama Organ	Tulis dengan huruf balok
1. PARS CENTRALIS (SYSTEMA NERVOSUM CENTRALE) **a) CRANIUM** Pelajari lagi ossa cranii (Cranialia), cari: • Foramen opticum → dilewati N.I. • Lamina et Foramina cribosa → N. II. • Fissura orbitalis superior → N. III, IV, V 1, VI • Foramen rotundum → N. V2 • Foramen ovale → N. V3 • Foramen spinosum → A. meningea media • Meatus acusticus internus → N. VII, VIII • Foramen jugular → N.IX, X. XI • Canalis hypoglossi → N. XII **b) MENINGES** ▪ Falx cerebri (pemisah kedua hemispherium cerebralis) ▪ Tentorium cerebelli (pemisah cerebrum dengan cerebellum) ▪ Falx cerebelli (pemisah kedua hemisphere cerebellum) ▪ Sinus sagitalis superior ▪ Sinus sagitalis unferior ▪ Confluens sinuum ▪ Sinus rectus ▪ Sinus sigmoideus ▪ Sinus transverses **c) CIRCULUS ARTERIOSUS CEREBRI, dibentuk oleh :** • **A. Carotis interna** o A. cerebri anterior ➢ A. communicans anterior o A. cerebri media ➢ A. communicans posterior **A. vertebralis, cari cabang-cabangnya sebelum bersatu menjadi A. basilaris :** **A. inferior posterior cerebelli** **A. spinalis anterior** **A. spinalis posterior**	…………………………………………………… ……………………………………………………

- **A. basilaris (persatuan A. vertebralis dextra dan sinistra), bercabang:**
  - A. inferior anterior cerebelli
  - Aa. Pontis
  - A. superior cerebelli
  - A. cerebri posterior

d) CEREBRUM

- **Lobus frontalis**
  - Gyrus precentralis
  - Sulcus precentralis
  - Gyrus frontalis superior
  - Gyrus frontalis medius
  - Gyrus frontalis inferior
  - Sulcus centralis

- **Lobus parietalis**
  - Sulcus postcentralis
  - Gyrus postcentralis
  - Gyrus supramarginalis
  - Gyrus angularis
  - Fissura parietooccipitalis

- **Lobus occipitalis**
  - Sulcus occipitalis transverses
  - Sulcus occipitalis anterior
  - Sulcus occipitalis lateralis

- **Lobus temporalis**
  - Fissurae cerebri lateralis
  - Gyrus temporalis superior
  - Sulcus temporalis superior
  - Gyrus temporalis medius
  - Sulcus temporalis inferior
  - Gyrus temporalis inferior

- **Lobus insularis (insula)**
  - Gyri breves insulae
  - Gyrus longus insulae

e) Facies medialis dan inferior hemispherii

- Gyrus cinguli (cingulatus**)**
- Gyrus frontalis medialis

- Lobulus paracentralis
- Precuneus
- Sulcus parieto-occipitalis
- Cuneus
- Sulcus calcarinus
- Uncus
- Gyrus hippocampi
- Gyrus lingualis

f) PENAMPANG HORIZONTALIS CEREBRUM

- Corpus callosum
  - Rostrum
  - Genu
  - Truncus
  - Splenium
- Ventriculus lateralis
  - Cornu anterior (frontale)
  - Cornu posterior (occipitale)
  - Cornu inferior (temporale)
- Nucleus caudatus
- Capsula interna
  - Crus anterior capsulae internae
  - Genu capsulae internae
  - Crus posterius capsulae internae
- Nucleus lentiformis (lenticularis)
- Radiatio optica
- Sulcus calcarinus
- Insula reili

g) PENAMPANG FRONTALIS CEREBRUM

- Corpus callosum
- Gyris cinguli
- Ventriculus lateralis II (cornu anterior)
- Ventriculus tertius (III)
- Caput nuclei caudatus
- Nucleus lentiformis
- Capsula interna
- Thalamus

h) POTONGAN KHUSUS LOBUS TEMPORALIS

i) DIENCEPHALON

- Epithalamus
- Thalamus

- Ventriculus tertius
- Foramen interventriculare
- Corpus mamillare
- Fornix
- Hypothalamus
- Septum pellucidum

j) MESENCEPHALON

- Pedunculus cerebri (cerebralis)
- Aqueductus cerebri (mesencephali)
- Tegmentum mesencephalicum
  - Colliculus superior
  - Colliculus inferior
- Pedunculus cerebellaris superior (brachium conjunctivum).

k) METENCEPHALON

- Pons
- Pedunculus cerebelli medius (brachium pontis/ pontinus).
- Ventriculus quartus

l) MYELENCEPHALON (Medulla oblongata)

- Pedunculus cerebellaris inferior (corpus restiforme)
- Pyramis
- Oliva
- Decussatio pyramidum (Dec. pyramidalis anterior motoria).

m) CEREBELLUM

a) Facies superior

- Lobulus quadrangularis (Pars anterior)
- Lobulus simplex (Pars inferoposterior)
- Lobulus semilunaris superior

b) Facies inferior

- Lobulus semilunaris inferior
- Lobulus biventer
- Tonsilla cerebelli
- Flocculus

Potongan mid sagital vermis cerebelli

- Lingula
- Lobulus centralis
- Culmen
- Declive

• Folium vermis • Tuber vermis • Pyramis vermis • Uvula vermis • Nodulus **n) MEDULLA SPINALIS** • Duramater spinalis • Cisterna lumbalis • Conus medullaris • Funiculi medullae spinalis o Funiculus anterior o Funiculus lateralis o Funiculus posterior • Filum terminale (spinale) • Cauda equine • Ganglion spinale • Radix anterior • Radix posterior	....

Paraf

(.....)

C. SYSTEMA INDERA dan OTOT WAJAH

Nama organ yang harus dicari	Tulis dengan huruf balok
ORGANA SENSORIA/ ORGANUM VISUS (VISUALE) **1. Oculus** ▪ Foramen opticum ▪ Canalis opticum ▪ Fissure orbitalis superior ▪ Fissure orbitalis inferior ▪ Nervus opticus o Chiasma opticum o Tractus opticus ▪ Bulbus oculi **2. Otot-otot wajah** • M. orbicularis oculi o pars palpebralis o pars orbitalis o pars lacrimalis • M. procerus • M. corrugator supercilii • M. orbicularis oris • M. depressor anguli oris • M. risorius • M. zygomaticus major • M. zygomaticus minor • M. buccinators • M. masseter • M. temporalis **3. Tunica fibrosa bulbi** • **Sclera** o Tunica conjunctiva bulbaris o Bulbus conjuctiva • **Cornea** **4. Tunica vasculosa bulbi (tractus uvealis)** • Choroidea • Corpus ciliare • Iris o Pupilla **5. Tunica internna bulbi** • Retina • Lensa • Camerae bulbi	....

- Camera anterior
  - Humor aquaosus
- Camera posterior
  - Humor aquosus
- Camera vitrea
  - Corpus vitreum
  - Humor vitreus

6. Organa oculi accessoria
Musculi bulbi

- M. orbitalis
- M. rectus superior
- M. rectus inferior
- M. rectus medialis
- M. rectus lateralis
- M. obliquus superior
- M. obliquus inferior
- M. levator palpebrae superior

Supercilium

cilia

Palpebrae

- Palpebra superior
  - Conjunctiva palpebra superior
  - Gld lacrimalis
- Palpebra inferior
  - Conjunctiva palpebra inferior
- Commissura palpebralis medialis
- Commissura palpebralis lateralis
- Caruncula acrimalis
- Ductus nasolacrimalis

ORGANUM VESTIBULOCOCHLEARE

<u>AURIS EXTERNA</u>

- **Meatus acusticus externus**
- **Porus acusticus externus**
- **Meatus acusticus externus catilagineus**
- **Auricula**
- **Lobulus auricularis**
- **Helix**
- **Antihelix**
- **Scapa**
- **Concha auricularis**
- **Tragus**

- **Antitragus**

AURIS MEDIA

- **Cavitas tympanica (Cavum tympani)**
  - Paries tegmentalis
  - Paries jugularis
  - Paries labyrinthicus
  - Paries mastoideus (Adnexa mastoidea)

- **Membara tympanica**
  - Pars flaccida
  - Pars tensa
  - Umbo membaranae tympanicae

- **Ossicula auditoria (auditus)**
  - **Stapes**
    - Capitulum stapedis
    - Crus anterius
    - Crus posterius
    - Basis stapedis
  - **Incus**
    - Corpus incudes
    - Crus breve
    - Dens
    - Crus longum
    - Processus lenticularis incudes
  - **Malleus**
    - Manubrium mallei
    - Collum mallei
    - Capitulum mallei
  - **Chorda tympani**

- **Musculi ossiculorum auditoriorum**
  - M. tensor tympani
  - M. stapedius
  - M. levator veli palatini

- **Tuba auditoria (auditiva)**
  - Ostium tympanicum tubae auditoriae
  - Pars ossea
  - Pars cartilaginea
    - Ostium pharyngeum tubae auditoriae (OPTA)

AURIS INTERNA

- **Labyrinthus membranaceus**
  - Utriculus
- **Labyrinthus cochlearis**
- **Aqueductus cochleae**
- **Labyrinthus osseus**
  - Vestibulum
    - Fenestra vestibule
    - Recessus ellipticus
    - Recessus sphaericus
- **Canales semicirculares ossei**
  - Canalis semicircularis anterior (superior)
    - Ampulla ossea anterior
  - Canalis semicircularis posterior
    - Ampulla ossea posterior
  - Canalis semicircularis lateralis
    - Ampulla ossea lateralis
- **Cochlea**
- **Cupula cochleae**
- **Canalis spiralis cochleae**
  - Pars cupularis
  - Pars media
  - Pars basalis
- **Fenestra cochleae**
- **Meatus acusticus internus**
  - Porus acusticus

LINGUA

Dorsum linguae

- **Pars presulcalis (anterior)**
- **Pars postsulcalis (posterior)**

Papillae linguales

- Papillae filiformes
- Papillae conicae
- Papillae fungiformes
- Papillae vallatae
- Papillae lentiformes
- Papillae foliatae

Tonsilla lingualis **Folliculi linguales**	....

Paraf

(.....)

II. HISTOLOGI

PENGANTAR PRAKTIKUM

PRAKTIKUM I :

HISTOLOGI SISTEM REPRODUKSI

PRIA & WANITA

PRAKTIKUM II:

HISTOLOGI KELENJAR-KELENJAR

ENDOKRIN

PRAKTIKUM III :

NERVOUS SYSTEM

PRAKTIKUM III:

SPECIAL SENSE ORGAN

PENGANTAR PRAKTIKUM

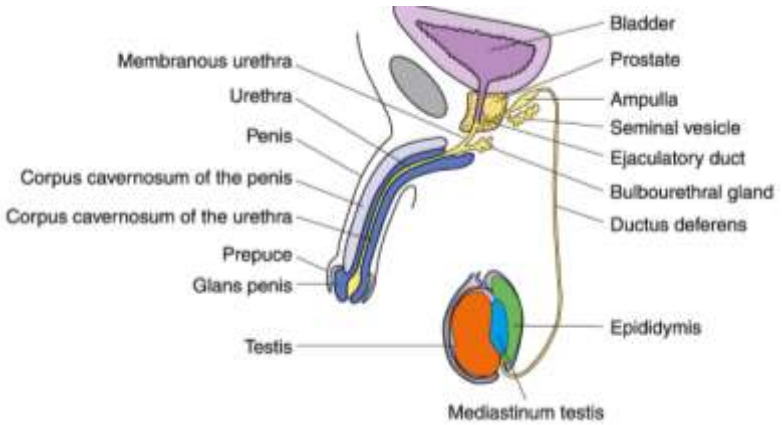
HISTOLOGI SISTEM REPRODUKSI PRIA DAN WANITA

Dosen Pengampu : Dr.Dewi Jantika Djuarna, Sp.PA & dr. Zahra Nurusshofa, Sp.PA

The Male Reproductive System:

Introduction

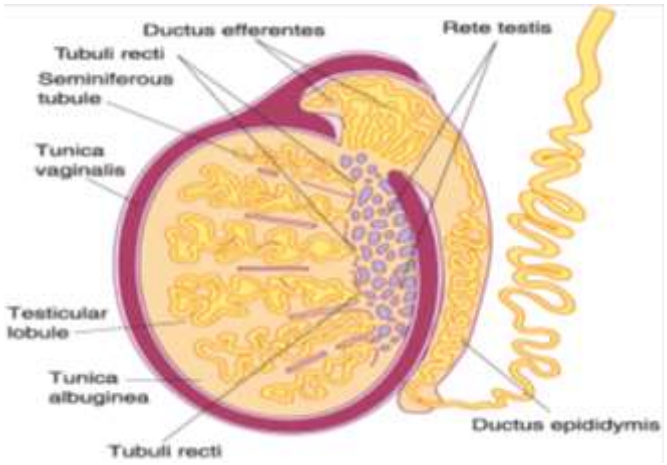
The male reproductive system is composed of the testes, genital ducts, accessory glands, and penis The dual function of the testis is to produce spermatozoa and hormones. The genital ducts and accessory glands produce secretions that, aided by smooth muscle contractions, conduct spermatozoa toward the exterior. These secretions also provide nutrients for spermatozoa while they are confined to the male reproductive tract. Spermatozoa and the secretions of the genital ducts and accessory glands make up the **semen** , which is introduced into the female reproductive tract through the penis. Although testosterone is the main hormone produced in the testes, both testosterone and one of its metabolites, dihydrotestosterone, are necessary for the physiology of men.



Testis

Each testis is surrounded by a thick capsule of dense connective tissue, the **tunica albuginea.** The tunica albuginea is thickened on the posterior surface of the testis to form the **mediastinum testis,** from which fibrous septa penetrate the gland, dividing it into about 250 pyramidal compartments called the **testicular lobules**. These septa are incomplete, and there is

frequent intercommunication between the lobules. Each lobule is occupied by one to four **seminiferous tubules** enmeshed in a web of loose connective tissue that is rich in blood and lymphatic vessels, nerves, and **interstitial cells,** also known as **Leydig cells.** Seminiferous tubules produce male reproductive cells, the spermatozoa, whereas interstitial cells secrete testicular androgens.

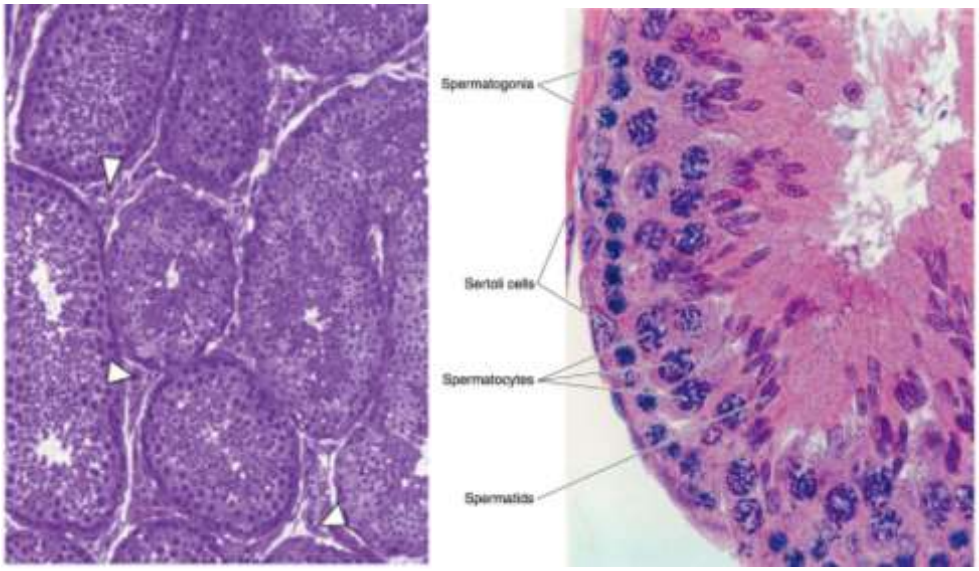


During embryonic development the testes develop retroperitoneally in the dorsal wall of the abdominal cavity. They migrate during fetal development and become positioned within the scrotum, at the ends of the spermatic cords. Because of this migration, each testis carries with it a serous sac, the **tunica vaginalis,** derived from the peritoneum. The tunic consists of an outer parietal layer and an inner visceral layer, covering the tunica albuginea on the anterior and lateral sides of the testis.

Seminiferous Tubules

Spermatozoids are produced in the seminiferous tubules at a daily rate of about 2 x 10^8 in the adult. The seminiferous tubules are lined with a complex stratified epithelium called **germinal** or **seminiferous epithelium.** Their outer wall is surrounded by a well-defined basal lamina and a fibrous connective tissue consisting of several layers of fibroblasts. The innermost layer, adhering to the basal lamina, consists of flattened **myoid cells** , which have characteristics of smooth muscle.Interstitial (Leydig) cells occupy much of the space between the seminiferous tubules. The seminiferous epithelium consists of two types of cells: **Sertoli,** or **supporting, cells** and cells that constitute the **spermatogenic lineage** . The cells of the spermatogenic

lineage are stacked in four to eight layers; their function is to produce spermatozoa. The production of spermatozoa is called **spermatogenesis,** a process that includes cell division through mitosis and meiosis and the final differentiation of spermatozoids, which is called **spermiogenesis.**



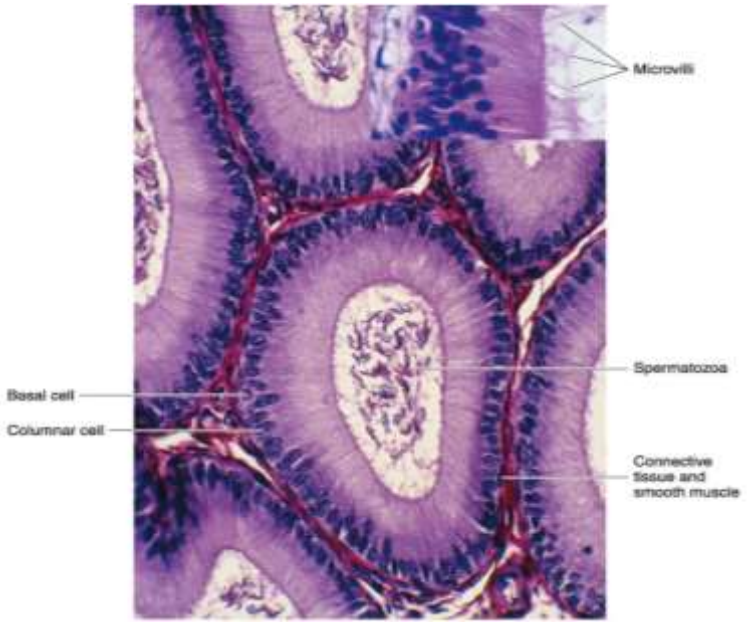
Intratesticular Genital Ducts

The intratesticular genital ducts are the **tubuli recti** (straight tubules), the **rete testis,** and the **ductuli efferentes** . These ducts carry spermatozoa and liquid from the seminiferous tubules to the ductus epididymidis. Most seminiferous tubules are in the form of loops, both ends of which join the rete testis by structures known as **tubuli recti.** These tubules are recognized by the gradual loss of spermatogenic cells, with an initial segment in which only Sertoli cells remain to form their walls, followed by a main segment consisting of cuboidal epithelium supported by a dense connective tissue sheath. Tubuli recti empty into the **rete testis,** contained within the mediastinum, a thickening of the tunica albuginea. The rete testis is a highly anastomotic network of channels lined with cuboidal epithelium. From the rete testis extend **ductuli efferentes** . They have an epithelium composed of groups of nonciliated cuboidal cells alternating with ciliated cells that beat in the direction of the epididymis. This gives the epithelium a characteristic scalloped appearance. The nonciliated cells absorb much of the fluid secreted by the seminiferous tubules. The activity of ciliated cells and fluid absorption

create a fluid flow that sweeps spermatozoa toward the epididymis. A thin layer of circularly oriented smooth muscle cells is seen outside the basal lamina of the epithelium. The ductuli efferentes gradually fuse to form the ductus epididymidis of the epididymis.

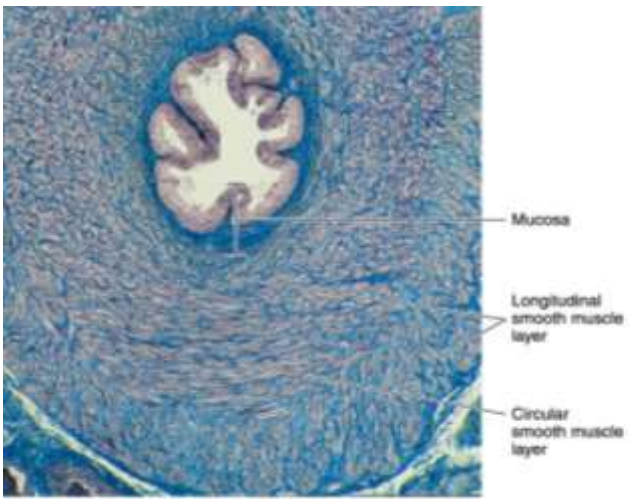
Excretory Genital Ducts

Excretory genital ducts transport the spermatozoa produced in the testis toward the penile meatus. These ducts are the **ductus epididymidis,** the **ductus** (**vas**) **deferens,** and the **urethra.** The **ductus epididymidis** is a single highly coiled tube 6 m in length. Together with surrounding connective tissue and blood vessels, this long canal forms the body and tail of the **epididymis.** It is lined with pseudostratified columnar epithelium composed of rounded basal cells and columnar cells . These cells are supported on a basal lamina surrounded by smooth muscle cells, whose peristaltic contractions help to move the sperm along the duct, and by loose connective tissue rich in blood capillaries. Their surface is covered by long, branched, irregular microvilli called **stereocilia.** The epithelium of the ductus epididymidis participates in the uptake and digestion of residual bodies that are eliminated during spermatogenesis.



From the epididymis the **ductus** (**vas**) **deferens,** a straight tube with a thick, muscular wall, continues toward the prostatic urethra and empties into it. It is characterized by a narrow lumen and a mucosa with longitudinal folds,

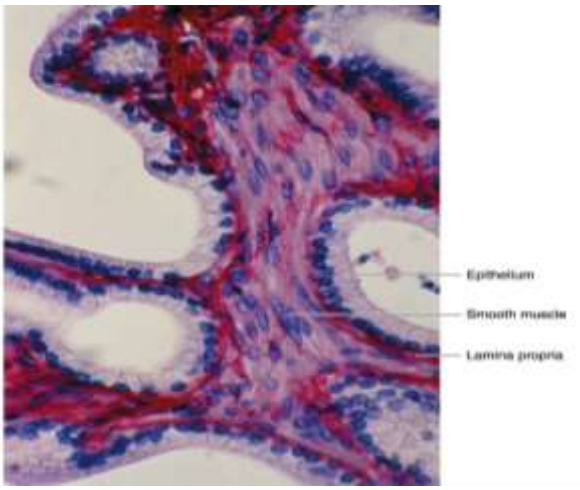
covered along most of its extent by pseudostratified columnar epithelium with stereocilia . The lamina propria is rich in elastic fibers, and the thick muscular layer consists of longitudinal inner and outer layers separated by a circular layer. The abundant smooth muscle produces strong peristaltic contractions that participate in the expulsion of the spermatozoa during ejaculation. The ductus deferens forms part of the spermatic cord, which includes the testicular artery, the pampiniform plexus, and nerves. Before it enters the prostate, the ductus deferens dilates, forming a region called the **ampulla** (Figure 21â€‘1). In this area, the epithelium becomes thicker and extensively folded. At the final portion of the ampulla, the seminal vesicles join the duct. From there on, the ductus deferens enters the prostate, opening into the prostatic **urethra.** The segment entering the prostate is called the **ejaculatory duct.** The mucous layer of the ductus deferens continues through the ampulla into the ejaculatory duct, but the muscle layer ends after the ampulla.



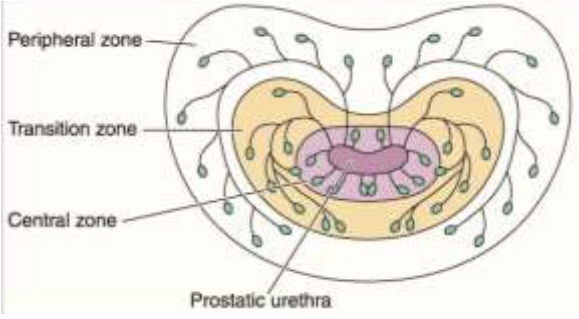
<u>Accessory Genital Glands</u>

The accessory genital glands produce secretions that are essential for the reproductive function in men. The accessory genital glands are the **seminal vesicles,** the **prostate,** and the **bulbourethral glands.** The **seminal vesicles** consist of two highly tortuous tubes about 15 cm in length. When the organ is sectioned, the same tube is observed in different orientations. It has a folded mucosa that is lined with cuboidal or pseudostratified columnar epithelium rich in secretory granules. These granules have

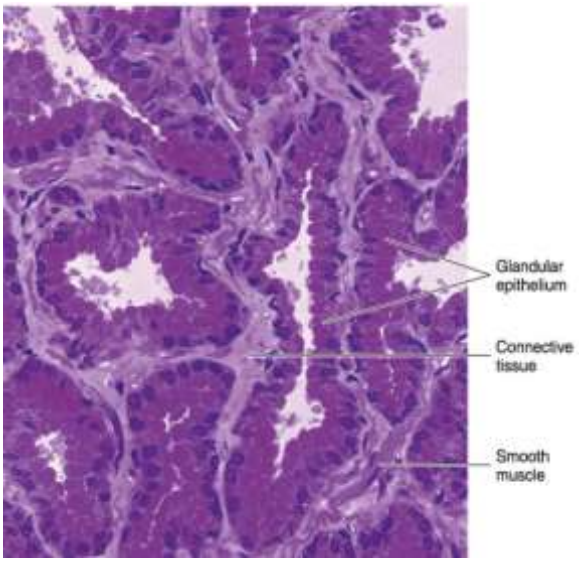
ultrastructural characteristics similar to those found in protein-synthesizing cells . The lamina propria of the seminal vesicles is rich in elastic fibers and surrounded by a thin layer of smooth muscle . The seminal vesicles are not reservoirs for spermatozoa. They are glands that produce a viscid, yellowish secretion that contains spermatozoa-activating substances such as carbohydrates, citrate, inositol, prostaglandins, and several proteins. The carbohydrates, of which **fructose** is the most abundant, are the source of energy for sperm motility. Seventy percent of human ejaculate originates in the seminal vesicles. The height of the epithelial cells of the seminal vesicles and the degree of activity of the secretory processes are dependent on testosterone levels.



The **prostate** is a collection of 50 branched tubuloalveolar glands. Their ducts empty into the prostatic urethra, which crosses the prostate. The prostate has three distinct zones: The **central zone** occupies 25% of the gland's volume. Seventy percent of the gland is formed by the **peripheral zone,** which is the major site of prostatic cancer. The **transition zone** is of medical importance because it is the site at which most benign prostatic hyperplasia originates.



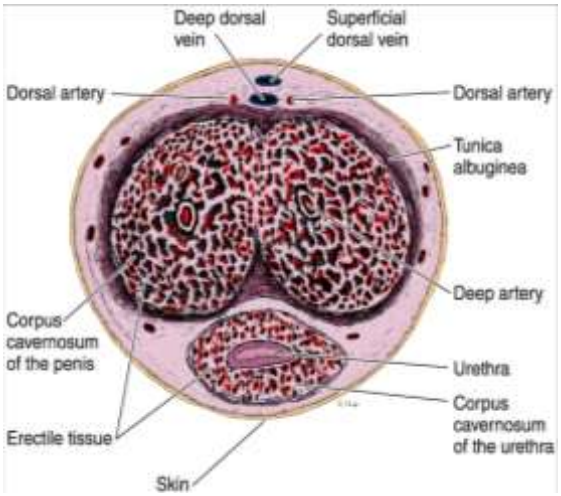
The tubuloalveolar glands of the prostate are formed by a cuboidal or a columnar pseudostratified epithelium. An exceptionally rich fibromuscular stroma surrounds the glands. The prostate is surrounded by a fibroelastic capsule rich in smooth muscle. Septa from this capsule penetrate the gland and divide it into lobes that are indistinct in adult men. The glands produce prostatic fluid and store it for expulsion during ejaculation. As with the seminal vesicle, the structure and function of the prostate depend on the level of testosterone.



Penis

The main components of the penis are three cylindrical masses of erectile tissue, plus the urethra, surrounded by skin. Two of these cylinders the **corpora cavernosa of the penis** are placed dorsally. The other the **corpus cavernosum of the urethra,** or **corpus spongiosum** is ventrally located and surrounds the urethra. At its end it dilates, forming the **glans penis** . Most of the penile urethra is lined with pseudostratified columnar epithelium; in the glans penis, it becomes stratified squamous epithelium. Mucus-secreting **glands of Littre** are found throughout the length of the penile urethra. The prepuce is a retractile fold of skin that contains connective tissue with smooth muscle in its interior. Sebaceous glands are present in the internal fold and in the skin that covers the glans. The corpora cavernosa are covered by a resistant layer of dense connective tissue, the **tunica albuginea**. The corpora cavernosa of the penis and the corpus cavernosum

of the urethra are composed of erectile tissue. This is a tissue with a large number of venous spaces lined with endothelial cells and separated by trabeculae of connective tissue fibers and smooth muscle cells.

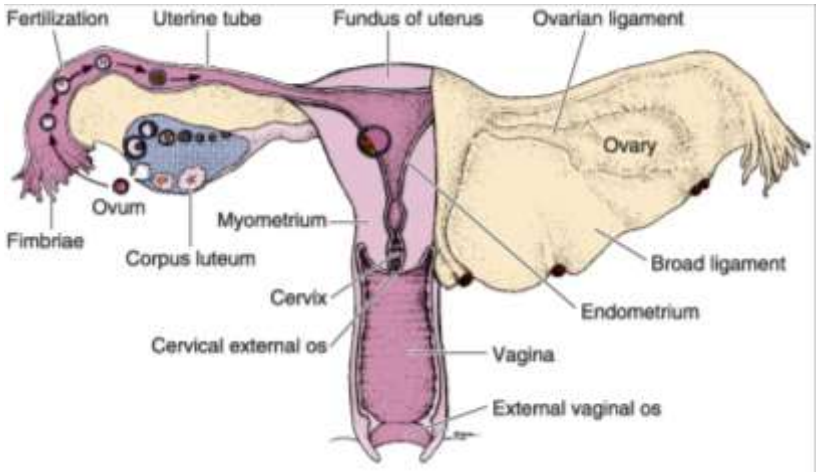


The arterial supply of the penis derives from the internal pudendal arteries, which give rise to the deep arteries and the dorsal arteries of the penis. Deep arteries branch to form nutritive and helicine arteries. Nutritive arteries supply oxygen and nutrients to the trabeculae, and helicine arteries empty directly into the cavernous spaces (erectile tissue). There are arteriovenous shunts between the helicine arteries and the deep dorsal vein. Penile erection is a hemodynamic event that is controlled by neural input to both arterial muscle and smooth muscle in the walls of the vascular spaces in the penis; in the flaccid state, there is minimal blood flow in the penis. The nonerect state is maintained by both the intrinsic tone of penile smooth muscle and the tone induced by continuous sympathetic input. Erection occurs when vasodilator impulses of parasympathetic origin cause relaxation of the penile vessels and cavernous smooth muscle. Vasodilatation also involves the concomitant inhibition of sympathetic vasoconstrictor impulses to penile tissues. Opening of the penile arteries and cavernous spaces accounts for the increase in blood flow, the filling of the cavernous spaces, and the resulting rigidity of the penis. Contraction and relaxation of corpora cavernosa depend on intracellular calcium, which in turn is modulated by guanosine monophosphate. After ejaculation and orgasm, parasympathetic activity declines, and the penis returns to its flaccid state.

The Female Reproductive System:

Introduction

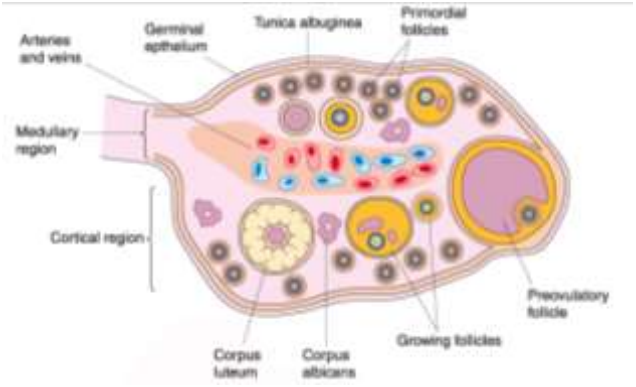
The female reproductive system consists of two ovaries, two oviducts (uterine tubes), the uterus, the vagina, and the external genitalia . Its functions are to produce female gametes (**oocytes**) and to hold a fertilized oocyte during its complete development through embryonic and fetal stages until birth. The system also produces sexual hormones that control organs of the reproductive system and influence other organs of the body. Beginning at **menarche,** when the first menses occurs, the reproductive system undergoes cyclic changes in structure and functional activity. These modifications are controlled by neurohumoral mechanisms. **Menopause** is a variable period during which the cyclic changes become irregular and eventually disappear. In the postmenopausal period there is a slow involution of the reproductive system. Although the mammary glands do not belong to the genital system, they are studied here because they undergo changes directly connected to the functional state of the reproductive system.

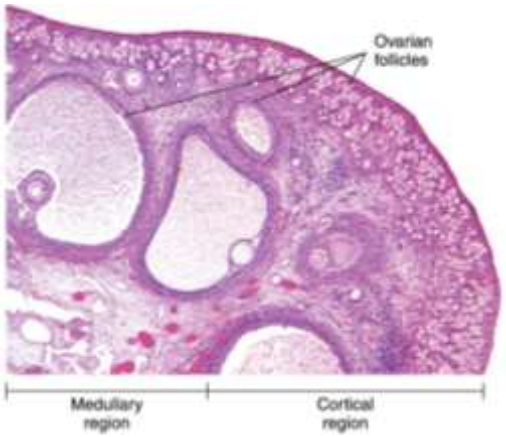


Ovaries

Ovaries are almond-shaped bodies approximately 3 cm long, 1.5 cm wide, and 1 cm thick. Their surface is covered by a simple squamous or cuboidal epithelium, the **germinal epithelium.** Under the germinal epithelium is a layer of dense connective tissue, the **tunica albuginea,** which is responsible for the whitish color of the ovary. Underneath the tunica albuginea is the **cortical region,** where ovarian follicles—structures that contain the oocytes—predominate. The follicles are embedded in the connective tissue

(**stroma**) of the cortical region. This stroma is composed of characteristic spindle-shaped fibroblasts that respond to hormonal stimuli in a different way than do fibroblasts of other organs. The most internal part of the ovary is the **medullary region,** containing a rich vascular bed within a loose connective tissue. There are no sharp limits between the cortical and medullary regions .





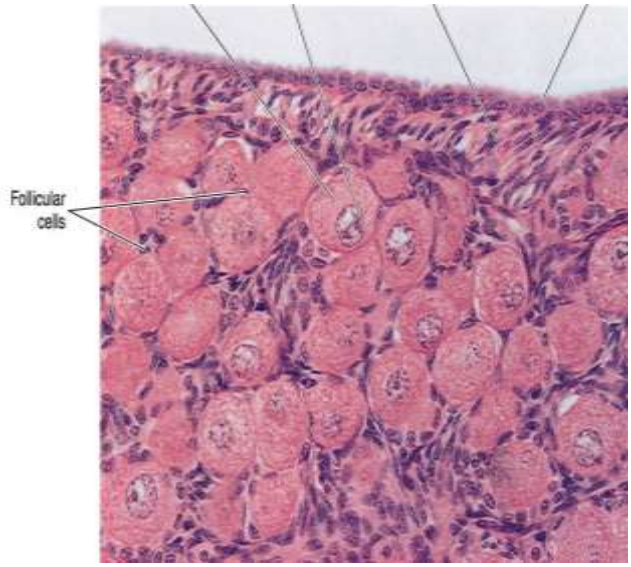
<u>Development of the Ovary & Its Function</u>

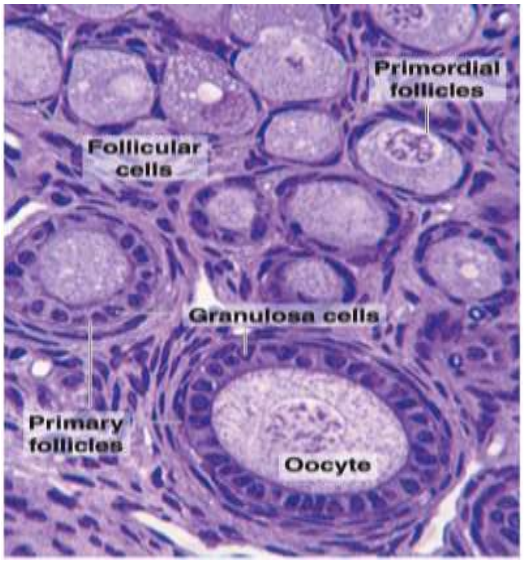
Around the end of the first month of embryonic life, a small population of **primordial germ cells** migrates from the yolk sac to the gonadal primordia. In the gonads these cells divide and transform into **oogonia.** Division is so intense that in the second month of intrauterine life there are around 600,000 oogonia, and around the fifth month more than 7 million. Beginning in the third month, oogonia begin to enter the prophase of the first meiotic division but stop at the diplotene stage and do not progress to other stages of meiosis. These cells are the **primary oocytes**, and they become surrounded by flattened cells called **follicular cells.** By the seventh month of pregnancy, most oogonia have been transformed into primary oocytes. Many primary oocytes, however, are lost through a degenerative process called **atresia.**

As a result, around puberty the ovaries contain about 300,000 oocytes. Atresia continues over the entire span of the woman's reproductive life so that by 40–45 years of age about 8000 oocytes are left. Because generally only one oocyte is liberated by the ovaries in each menstrual cycle (average duration, 28 days) and the reproductive life of a woman lasts about 30–40 years, only about 450 oocytes are liberated. All others degenerate through atresia.

Ovarian Follicles

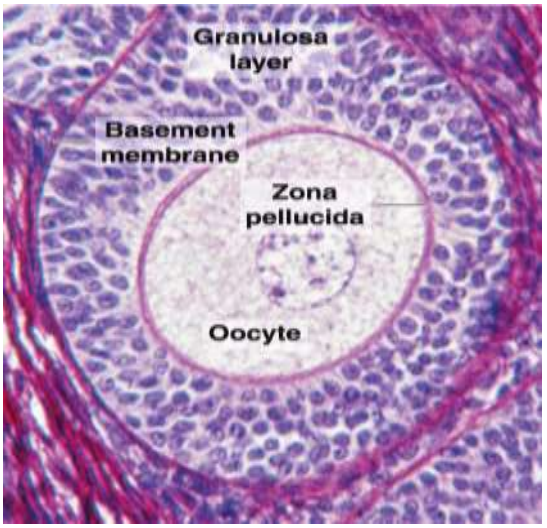
An ovarian follicle consists of an oocyte surrounded by one or more layers of **follicular** cells, or **granulosa cells.** A basal lamina underlies the follicular cells and marks the boundary between the follicle and the surrounding stroma. The follicles that are formed during fetal life **primordial follicles** consist of a primary oocyte enveloped by a single layer of flattened follicular cells . These follicles are found in the superficial layer of the cortical region. The oocyte in the primordial follicle is a spherical cell about 25 m in diameter. Its nucleus is large and has a large nucleolus. These cells are in the first prophase of meiosis. The chromosomes are mostly uncoiled and do not stain intensely. The organelles in the cytoplasm tend to form a clump adjacent to the nucleus. There are numerous mitochondria, several Golgi complexes, and cisternae of endoplasmic reticulum.

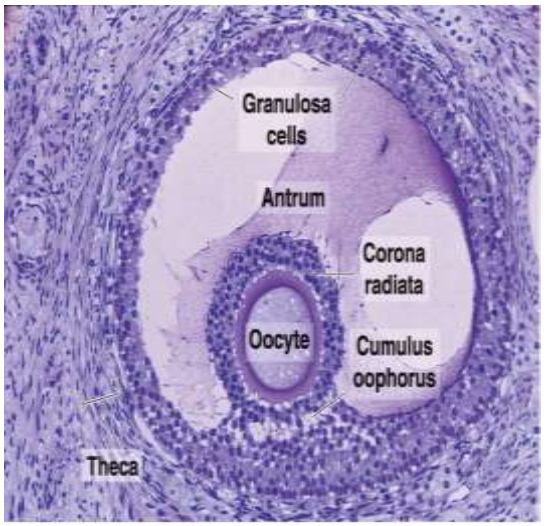




Follicular Growth

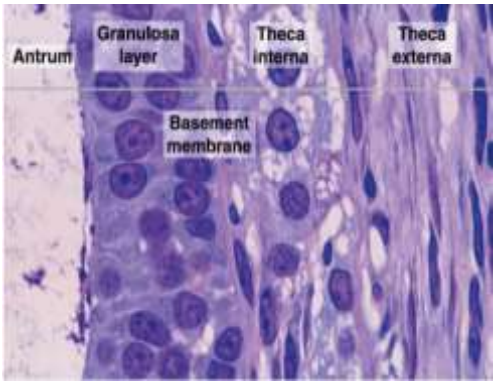
Beginning in puberty, each day a small group of primordial follicles begins a process called follicular growth. This consists of modifications of the oocyte, of the granulosa cells, and of the stromal fibroblasts that surround these follicles. It is not known how the particular follicles that enter the growth stage are selected from the large population of primordial follicles. Follicular growth is stimulated by follicle-stimulating hormone, secreted by the hypophysis. Oocyte growth is most rapid during the first part of follicular growth, with the oocyte reaching a maximum diameter of about 120 m. The nucleus enlarges, the mitochondria increase in number and become uniformly distributed throughout the cytoplasm, the endoplasmic reticulum hypertrophies, and the Golgi complexes migrate to just beneath the cell surface. Follicular cells divide by mitosis and form a single layer of cuboidal cells; the follicle is then called a **unilaminar primary follicle** . The follicular cells continue to proliferate and form a stratified follicular epithelium, or **granulosa layer,** whose cells communicate through gap junctions. The follicle is then called a **multilaminar primary** or **preantral follicle**. A thick amorphous layer, the **zona pellucida,** composed of several glycoproteins, is secreted and surrounds the oocyte . Both the oocyte and follicular cells are believed to contribute to the synthesis of the zona pellucida. Filopodia of follicular cells and microvilli of the oocyte penetrate the zona pellucida and make contact with one another via gap junctions.





As the follicles grow due mainly to the increase in size and number of granulosa cells they move to deeper areas of the cortical region. Liquid (**liquor folliculi**) begins to accumulate between the follicular cells. The small spaces that contain this fluid coalesce, and the granulosa cells reorganize themselves to form a larger cavity, the **antrum** . The follicles are then called **secondary** or **antral follicles.** Follicular fluid contains components of the plasma and products secreted by follicular cells. Glycosaminoglycans, several proteins (including steroid-binding proteins), and high concentrations of steroids (progesterone, androgens, and estrogens) are present. During the reorganization of the granulosa cells to form the antrum, some cells of this layer concentrate at a certain point on the follicular wall. This group forms a small hillock of cells, the **cumulus oophorus,** that protrudes toward the interior of the antrum and contains the oocyte. A group of granulosa cells

concentrates around the oocyte and forms the **corona radiata.** These granulosa cells accompany the oocyte when it leaves the ovary. While modifications are taking place in the oocyte and granulosa layer, the fibroblasts of the stroma immediately around the follicle differentiate to form the **theca folliculi** . This layer subsequently differentiates into the **theca interna** and the **theca externa** . The cells of the theca interna, when completely differentiated, acquire the ultrastructural characteristics of cells that produce steroids. These characteristics include abundant profiles of smooth endoplasmic reticulum, mitochondria with tubular cristae, and numerous lipid droplets. These cells are known to synthesize a steroid hormone **androstenedione** that is transported to the granulosa layer. The cells of the granulosa, under the influence of follicle-stimulating hormone, synthesize an enzyme, aromatase, that transforms androstenedione into estrogen. Estrogen returns to the stroma, enters the blood vessels, and is distributed throughout the body. The theca externa, on the other hand, consists mainly of organized layers of fibroblasts that surround the theca interna. The boundary between the two thecas is not sharp; neither is there a clear boundary between the theca externa and the ovarian stroma. On the other hand, the boundary between the theca interna and the granulosa layer is well defined, since their cells are morphologically different and there is a thick basement membrane between them .

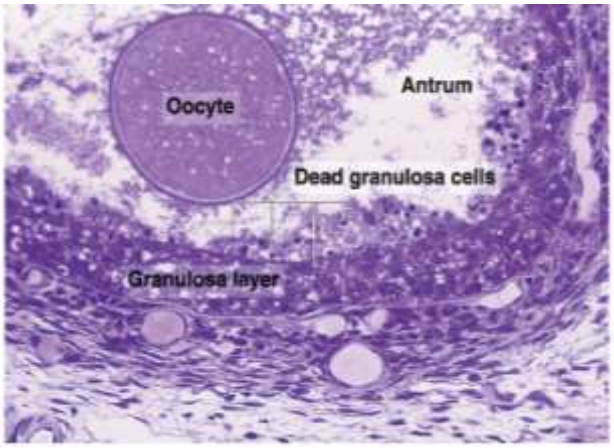


Small blood vessels penetrate the theca interna and supply a rich capillary plexus around the secretory cells of this region, which, like all organs of endocrine function, is richly vascularized. There are no blood vessels in the granulosa cell layer during the stage of follicular growth.During each menstrual cycle, usually one follicle grows much more than the others and

becomes the dominant follicle. The other follicles of the group that is growing enter atresia. The dominant follicle may reach the most developed stage of follicular growth the **mature, preovulatory,** or **graafian follicle** and may ovulate. At the peak of its development, this follicle is so large (about 2.5 cm in diameter) that it protrudes from the surface of the ovary and can be detected with ultrasound. As a result of the accumulation of liquid, the follicular cavity increases in size, and the oocyte adheres to the wall of the follicle through the cumulus oophorus formed by granulosa cells. Because the granulosa cells of the follicle wall do not multiply in proportion to the growth of the follicle, the granulosa layer becomes thinner. These follicles have a very thick theca layer.The whole process of growth from primordial to mature follicle lasts about 90 days.

Follicular Atresia

Most ovarian follicles undergo atresia, in which follicular cells and oocytes die and are disposed of by phagocytic cells. Follicles at any stage of development (primordial, primary, preantral, and antral) may undergo atresia . This process is characterized by cessation of mitosis in the granulosa cells, detachment of granulosa cells from the basal lamina, and death of the oocyte and granulosa cells. After a certain point macrophages invade the follicle to phagocytose the debris. At a later stage, fibroblasts occupy the follicle and produce a scar of collagen that may persist for a long time. Although follicular atresia takes place from before birth until a few years after menopause, there are times at which it is particularly intense. Atresia is greatly accentuated just after birth, when the effect of maternal hormones ceases, and during puberty and pregnancy, when marked qualitative and quantitative hormonal modifications take place.



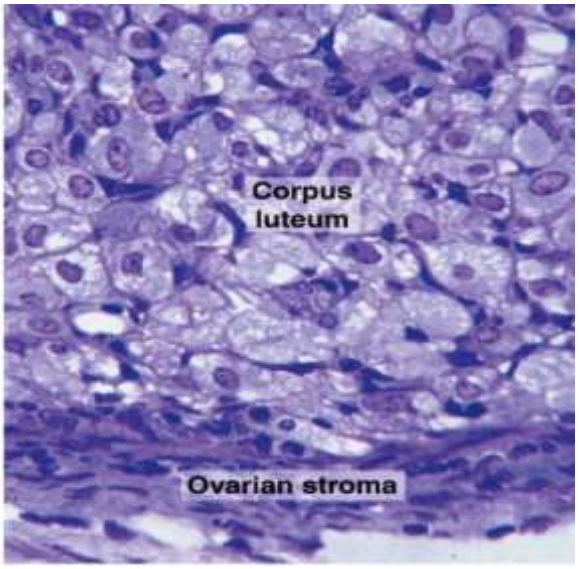
Ovulation

Ovulation consists of the rupture of part of the wall of the mature follicle and liberation of the oocyte, which is caught by the dilated extremity of the oviduct. It takes place in approximately the middle of the menstrual cycle, ie, around the fourteenth day of a 28-day cycle. In the human, usually only one oocyte is liberated by the ovary during each cycle, but sometimes no oocyte is ovulated (anovulatory cycle). Sometimes two or more oocytes can be expelled at the same time, and if they are fertilized, there may be two or more fetuses. The stimulus for ovulation is a surge of luteinizing hormone (LH) secreted by the anterior pituitary gland in response to high levels of circulating estrogen produced by the growing follicles. Within minutes after the increase in blood LH, there is an increase in blood flow through the ovary, and plasma proteins leak through capillaries and postcapillary venules, resulting in edema. There is a local release of prostaglandins, histamine, vasopressin, and collagenase. The granulosa cells produce more hyaluronic acid and become loose. A small area of the wall of the follicle becomes weak because of collagen degradation of the tunica albuginea, ischemia, and the death of some cells. This weakness, combined with an increased pressure of the follicular fluid and possibly the contraction of contractile cells that surround the follicle, leads to the rupture of the outer follicular wall and ovulation. An indication of impending ovulation is the appearance on the surface of the follicle of the **stigma,** in which the flow of blood ceases, resulting in a local change in color and translucence of the follicular wall.The first meiotic division is completed just before ovulation (until this moment the oocyte was in prophase I of meiosis, initiated during fetal life). The

chromosomes are equally divided between the daughter cells, but one of the secondary oocytes retains almost all of the cytoplasm. The other becomes the **first polar body,** a very small cell containing a small nucleus and a minimal amount of cytoplasm. Immediately after expulsion of the first polar body, the nucleus of the oocyte starts the second meiotic division, which stops in metaphase. Because of the rupture of the follicular wall, the oocyte and the first polar body, both enclosed by the zona pellucida, the corona radiata, and some follicular fluid, leave the ovary and enter the open extremity of the uterine tube where the oocyte may be fertilized. If this does not happen within the first 24 h after ovulation, it degenerates.

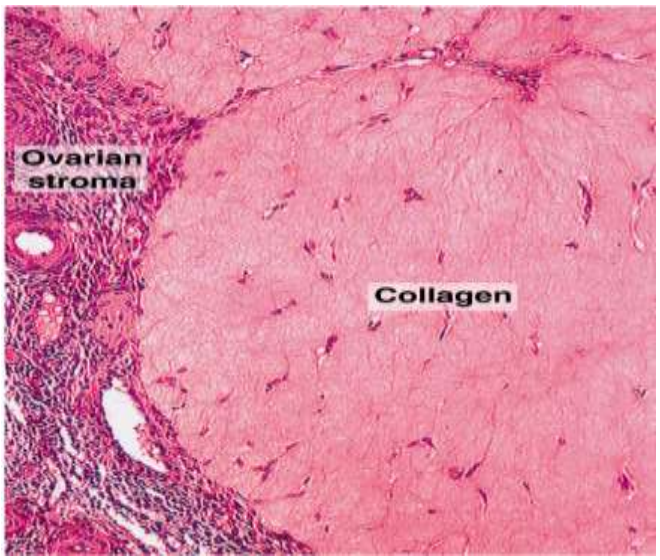
Corpus Luteum

After ovulation, the granulosa cells and the cells of the theca interna of the ovulated follicle reorganize to form a temporary endocrine gland called the **corpus luteum,** which becomes embedded within the cortical region. Release of the follicular fluid during ovulation results in collapse of the follicle's wall so that it becomes folded. Some blood flows into the follicular cavity, where it coagulates and is later invaded by connective tissue. This connective tissue, with remnants of blood clots that are gradually removed, remains as the most central part of the corpus luteum.Although the granulosa cells do not divide after ovulation, they increase greatly in size (20–35 m in diameter). They make up about 80% of the parenchyma of the corpus luteum and are then called **granulosa lutein cells** , with the characteristics of steroid-secreting cells. This is in contrast to their structure in the preovulatory follicle, where they appear to be protein-secreting cells.



Cells of the theca interna also contribute to the formation of the corpus luteum by giving rise to **theca lutein cells**. These cells are similar in structure to granulosa lutein cells but are smaller (about 15 m in diameter) and stain more intensely. They are located in the folds of the wall of the corpus luteum.The blood capillaries and lymphatics that were restricted to the theca interna now grow into the interior of the corpus luteum and form the rich vascular network of this structure.The reorganization of the ovulated follicle and the development of the corpus luteum result from the LH released before ovulation. Also under stimulus by LH, the cells of the corpus luteum change their sets of enzymes and begin secreting progesterone and estrogens. The fate of the corpus luteum depends on whether pregnancy is established. Following the stimulus by LH, the corpus luteum is programmed to secrete for 10–12 days. If pregnancy does not occur, no further hormonal stimulation takes place and the cells of the corpus luteum degenerate by apoptosis. One of the consequences of the decreasing secretion of progesterone is menstruation, which constitutes the shedding of part of the uterine mucosa. Estrogen produced by the active corpus luteum inhibits the liberation of follicle-stimulating hormone from the hypophysis. However, after the corpus luteum degenerates, the concentration of blood steroids decreases and follicle-stimulating hormone is liberated, stimulating the growth of another group of follicles, beginning the next menstrual cycle. The corpus luteum that lasts for only part of a menstrual cycle is called the **corpus luteum of menstruation.** Its cellular remnants are phagocytosed

by macrophages. Neighboring fibroblasts invade the area and produce a scar of dense connective tissue called the **corpus albicans** ("white body," because of the large amount of collagen).



If pregnancy occurs, the uterine mucosa cannot be allowed to shed. If it does, the implanting embryo dies and the pregnancy is aborted. Instead, a signal to the corpus luteum is given by a hormone called **human chorionic gonadotropin** (**HCG**) secreted by the trophoblastic cells of the implanting embryo. The action of HCG is similar to that of LH. Thus, HCG rescues the corpus luteum from degeneration, causes further growth of this endocrine gland, and stimulates secretion of progesterone (which will maintain the uterine mucosa throughout pregnancy). In addition to maintaining the uterine mucosa, progesterone also stimulates secretion of the uterine glands, which is thought to be important for the nutrition of the embryo before the placenta is functional. This is the **corpus luteum of pregnancy.** It persists for 4–5 months and then degenerates and is replaced by a corpus albicans that is much larger than the corpus albicans of menstruation.

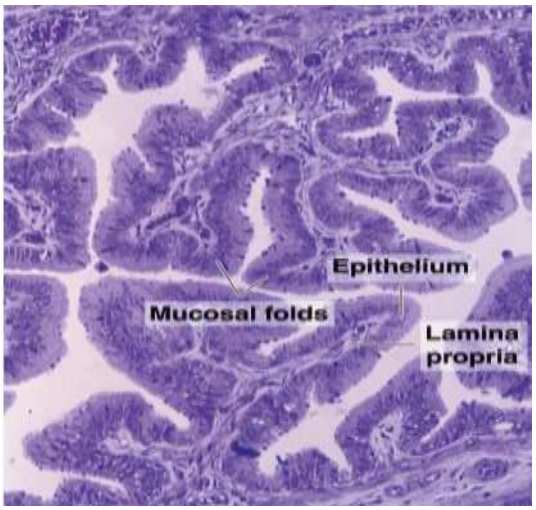
Interstitial Cells

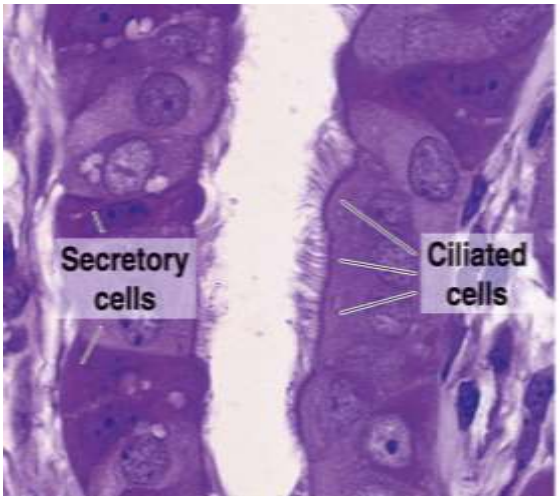
Although granulosa cells and the oocytes undergo degeneration during follicular atresia, the theca interna cells frequently persist in isolation or in small groups throughout the cortical stroma and are called **interstitial cells.** Present from childhood through menopause, interstitial cells are active steroid secretors, stimulated by LH.

Oviducts

The oviducts are two muscular tubes of great mobility, each measuring about 12 cm in length. One of its extremities, the infundibulum, opens into the peritoneal cavity next to the ovary and has a fringe of fingerlike extensions called **fimbriae;** the other extremity, the intramural portion, passes through the wall of the uterus and opens into the interior of this organ.

The wall of the oviduct is composed of three layers: (1) a mucosa, (2) a thick muscularis composed of smooth muscle disposed as an inner circular or spiral layer and an outer longitudinal layer, (3) and a serosa composed of visceral peritoneum. The mucosa has longitudinal folds that are most numerous in the ampulla. In cross sections, the lumen of the ampulla resembles a labyrinth . These folds become smaller in the segments of the tube that are closer to the uterus. In the intramural portion, the folds are reduced to small bulges in the lumen, so its internal surface is almost smooth. The mucosa is composed of a simple columnar epithelium and a lamina propria composed of loose connective tissue. The epithelium contains two types of cells: one has cilia and the other is secretory . The cilia beat toward the uterus, causing movement of the viscous liquid film that covers its surface. This liquid consists mainly of products of the secretory cells interspersed between ciliated cells.





At the moment of ovulation, the oviduct exhibits active movement. The funnel-shaped extremity (fringed with numerous fimbriae) comes very close to the surface of the ovary. This favors the transport of the ovulated oocyte into the tube. Promoted by muscle contraction and the activity of ciliated cells, the oocyte enters the infundibulum of the oviduct. The secretion of the tube epithelium contains nutrients for the oocyte. Unless it is fertilized, the oocyte remains viable for a maximum of about 24 h. The secretion also promotes activation (**capacitation**) of spermatozoa.Fertilization usually occurs in the ampulla and reconstitutes the diploid number of chromosomes typical of the species. It also serves as a stimulus for the oocyte to complete the second meiotic division. Only at this moment does the primary oocyte transform into a secondary oocyte. The corona radiata is usually still present when the spermatozoon fertilizes the oocyte; it is retained for some time during the passage of the oocyte through the oviduct. Once fertilized, the oocyte, now called a zygote (Gr. *zygotos,* yolked), begins cell division and is transported to the uterus, a process that lasts about 5 days. Movement of the film that covers the mucosa of the tube, in conjunction with contractions of the muscle layer, helps to transport the oocyte or the conceptus toward the uterus. This movement also hampers the passage of microorganisms from the uterus to the peritoneal cavity. Transport of the oocyte or conceptus to the uterus, however, is normal in females with **immotile cilia syndrome,** showing that ciliary activity is not essential for transport.

Uterus

The uterus is a pear-shaped organ that consists of a **body** (**corpus**), which lies above a narrowing of the uterine cavity (**the internal os**), and a lower cylindrical structure, the **cervix,** which lies below the internal os. The dome-shaped part of the body of the uterus is called the **fundus** .The wall of the uterus is relatively thick and is composed of three layers. Depending on the part of the uterus, there is either an outer **serosa** (connective tissue and mesothelium) or **adventitia** (connective tissue). The other uterine layers are the **myometrium,** a thick tunic of smooth muscle, and the **endometrium,** or mucosa of the uterus.

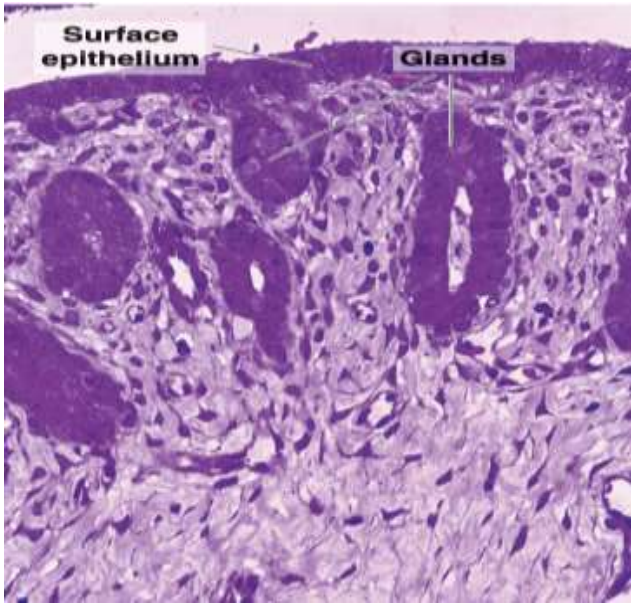
Myometrium

The myometrium (Gr. *mys,* muscle, + *metra,* uterus), the thickest tunic of the uterus, is composed of bundles of smooth muscle fibers separated by connective tissue. The bundles of smooth muscle form four poorly defined layers. The first and fourth layers are composed mainly of fibers disposed longitudinally, ie, parallel to the long axis of the organ. The middle layers contain the larger blood vessels. During pregnancy, the myometrium goes through a period of great growth as a result of both **hyperplasia** (an increase in the number of smooth muscle cells) and **hypertrophy** (an increase in cell size). During pregnancy, many smooth muscle cells actively synthesize collagen, promoting a significant increase in uterine collagen content. After pregnancy, there is destruction of some smooth muscle cells, reduction in the size of others, and enzymatic degradation of the collagen. The uterus is reduced in size almost to its prepregnancy dimensions.

Endometrium

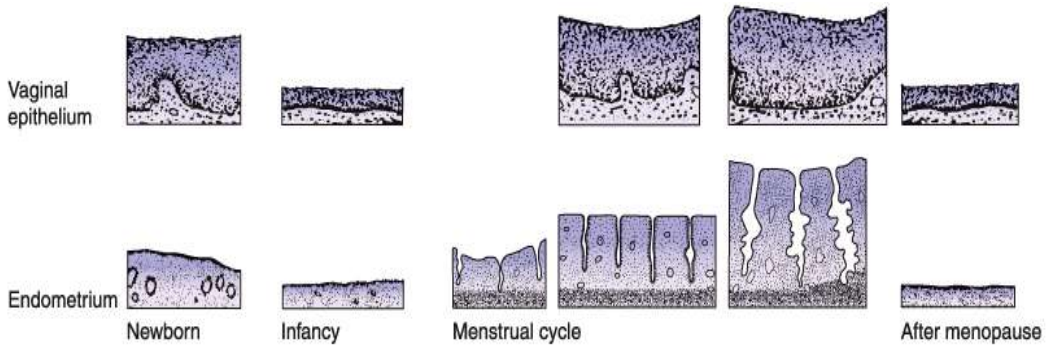
The endometrium consists of epithelium and a lamina propria containing simple tubular glands that sometimes branch in their deeper portions (near the myometrium). Its covering epithelial cells are a mixture of ciliated and secretory simple columnar cells. The epithelium of the uterine glands is similar to the superficial epithelium, but ciliated cells are rare within the glands. The connective tissue of the lamina propria is rich in fibroblasts and contains abundant ground substance. Connective tissue fibers are mostly

made of collagen type III. The endometrial layer can be subdivided into two zones: (1) The **basalis** is the deepest one, adjacent to the myometrium; it contains lamina propria and the closed tips of the uterine glands. (2) The **functionalis** contains the remainder of the lamina propria and the glands, as well as the surface epithelium. Whereas the functionalis undergoes profound changes during the menstrual cycles, the basalis remains mostly unchanged. The blood vessels supplying the endometrium are of special significance in the periodic sloughing of most of this layer. **Arcuate arteries** are circumferentially oriented in the middle layers of the myometrium. From these vessels, two sets of arteries arise to supply blood to the endometrium: **straight arteries,** which supply the basalis, and **spiral arteries,** which bring blood to the functionalis.



The Menstrual Cycle

Estrogens and progesterone control the organs of the female reproductive system. The proliferation and the differentiation of epithelial cells and the associated connective tissues depend on these hormones. Even before birth, these organs are influenced by estrogen and progesterone that circulate in the maternal blood and reach the fetus through the placenta . After menopause, the diminished synthesis of these hormones causes a general involution of the reproductive organs.

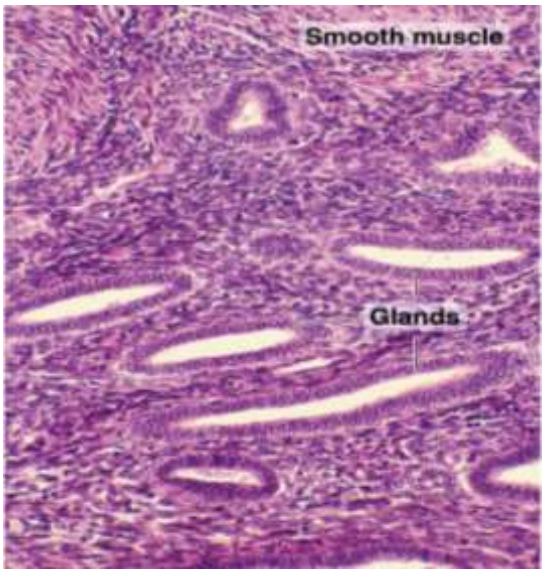


After puberty, the ovarian hormones, under the stimulus of the anterior lobe of the pituitary, cause the endometrium to undergo cyclic structural modifications during the menstrual cycle. The duration of the menstrual cycle is variable but averages 28 days. Menstrual cycles usually start between 12 and 15 years of age and continue until about age 45–50 years. Because menstrual cycles are a consequence of ovarian modifications related to the production of oocytes, the female is fertile only during the years when she is having menstrual cycles. This does not mean that sexual activity is terminated by menopause only that fertility ceases. For practical purposes, the beginning of the menstrual cycle is taken as the day when menstrual bleeding appears. The menstrual discharge consists of degenerating endometrium mixed with blood from the ruptured blood vessels. The **menstrual phase** lasts 3–4 days on average. The next phases of the menstrual cycle are called the **proliferative** and **secretory** (or **luteal**) phases. The secretory phase begins at ovulation and lasts about 14 days. The duration of the proliferative phase is variable, 10 days on average. The structural changes that occur during the cycle are gradual, and the clear division of the phases implied here is mainly for teaching value.

The Proliferative, Follicular, or Estrogenic Phase

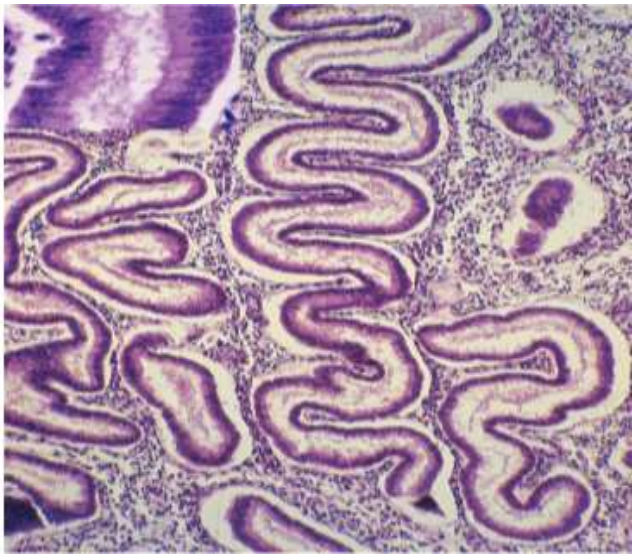
After the menstrual phase, the uterine mucosa is relatively thin (about 0.5 mm). The beginning of the proliferative phase coincides with the rapid growth of a small group of ovarian follicles that, when the cycle began, was probably at the transition from preantral to antral follicles. When their theca interna develops, these follicles begin to actively secrete estrogens, whose plasma concentrations increase gradually. Estrogens act on the endometrium, inducing cell proliferation and reconstituting the endometrium

lost during menstruation. (Estrogen also acts on other parts of the reproductive system, eg, inducing the production of cilia by epithelial cells of the oviduct. During the proliferative phase, the endometrium is covered by a simple columnar epithelium . The glands, formed by simple columnar epithelial cells, are straight tubules with narrow lumens . These cells gradually accumulate more cisternae of rough endoplasmic reticulum, and the Golgi complex increases in size in preparation for secretory activity. At the end of the proliferative phase, the endometrium is 2–3 mm thick.



The Secretory, or Luteal, Phase

The secretory phase starts after ovulation and results from the action of progesterone secreted by the corpus luteum. Acting on glands already developed by the action of estrogen, progesterone further stimulates the gland cells. The epithelial cells begin to accumulate glycogen below their nuclei. Later, the amount of glycogen diminishes, and glycoprotein secretory products dilate the lumens of the glands. One important feature of this phase is that the glands become highly coiled. In this phase, the endometrium reaches its maximum thickness (5 mm) as a result of the accumulation of secretions and of edema in the stroma. Mitoses are rare during the secretory phase During the luteal phase, the uterine glands become tortuous and their lumen is filled with secretions. Some edema is present in the connective tissue.



If fertilization has taken place, the embryo has been transported to the uterus and attaches to the uterine epithelium during the secretory stage, around 7 or 8 days after ovulation. It is thought that the secretion of the glands is the major source of embryonic nutrition before embryo implantation. Progesterone inhibits the contractions of smooth muscle cells of the myometrium that might otherwise interfere with the implantation of the embryo.

The Menstrual Phase

When fertilization of the oocyte and embryo implantation do not occur and the corpus luteum ceases functioning, the consequent rapid decrease of blood levels of progesterone and estrogens causes menstruation. Menstruation is a complex phenomenon and its exact mechanisms are still not completely understood. Several factors are involved in the shedding of the endometrium, such as cycles of contraction and relaxation of the spiral arteries, activation (by lack of progesterone) of locally produced matrix metalloproteinases, and local release of prostaglandins, cytokines, and nitric oxide. These factors lead to breakdown of blood vessel walls and basement membranes as well as collagen of the endometrial lamina propria. Blood vessels rupture above the constrictions, and bleeding begins. Consequently, part of the functional layer of the endometrium becomes detached. The amount of endometrium and blood lost varies between women and even in the same woman at different times.At the end of the menstrual phase, the

endometrium is usually reduced to a thin layer of lamina propria, the blind ends of uterine glands (both of which present in the basalis layer), and some covering epithelium. The endometrium is thus ready to begin a new cycle as its epithelial, connective tissue, and vascular cells begin dividing to reconstitute the mucosa. Table 22–1 summarizes the main events of the menstrual cycle.

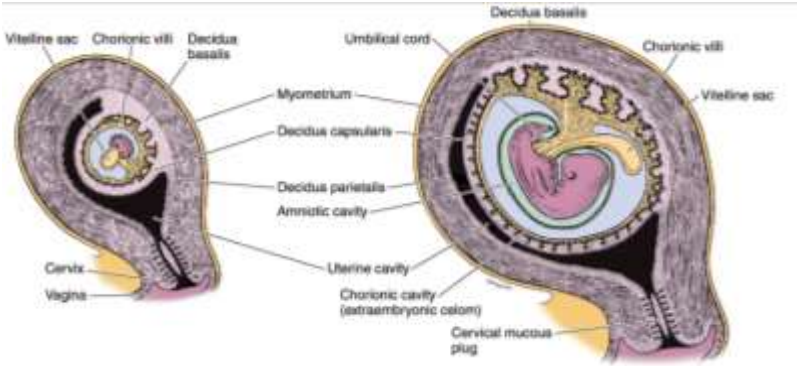
Pregnant Endometrium

If implantation occurs, embryonic trophoblast cells produce HCG, which stimulates the corpus luteum to continue secreting progesterone. As pregnancy is established, menstruation does not occur, and the menstrual cycle is deferred during the whole duration of pregnancy. Progesterone makes the uterine glands wider, more tortuous, and able to contain more secretions than during the secretory stage. The endometrium as a whole becomes thicker during the beginning of pregnancy.

Implantation, Decidua, & Placenta

The human oocyte is fertilized in the lateral third of the uterine tube, and the zygote undergoes cell division as it is moved passively toward the uterus. Through successive mitoses, a compact collection of cells, the **morula,** is formed. The morula, covered by the zona pellucida, is about the same size as the fertilized oocyte. The cells that result from segmentation of the zygote are called **blastomeres** (Gr. *blastos,* germ, + *meros,* part). Because the zygote does not grow in size, at each division the blastomeres become smaller. At the center of the morula a liquid-filled cavity develops and the blastomeres arrange themselves in a peripheral layer (**trophoblast**) while a few blastomeres accumulate inside the cavity (**inner cell mass**). This embryo is now called a **blastocyst,** which is the stage at which it arrives in the uterus. This happens on approximately the fourth or fifth day after ovulation. The blastocyst remains in the lumen of the uterus for 2 or 3 days, immersed in the secretion of the endometrial glands, and comes into contact with the surface of the endometrium. The zona pellucida is then dissolved, allowing cells of the trophoblast to interact directly with cells of the uterine surface epithelium. Implantation, or nidation, involves the attachment of the

embryo to the endometrial epithelial cells and its penetration into the lamina propria. This type of implantation is called **interstitial** and occurs in humans and a few other mammals. The process starts around the seventh day; on about the ninth day after ovulation, the embryo is totally submerged in the endometrium, from which it will receive protection and nourishment during pregnancy. During implantation of the embryo, the endometrial connective tissue goes through profound changes. The fibroblasts of the lamina propria become enlarged and round and exhibit the characteristics of protein-synthesizing cells. They are now called decidual cells, and the whole endometrium is called the **decidua.** Based on the endometrial region, the decidua can be classified as the **decidua basalis,** situated between the embryo and the myometrium; the **decidua capsularis,** situated between the embryo and the lumen of the uterus; and the **decidua parietalis,** the remainder of the decidua.



The placenta is a temporary organ and is the site of physiological exchanges between the mother and the fetus. It consists of a fetal part (**chorion**) and a maternal part (decidua basalis). Thus the placenta is composed of cells derived from two genetically distinct individuals. The decidua basalis supplies maternal arterial blood to, and receives venous blood from, spaces that exist inside the placenta. The placenta is also an endocrine organ, producing hormones such as HCG, a placental prolactin, estrogens, and progesterone.

Uterine Cervix

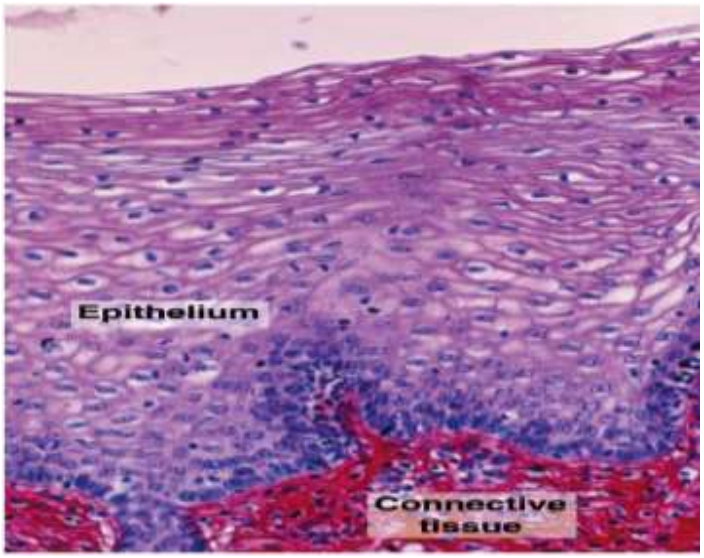
The **cervix** is the lower, cylindrical part of the uterus , and it differs in histological structure from the rest of the uterus. The lining consists of a mucus-secreting simple columnar epithelium. The cervix has few smooth

muscle fibers and consists mainly (85%) of dense connective tissue. The external aspect of the cervix that bulges into the lumen of the vagina is covered with stratified squamous epithelium.The mucosa of the cervix contains the mucous **cervical glands,** which are extensively branc hed. This mucosa does not undergo remarkable changes during the menstrual cycle and does not desquamate during menstruation. During pregnancy, the cervical mucous glands proliferate and secrete a more viscous and abundant mucus. Cervical secretions play a significant role in fertilization of the oocyte. At the time of ovulation, the mucous secretions are watery and allow penetration of the uterus by sperm. In the luteal phase or in pregnancy, the progesterone levels alter the mucous secretions so that they become more viscous and prevent the passage of sperm, as well as microorganisms, into the body of the uterus. The dilation of the cervix that precedes parturition is due to intense collagenolysis, which promotes its softening.

Vagina

The wall of the vagina (from Latin, meaning sheath) is devoid of glands and consists of three layers: a **mucosa,** a **muscular layer,** and an **adventitia.** The mucus found in the lumen of the vagina comes from the glands of the uterine cervix. The epithelium of the vaginal mucosa of an adult woman is stratified squamous and has a thickness of 150–200 m. Its cells may contain a small amount of keratohyalin. Intense keratinization, however, with the cells changing into keratin plates, as in typical keratinized epithelia, does not occur . Under the stimulus of estrogen, the vaginal epithelium synthesizes and accumulates a large quantity of glycogen, which is deposited in the lumen of the vagina when the vaginal cells desquamate. Bacteria in the vagina metabolize glycogen and form lactic acid, which is responsible for the usually low pH of the vagina. The acidic vaginal environment provides a protective action against some pathogenic microorganisms. The lamina propria of the vaginal mucosa is composed of loose connective tissue that is very rich in elastic fibers. Among the cells present are lymphocytes and neutrophils in relatively large quantities. During certain phases of the menstrual cycle, these two types of leukocytes invade the epithelium and pass into the lumen of the vagina. The vaginal mucosa is virtually devoid of

sensory nerve endings, and the few naked nerve endings that do exist are probably pain fibers. The muscular layer of the vagina is composed mainly of longitudinal bundles of smooth muscle fibers. There are some circular bundles, especially in the innermost part (next to the mucosa). Outside the muscular layer, a coat of dense connective tissue, the adventitia, rich in thick elastic fibers, unites the vagina with the surrounding tissues. The great elasticity of the vagina is related to the large number of elastic fibers in the connective tissues of its wall. In this connective tissue are an extensive venous plexus, nerve bundles, and groups of nerve cells



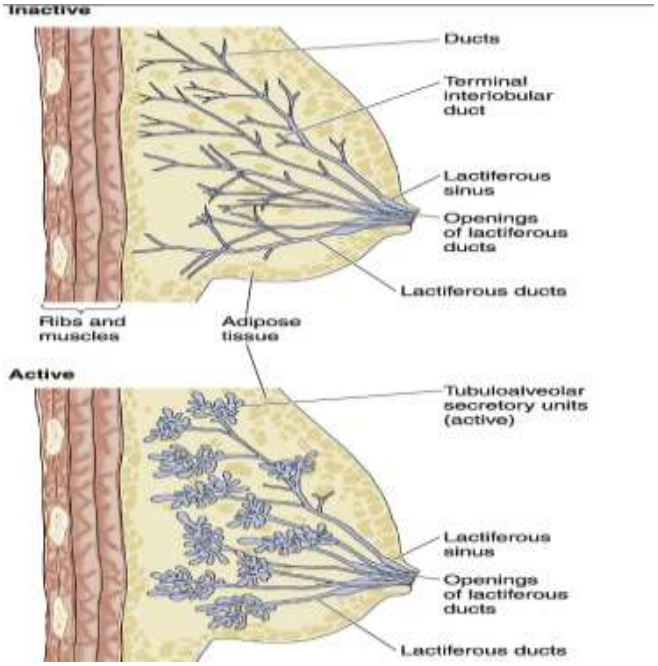
External Genitalia

The female external genitalia, or vulva, consist of the **clitoris, labia minora, labia majora,** and some glands that open into the vestibulum, a space enclosed by the labia minora. The urethra and the ducts of the vestibular glands open into the vestibulum. The two **glandulae vestibulares majores,** or **glands of Bartholin,** are situated on either side of the vestibulum. These glands are homologous to the bulbourethral glands in the male. Women frequently experience inflammation of these glands and the formation of very painful cysts. The more numerous **glandulae vestibulares minores** are scattered, found with greater frequency around the urethra and clitoris. All the glandulae vestibulares secrete mucus. The clitoris and the penis are homologous in embryonic origin and histological structure. The clitoris is formed by two erectile bodies ending in a

rudimentary **glans clitoridis** and a prepuce. The clitoris is covered with stratified squamous epithelium.The labia minora are folds of skin with a core of spongy connective tissue permeated by elastic fibers. The stratified squamous epithelium that covers them has a thin layer of keratinized cells on the surface. Sebaceous and sweat glands are present on the inner and outer surfaces of the labia minora. The labia majora are folds of skin that contain a large quantity of adipose tissue and a thin layer of smooth muscle. Their inner surface has a histological structure similar to that of the labia minora. The external surface is covered by skin and coarse, curly hair. Sebaceous and sweat glands are numerous on both surfaces. The external genitalia are abundantly supplied with sensory tactile nerve endings, including Meissner's and Pacinian corpuscles, which contribute to the physiology of sexual arousal.

Mammary Glands

Each mammary gland consists of 15–25 **lobes** of the compound tubuloalveolar type whose function is to secrete milk to nourish newborns. Each lobe, separated from the others by dense connective tissue and much adipose tissue, is really a gland in itself with its own **excretory lactiferous duct**. These ducts, 2–4.5 cm long, emerge independently in the **nipple,** which has 15–25 openings, each about 0.5 mm in diameter. The histological structure of the mammary glands varies according to sex, age, and physiological status.



Breast Development in Puberty & in the Adult

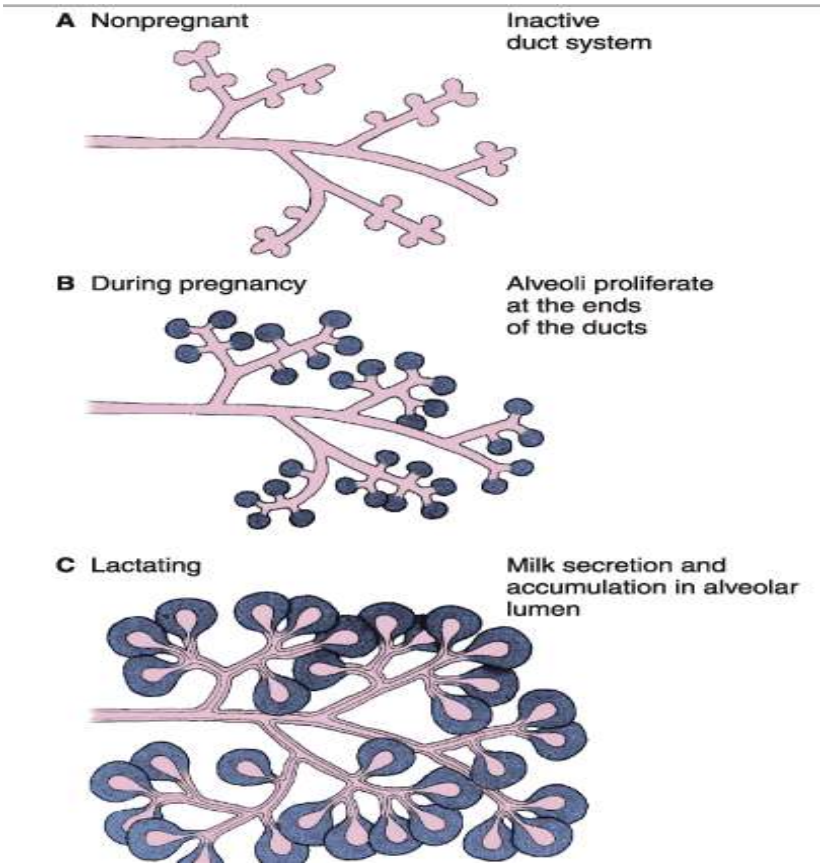
Before puberty, the mammary glands are composed of **lactiferous sinuses** and several branches of these sinuses, the **lactiferous ducts** .In girls during puberty the breasts increase in size and develop a prominent nipple. In boys, the breasts remain flattened. Breast enlargement during puberty is the result of the accumulation of adipose tissue and connective tissue, with increased growth and branching of lactiferous ducts due to an increase in the amount of ovarian estrogens.The characteristic structure of the gland the **lobe** in the adult woman is developed at the tips of the smallest ducts. A lobe consists of several ducts that empty into one terminal duct. Each lobe is embedded in loose connective tissue. A denser, less cellular connective tissue separates the lobes. Near the opening of the nipple, the lactiferous ducts dilate to form the lactiferous sinuses . The lactiferous sinuses are lined with stratified squamous epithelium at their external openings. This epithelium very quickly changes to stratified columnar or cuboidal epithelium. The lining of the lactiferous ducts and terminal ducts is formed of simple cuboidal epithelium covered by closely packed myoepithelial cells. The connective tissue surrounding the alveoli contains many lymphocytes and plasma cells. The plasma cell population increases significantly toward the end of pregnancy; it is responsible for the secretion of immunoglobulins (secretory IgA) that

confer passive immunity on the newborn. The histological structure of these glands undergoes small alterations during the menstrual cycle, eg, proliferation of cells of the ducts at about the time of ovulation. These changes coincide with the time at which circulating estrogen is at its peak. Greater hydration of connective tissue in the premenstrual phase produces breast enlargement.

The **nipple** has a conical shape and may be pink, light brown, or dark brown. Externally, it is covered by keratinized stratified squamous epithelium continuous with that of the adjacent skin. The skin around the nipple constitutes the **areola.** The color of the areola darkens during pregnancy, as a result of the local accumulation of melanin. After delivery, the areola may become lighter in color but rarely returns to its original shade. The epithelium of the nipple rests on a layer of connective tissue rich in smooth muscle fibers. These fibers are disposed in circles around the deeper lactiferous ducts and parallel to them where they enter the nipple. The nipple is abundantly supplied with sensory nerve endings.

The Breasts during Pregnancy & Lactation

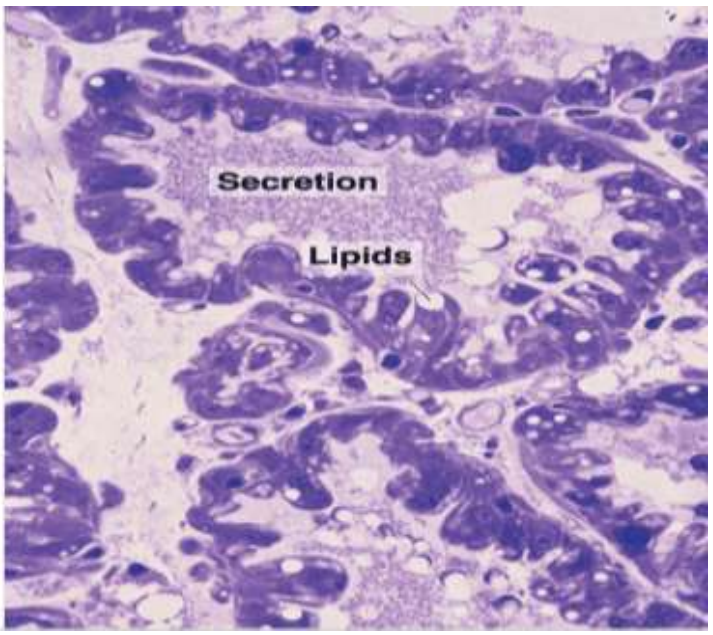
The mammary glands undergo intense growth during pregnancy as a result of the synergistic action of several hormones, mainly estrogen, progesterone, prolactin, and human placental lactogen. One of the actions of these hormones is the proliferation of **alveoli** at the ends of the terminal ducts. Alveoli are spherical collections of epithelial cells that become the active milk-secreting structures in lactation . A few fat droplets and membrane-limited secretory vacuoles containing from one to several dense aggregates of milk proteins can be seen in the apical cytoplasm of alveolar cells. The number of secretory vacuoles and fat droplets greatly increases in lactation . Stellate myoepithelial cells are found between the alveolar epithelial cells and the basal lamina. The amounts of connective tissue and adipose tissue, relative to the parenchyma, decrease considerably during lactation



Changes in the mammary gland. **A:** In nonpregnant women, the gland is quiescent and undifferentiated, and its duct system is inactive. **B:** During pregnancy, alveoli proliferate at the ends of the ducts and prepare for the secretion of milk. **C:** During lactation, alveoli are fully differentiated, and milk secretion is abundant. Once lactation is completed, the gland reverts to the nonpregnant condition.

During lactation, milk is produced by the epithelial cells of the alveoli and accumulates in their lumens and inside the lactiferous ducts. The secretory cells become small and low cuboidal, and their cytoplasm contains spherical droplets of various sizes containing mainly neutral triglycerides. These lipid droplets pass out of the cells into the lumen and in the process are enveloped with a portion of the apical cell membrane. Lipids constitute about 4% of human milk. In addition to the lipid droplets, there are a large number of membrane-limited vacuoles that contain granules composed of caseins and other milk proteins. Milk proteins include several caseins, lactalbumin, and plasmocyte-produced IgA. Proteins constitute approximately 1.5% of human

milk. Lactose, the sugar of milk, is synthesized from glucose and galactose and constitutes about 7% of human milk.



PENGANTAR PRAKTIKUM

HISTOLOGI KELENJAR-KELENJAR ENDOKRIN

Dosen pengampu : dr. Dewi Jantika Djuarna Sp.PA & dr. Zahra Nurusshofa, Sp.PA

Endocrine glands do not have ducts. They synthesize and secrete products, called hormones, into the blood where they are transported to other tissues. These hormones will bind with receptors on target cells and alter their function

Endocrine gland can be further classified onto :

1. **Discrete Endocrine Glands** - pituitary (hypophysis), thyroid, parathyroid, adrenal and pineal glands.
2. **Endocrine component of Glands with both an Endocrine and an Exocrine Function.** kidney, pancreas and gonads.
3. **Diffuse Neuroendocrine system**, which includes APUD cells.

In this laboratory activity, we will only learn the major endocrine glands in human body

A. Pituitary gland
B. Pineal body
C. Thyroid gland
D. Parathyroid gland
E. Pancreas
F. Adrenal glands
G. Ovaries
H. Testes.

A. PITUITARY GLAND

The pituitary gland produces and regulates hormones that affect processes throughout the body. Macroscopically, the pituitary gland can be divided into *neurohypophysis* and *adenohypophysis*.

Adenohypophysis (Anterior pituitary)

Microscopically, you should be able to distinguish 3 types of chromopils (cells which take upd the stain) in anterior pituitary

1. Acidophil cells (or acidophils)

Acidophils are rounded cells and typically smaller than basophil cells. Acidophils account for roughly 65% of the cells in the adenohypophysis.

1. The most frequent subtype of acidophils are the *somatotrophs*. Somatotrophs produce *growth hormone* (GH) or somatotropin
2. *Mammotrophs* (or lactotrophs), the second group of acidophils, secrete *prolactin*. Their number increases significantly in late pregnancy and the early months of lactation.

2. Basophil cells (or basophils)

Based on their hormone products basophils are divided into three subtypes.

1. *Thyrotrophs* produce *thyroid stimulating hormone* (TSH or thyrotropin).
2. *Gonadotrophs* produce *follicle stimulating hormone* (FSH) and *luteinizing hormone* (LH),
3. *Corticotrophs* (or adrenocorticolipotrophs) secrete *adrenocorticotropic hormone* (ACTH or corticotropin), *lipotropin* (LPH, no known function in humans) and *melanocyte stimulating hormone* (MSH).

3. Chromophobe cells

Chromophobe cells are unstained or weakly stained cells.

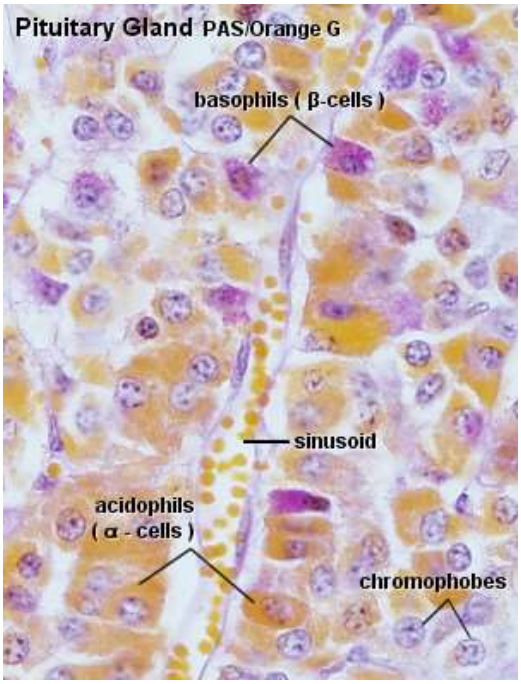
Pituitary- PAS/ORANGE G staining or **Pituitary, H&E** staining

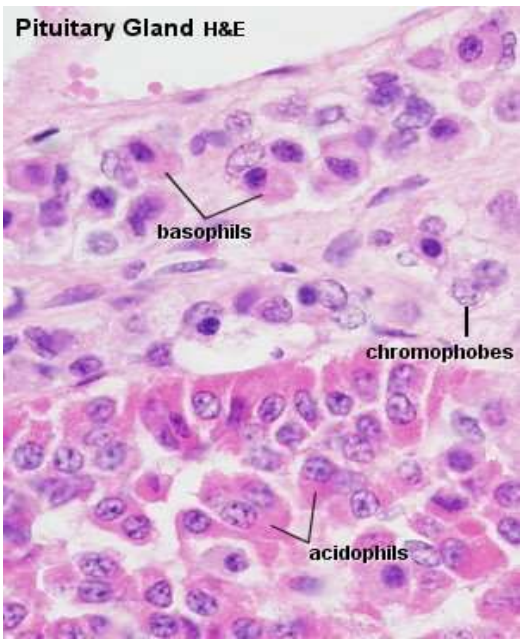
The best slide to identify the different cell types of the adenohypophysis is the PAS/Orange G stained one. Identify acidophils, basophils and chromophobes. Survey the tissue, and verify that the relative frequencies of the cells are different in different parts of the adenohypophysis.

In the H&E stained sections acidophils are dark pink and basophils look

light pink/blue.

INSTRUCTION : In the laboratory, draw the pituitary at low magnification and identify its divisions (those visible in the slide) and portal venules in your drawing. Then change it to higher magnification and draw the adenohypophysis which contains, if possible, all three cell types. Label your drawing and give the explanation.





Neurohypophysis (Posterior Pituitary)

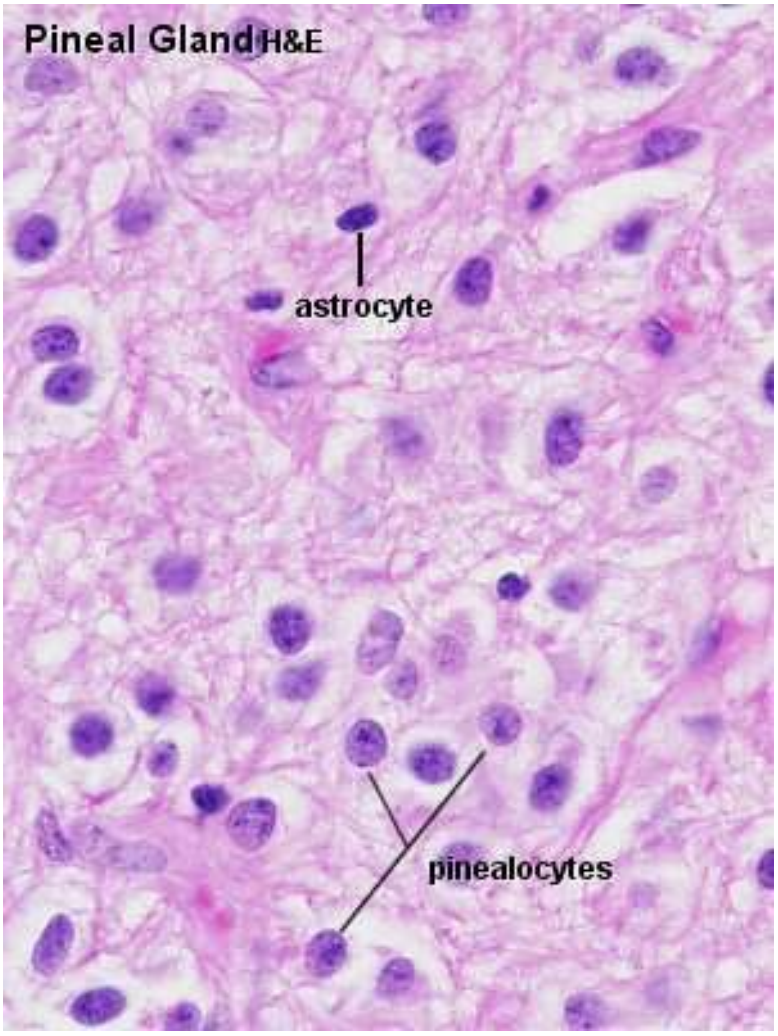
The neurohypophysis consists of

1. unmyelinated nerve fibres derived from neurosecretory cells of the supraoptic and paraventricular hypothalamic nuclei and
2. *pituicytes.*

Release-inhibiting and releasing factors, which regulate the activity of the adenohypophysis, are not the only hormones secreted in the neurohypophysis. Two additional hormones are *oxytocin*, which stimulates the contraction of smooth muscle cell in the uterus and participates in the milk ejection reflex, and *antidiuretic hormone* (ADH or vasopressin), which facilitates the concentration of urine in the kidneys and, thereby, the retention of water.

B. PINEAL BODY

In the pineal we find two cell types: *pinealocytes* (about 95% of the cells; large, light and round nuclei) and *astrocytes* (glial cells; dark, elongated nuclei).



The parenchyma of the pineal gland looks rather homogeneous at low magnification. A few blood vessels are visible criss-crossing through the gland. At higher magnification three types of nuclei can be distinguished. Small dark nuclei belong to the astrocytes found in the pineal gland. Pinealocytes have larger, lighter and round nuclei, which are surrounded by a broad rim of light cytoplasm. Most nuclei present are the nuclei of pinealocytes. Endothelial cell nuclei are found in association with the vessels and capillaries traversing the tissue. Both pinealocytes and astrocytes have long processes which give the tissue between the nuclei its "stringy" appearance.

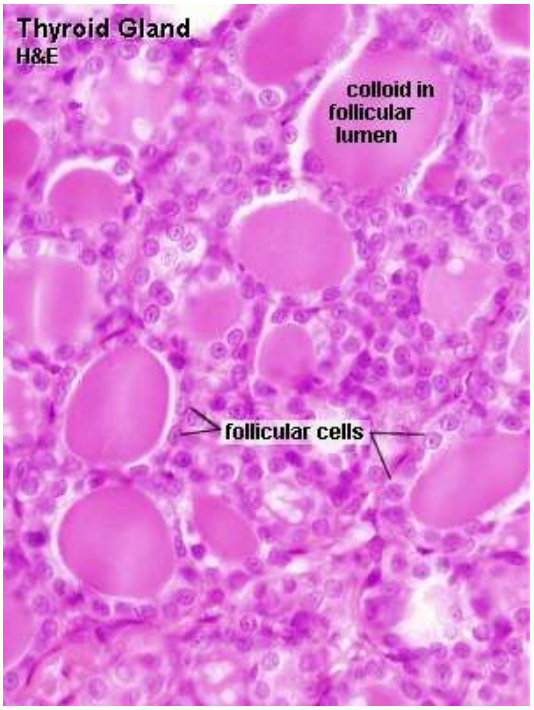
INSTRUCTION : In the laboratory, draw the small part of the parenchyma of the pineal gland at high magnification. Label the the name of the cells and give the explanation of your drawing.

C. THYROID GLAND

The thyroid gland produces hormones that primarily influence the metabolic rate and protein synthesis. It is unique in that it stores its hormones extracellularly in large follicles

Thyroid gland, human - H&E

Identify the follicles of the thyroid gland. Have a look at the height of the epithelium and make an educated guess at the functional activity in the thyroid. Notice the capillaries in the interstices between the thyroid follicles. C cells are very difficult to identify.



INSTRUCTIONS : In the laboratory, pick a nice follicle and draw it. Label your drawing and give an explanation of your drawing

D. PARATHYROID GLANDS

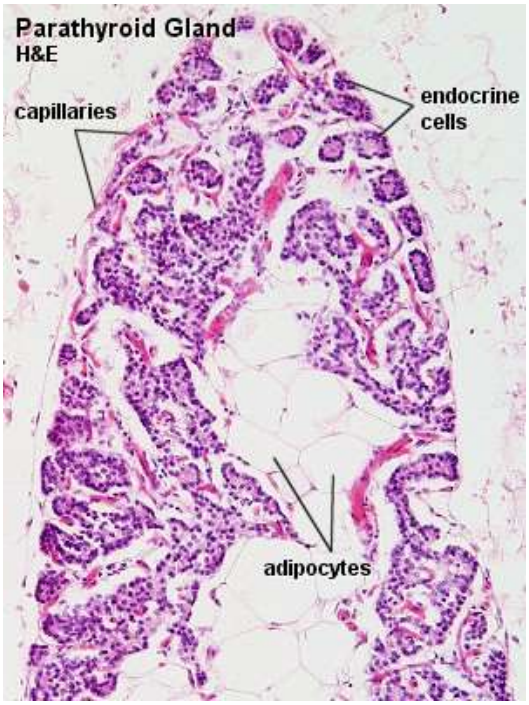
The parathyroid glands secrete parathyroid hormone that regulates the amount of calcium in the blood and within the bones.

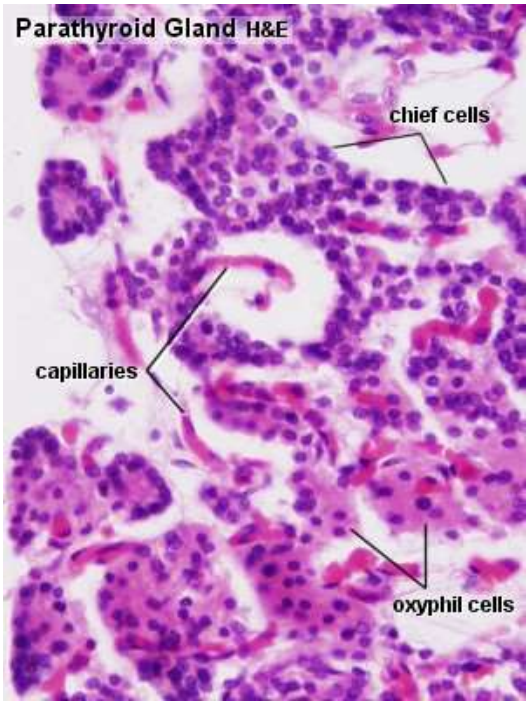
Two cell types can be distinguished in the parathyroid glands:

1. *Chief cells* are the most numerous type. They are rather small, a round, light and centrally placed nucleus and a very weakly acidophilic cytoplasm. They synthesise *parathyroid hormone* (PTH or parathormone) which is of pivotal importance for normal calcium concentrations in the fluids and tissues of the body.
2. *Oxyphilic cells* are less frequent (entirely lacking in small children; occurring first in children six to seven years old and afterwards increasing in number with age - funny enough they have so far only been demonstrated in Rhesus monkey, the ox and, of course, humans). Their cytoplasm is strongly acidophilic, the nucleus is small and uniformly intense basophilic. They contain large amounts of mitochondria.

There are plenty of transitional cells, i.e. cells that morphologically represent transitions between chief cells and oxyphilic cells.

Parathyroid gland, human - H&E





Find the parathyroid glands. The glands are small and usually occupy only a small fraction of the tissue on the slide. Identify chief cells and oxyphilic cells.

INSTRUCTION : In the laboratory, draw a part of the tissue in which both cell types are both visible. Include if possible some of the fat cells which may occupy a large part of the parenchyma of the parathyroid. . Label your drawing and give an explanation of your drawing

E. ADRENAL GLANDS

The adrenal glands produce a variety of hormones including adrenaline and the steroids aldosterone and cortisol. The adrenal glands consist of an outer *cortex* (the main part of the adrenal glands) and an inner *medulla* (which accounts for about 10% of the adrenal glands).

Cortex

The cortex is divided into three concentric zones :

a. *Zona glomerulosa* (accounting for about 15% of the cortical thickness)
b. *Zona fasciculata* (about 75%)
c. *Zona reticularis*(about 10%).

1. Cells of the zona glomerulosa are organised into small rounded groups or curved columns. Cells are smaller than in the two other zones, their nuclei are dark and round, and the cytoplasm is light basophilic. *The zona glomerulosa is not influenced by ACTH*.
2. The zona fasciculata consists of radially arranged cell cords separated by fenestrated sinusoid capillaries. The nucleus is light and typically located centrally. The cytoplasm is also light and often has a characteristic foamy or spongy appearance (lipid droplets in the cytoplasm extracted during tissue processing) - they are for this reason also called spongiocytes.
3. Anastomosing cell chords separated by sinusoid spaces form the zona reticularis. Cells are typically smaller than in the zona fasciculata. Their cytoplasm is eosinophilic and less spongy than that of other cells in the cortex. The nucleus is rather light and large. Lipofucsin, a pigment, accumulates in the cells with age.

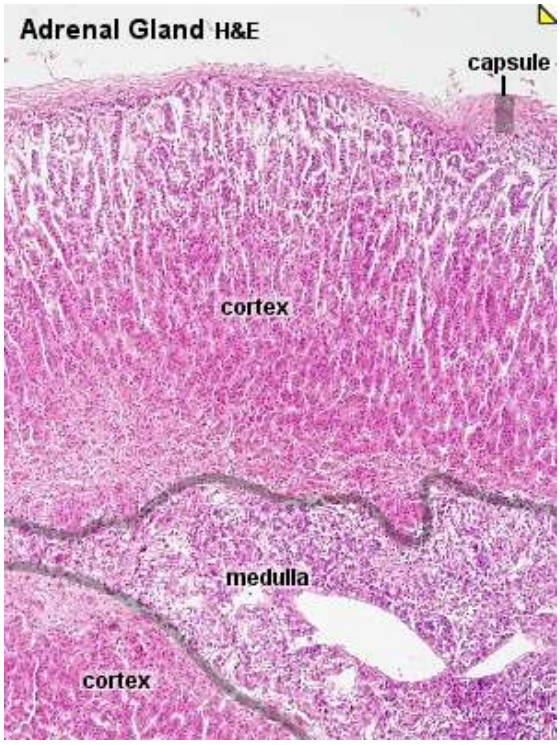
These accumulations have an orange tinge in H&E stained preparations.

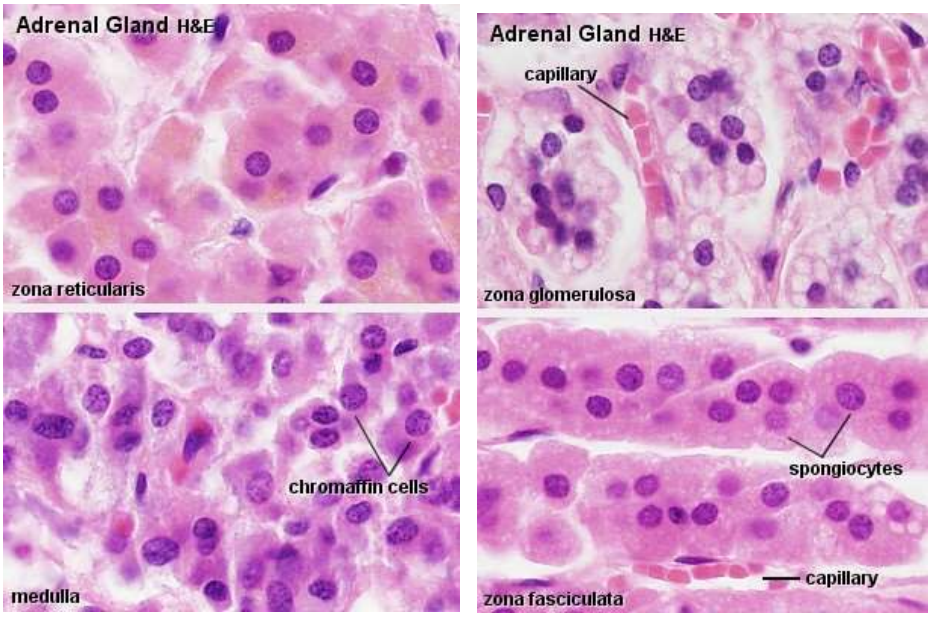
Both the zona fasciculata and zona reticularis depend on ACTH to sustain their function and survival.

Medulla

This region of the adrenal glands contains basophilic staining cells, with a granular cytoplasm and no stored lipid. It also contains many venous channels which drain blood from the sinusoids of the cortex, pass through the medulla, and drain into the medullary vein.

This is because these cells are actively secreting the peptide based hormones - nor-**adrenaline** and **adrenalin** (catecholamines), which are stored in the granules.



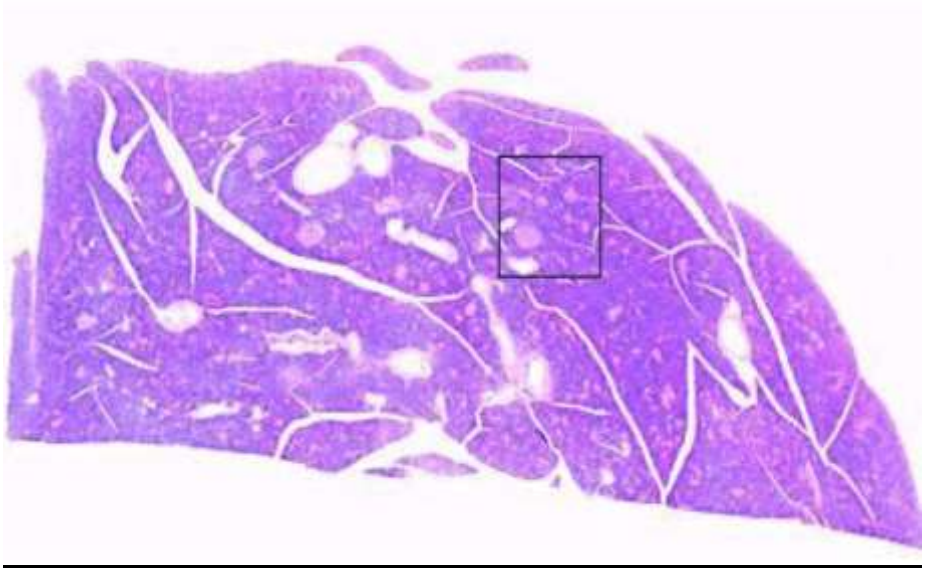


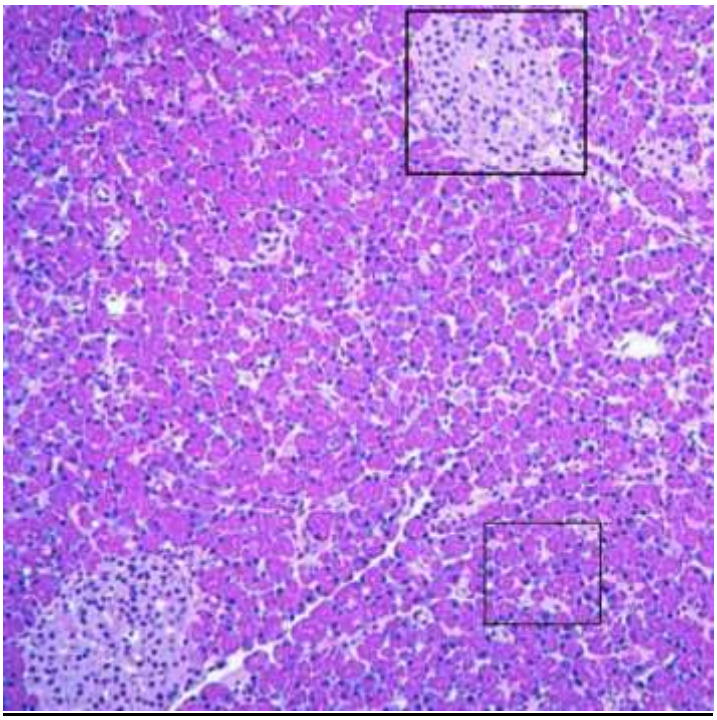
Try to find a transect through the adrenal gland where you can see all three zones of the cortex and, if possible, also a bit of the medulla. Note that the relative thickness of the cortical zones may vary. It is not always possible to identify the adrenal medulla beneath the cortex. In addition to chromaffin cells you may find ganglion cells, sometimes in small clusters, in the medulla. They can be recognized by the "typical" ganglion cell nucleus - LARGE, light and with a distinct nucleolus.

INSTRUCTION : Draw and label a transect of the adrenal gland which contains the three zones and the medulla. Give label to your drawing and give an explanation

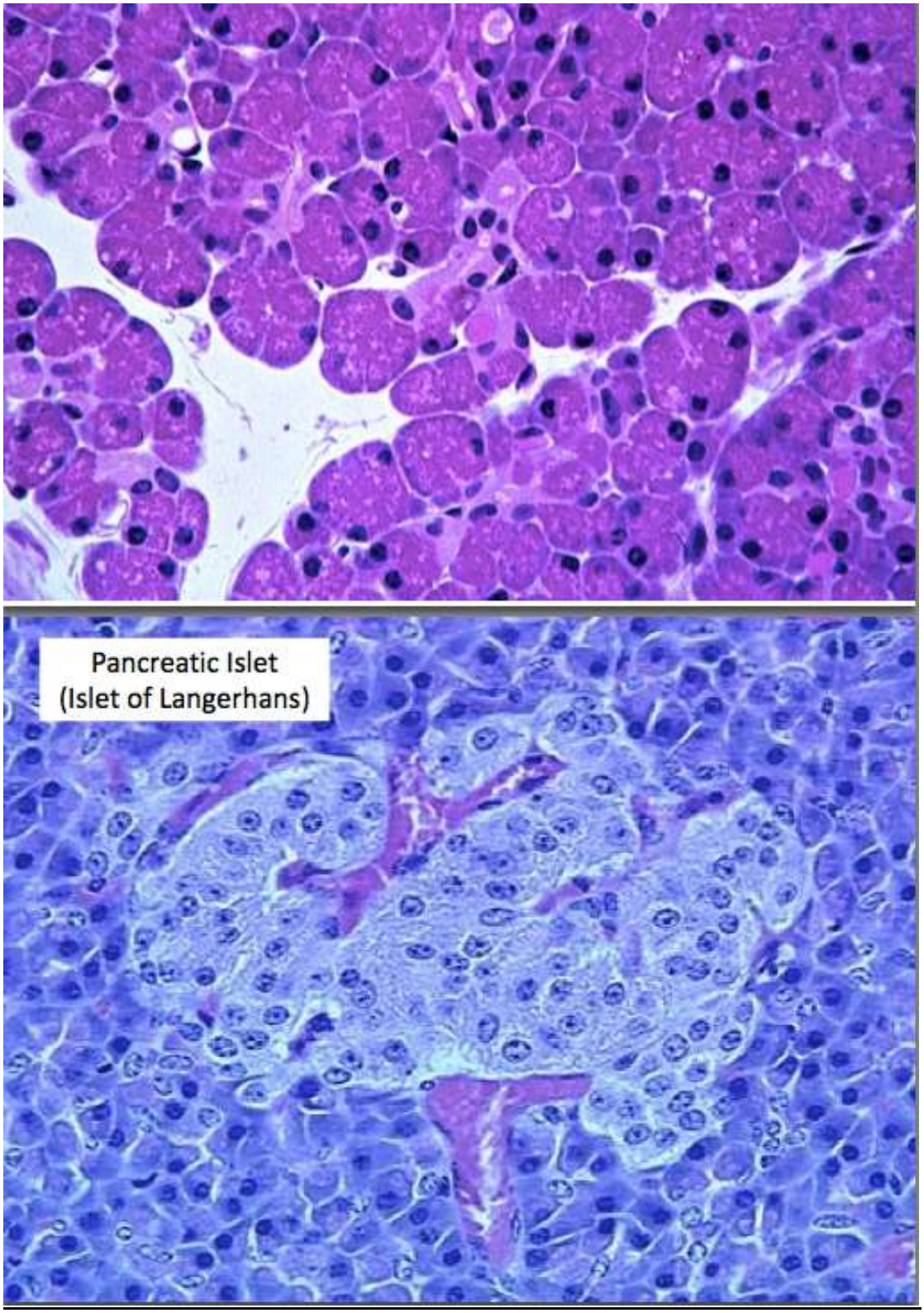
F. PANCREAS

Pancreatic islets (or islets of Langerhans) are 'islands' of endocrine cells located within the pancreas. They secrete hormones (insulin and glucagon) important in regulation of glucose in the blood.



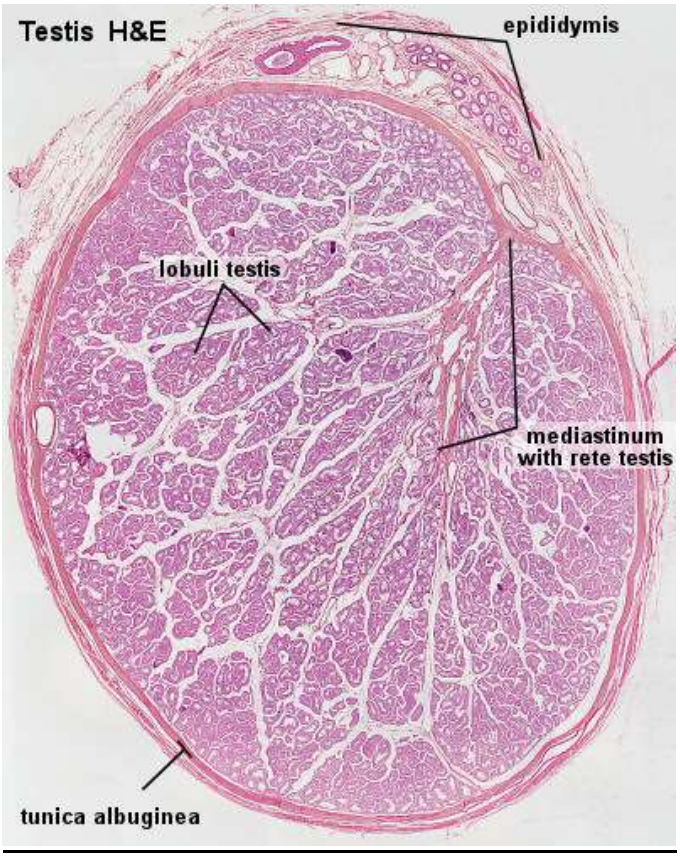


INSTRUCTION : Try to find pancreatic islet and pancreatic acini on low magnification, swith to high magnification and draw each structure you find. Give label to your drawing and give an explanation

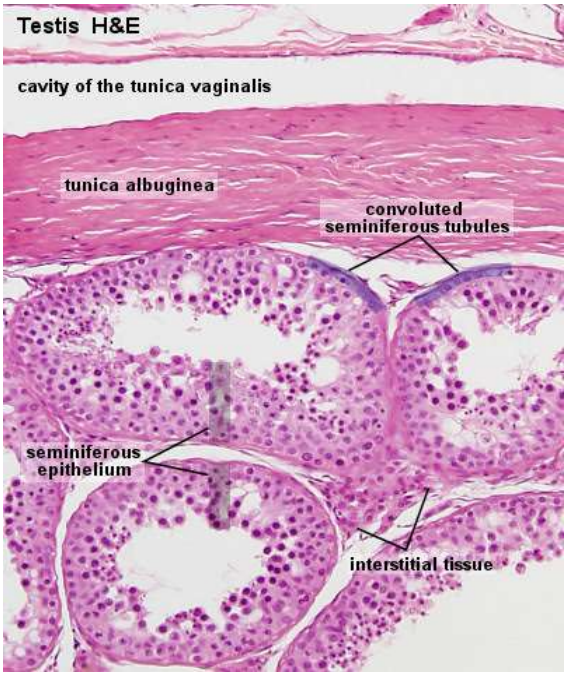

Pancreatic Islet
(Islet of Langerhans)

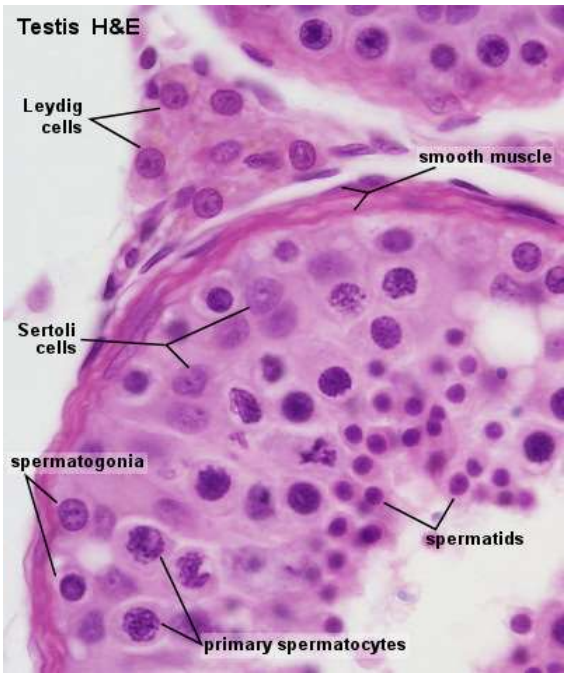
G. TESTES

Use the lowest magnification available. Identify the capsule and the connective tissue septa extending from it. Identify lobules, convoluted seminiferous tubules and clusters of interstitial cells. The mediastinum testis and rete testis are not visible in all sections.



Then change it to high magnification, Find a nice seminiferous tubule and identify smooth muscle cells that surround the tubule, spermatogonia, primary spermatocytes and spermatids. Look at different tubules to see different stages of spermio- and spermatogenesis. Identify Sertoli cells and Leydig cells.

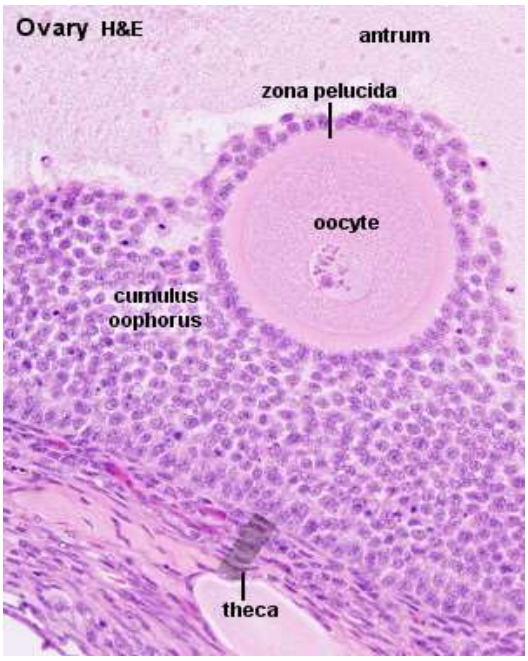


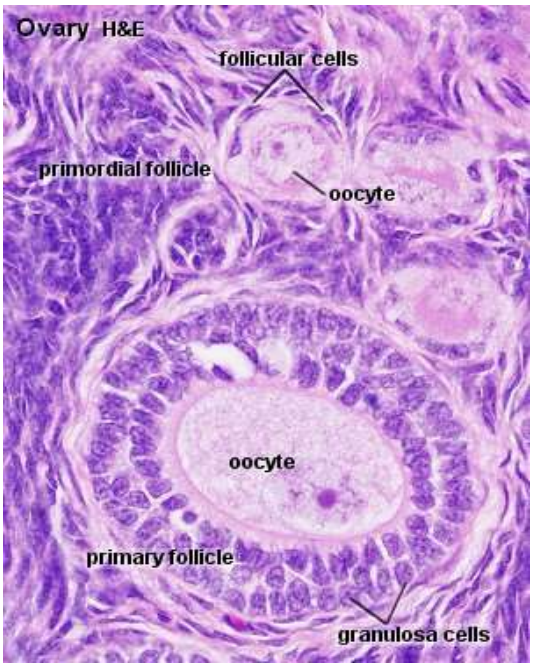


H. OVARY

Identify cortex and medulla at low magnification and verify the presence of large numbers of blood vessels in the medulla. Now have a look at the cortex at medium/high magnification. Identify the cuboidal epithelium covering the ovary and the underlying tunica albuginea. Find a part of the cortex where you can observe primordial, primary and secondary follicles.

Draw this section of the cortex with its follicles, the surrounding theca (if present), connective tissue stroma, tunica albuginea and epithelium.





PENGANTAR PRAKTIKUM

NERVOUS SYSTEM

Dosen pengampu : dr. Dewi Jantika Djuarna Sp.PA & dr. Zahra Nurusshofa, Sp.PA

The human nervous system is by far the most complex system in the body histologically and physiologically and is formed by a network of many billion nerve cells (**neurons**), all assisted by many more supporting **glial cells**. Each neuron has hundreds of interconnections with other neurons, forming a very complex system for processing information and generating responses. Nerve tissue is distributed throughout the body as an integrated communications network. Anatomists divide the nervous system into the following:

- **Central nervous system (CNS)**, consisting of the brain and spinal cord
- **Peripheral nervous system (PNS)**, composed of the cranial, spinal, and peripheral nerves conducting impulses to and from the CNS (motor and sensory nerves respectively) and **ganglia** which are small groups of nerve cells outside the CNS

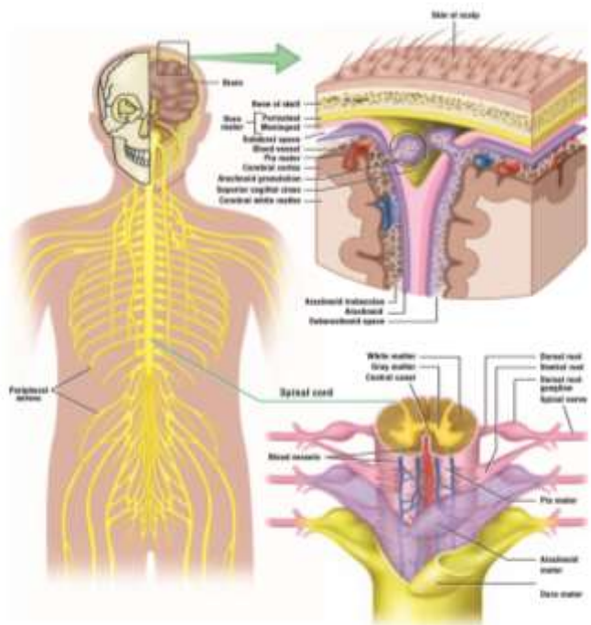


Figure. Central Nervous System

Neurons

The functional unit in both the CNS and PNS is the neuron or nerve cell. Most neurons consist of three parts (Figure): the **cell body,** or **perikaryon**, which is the synthetic or trophic center for the entire nerve cell and is receptive to stimuli; the **dendrites,** many elongated processes specialized to receive stimuli from the environment, sensory epithelial cells, or other neurons; and the **axon** (Gr. *axon*, axis), which is a single process specialized in generating and conducting nerve impulses to other cells (nerve, muscle, and gland cells). Axons may also receive information from other neurons, information that mainly modifies the transmission of action potentials to those neurons. The distal portion of the axon is usually branched as the **terminal arborization.** Each

branch terminates on the next cell in dilatations called **end bulbs** (**boutons**), which interact with other neurons or nonnerve cells at structures called **synapses.** Synapses initiate impulses in the next cell of the circuit

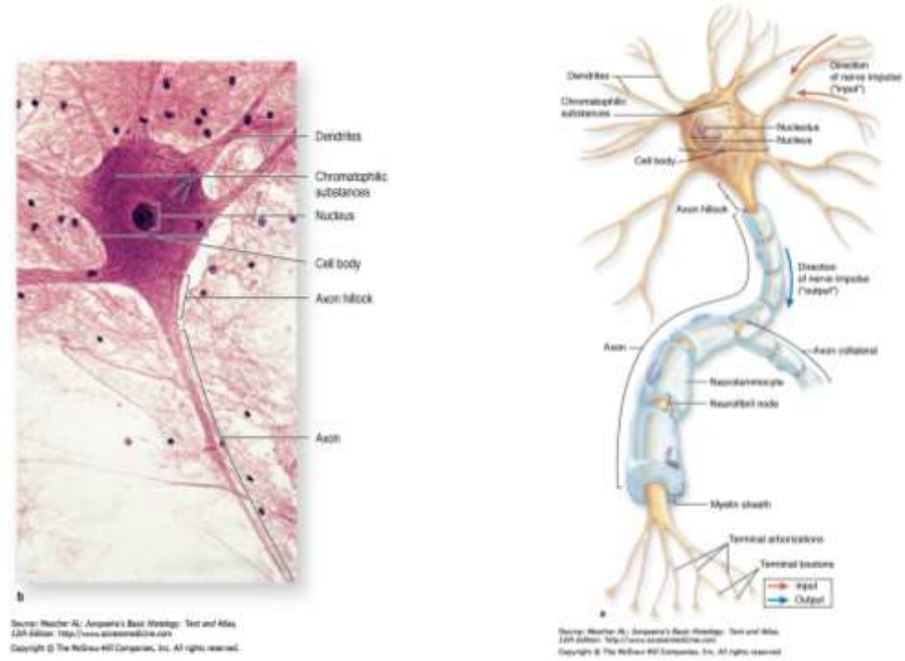
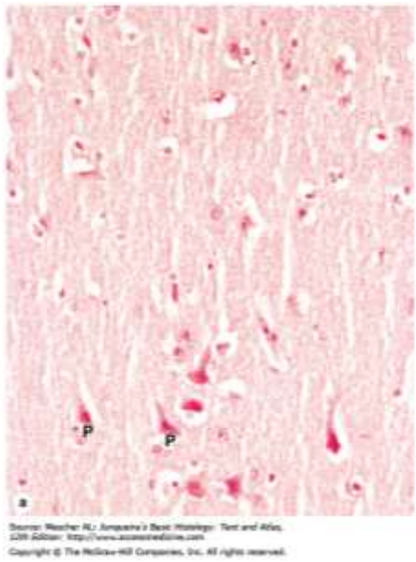


Figure. Histology and illustration of neuron cells.

In this laboratory activity, we will learn nervous system in Cerebrum and Cerebellum

A. <u>CEREBRUM</u>



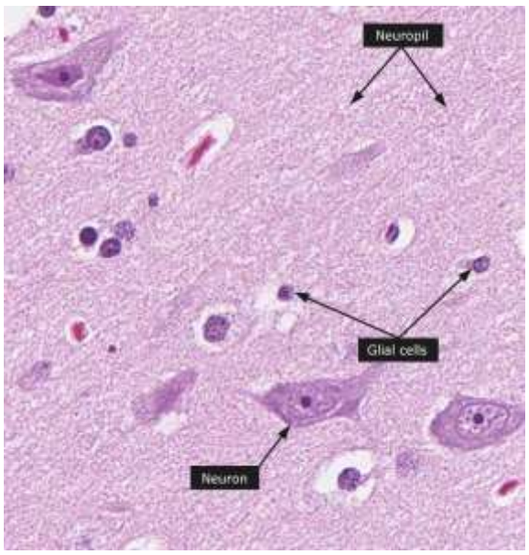
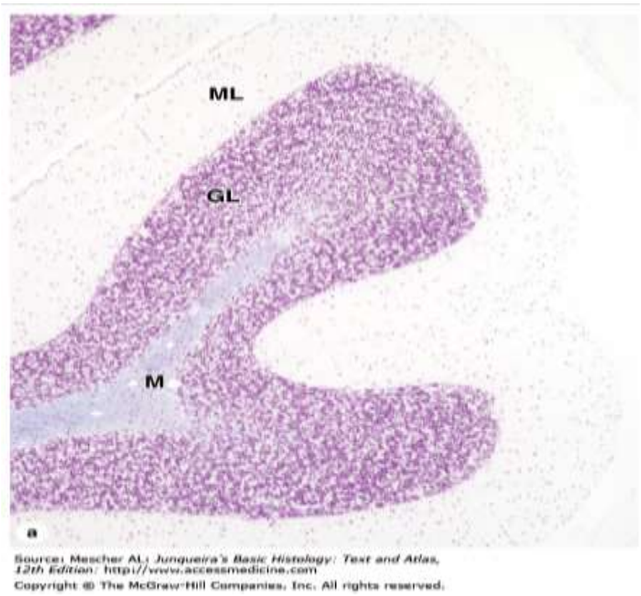
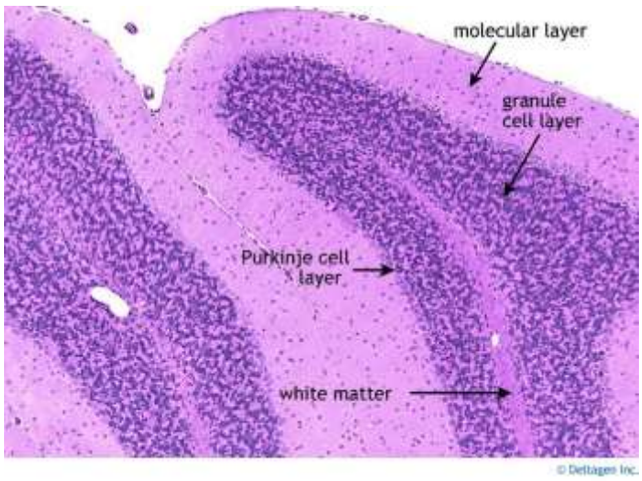


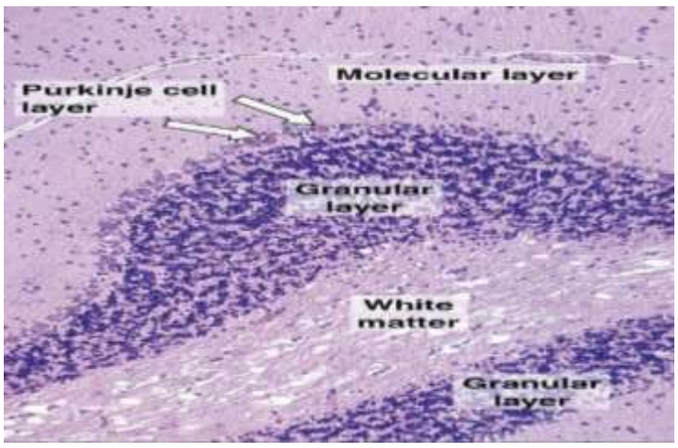
Figure. Cerebral cortex. Important neurons of the cerebrum are pyramidal neurons (P), which are arranged vertically and interspersed with numerous glial cells in the eosinophilic neuropil. X200. x400 H&E.

INSTRUCTION : Try to identify cerebral cortex tissue on low magnification, switch to high magnification and draw each structure you find. Give label to your drawing and give an explanation

CEREBELLUM







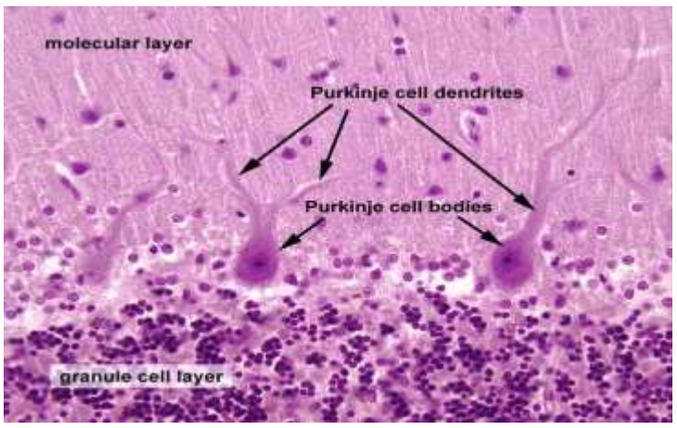


Figure. Cerebellum. Immediately surrounding the white matter of the medulla is the granular layer of the cortex, which is densely packed with very small, rounded neuronal cell bodies. The outer, "molecular layer" consists of neuropil with fewer, more scattered small neurons. X200. H&E. At the interface between the granular and molecular layers is a single layer with very large neuronal cell bodies of unique Purkinje cells, whose axons pass through the granular layer to join tracts in the medulla and whose multiple branching dendrites ramify throughout the molecular layer. X400. H&E.

INSTRUCTION : Try to identify cerebellum tissue on low magnification, switch to high magnification and draw each structure you find. Give label to your drawing and give an explanation

PENGANTAR PRAKTIKUM

SPECIAL SENSE ORGAN

Dosen pengampu : dr. Dewi Jantika Djuarna Sp.PA & dr. Zahra Nurusshofa, Sp.PA

Information about the external world is conveyed to the central nervous system from sensory **receptors.**

- Chemoreceptor units for the senses of taste and smell are tongue and nose
- Mechanoreceptors that mediate the sense of touch in its various components was found in skin.
- The systems responsible for vision via photoreceptors of the eye and for the senses of equilibrium and hearing that involve mechanoreceptors in the vestibulocochlear apparatus of the ear.

In this laboratory activity, we will learn Special Sense Organ in Human Body:

A. Eye

B. Ear

C. Skin

D. Tongue

E. Nose

A. EYE

The **eye** is a complex and highly developed photosensitive organ that analyses the form, intensity, and color of light reflected from objects, providing the sense of sight. The eyes are located in protective areas of the skull, the **orbits**, which also contain cushions of adipose tissue. Each eyeball includes a tough, fibrous globe to maintain its shape, a system of transparent tissues that refract light to focus the image, a layer of photosensitive cells, and a system of neurons whose function it is to collect, process, and transmit visual information to the brain. Each eye is composed of three concentric tunics or layers: a tough external layer consisting of the **sclera** and the **cornea;** a more vascular middle layer consisting of the **choroid, ciliary body,** and **iris;** and an inner sensory layer, the **retina,** which consists of an outer pigmented epithelium and an inner retina proper. The photosensitive inner layer of the retina communicates with the cerebrum through the **optic nerve** on the eye's posterior side; its anterior edge is called the **ora serrata**.

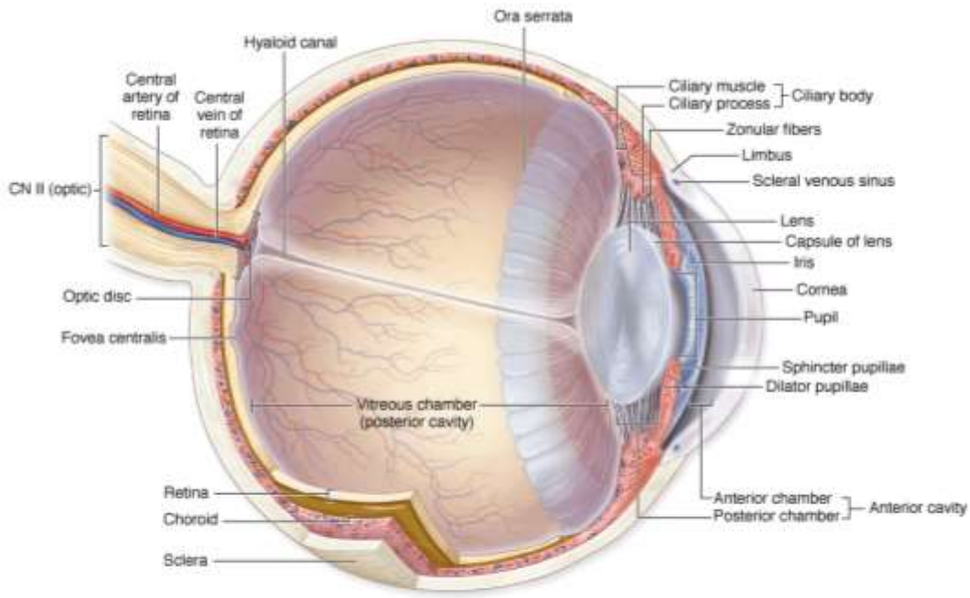
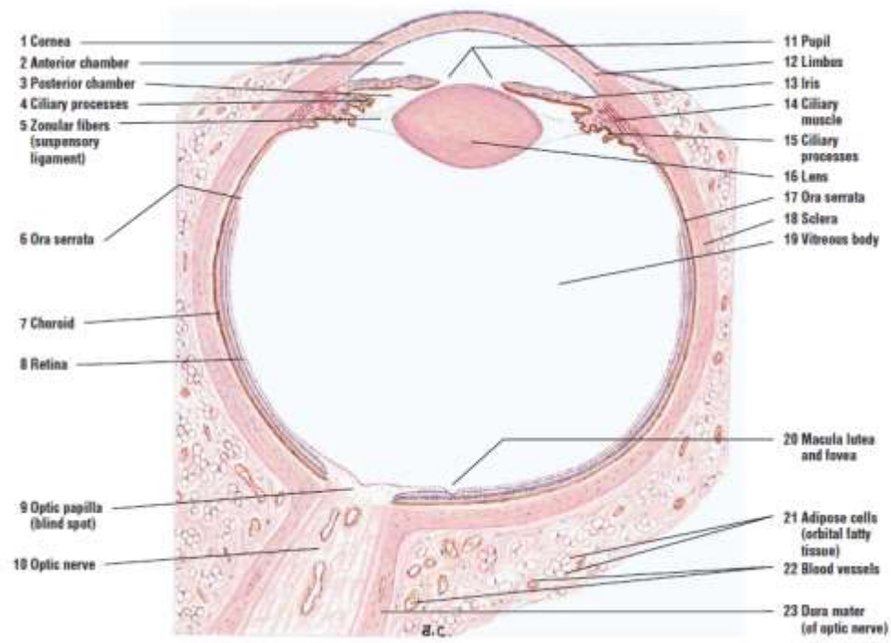


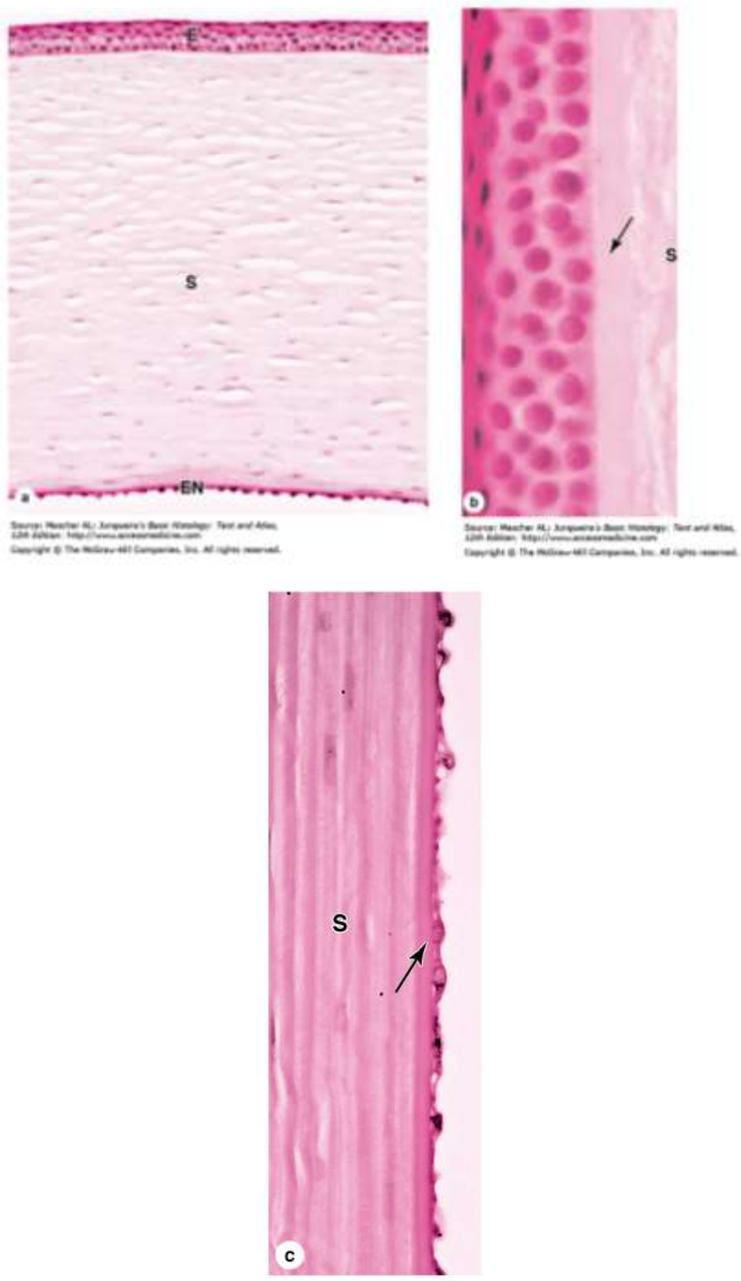
Figure. The sagittal section of an eye shows the inter-relationships among the major ocular structures, the three major layers or tunics of the wall, important regions within those layers and the refractive elements (cornea, lens, and vitreous).



The anterior structure of the eye, the cornea has five layers. **(a):** The micrograph shows the external stratified squamous epithelium (E), which is nonkeratinized and five or six cells thick. It is densely supplied with sensory free nerve endings that trigger the blinking reflex and its surface is covered with a tear film produced by glands in the eyelids and superior orbit. The stroma (S) comprises approximately 90% of the cornea's thickness, consisting of some 60 layers of long type I collagen fibers arranged in a precise orthogonal array and alternating with flattened cells called keratocytes. The stroma is lined internally by endothelium (EN). X100. H&E. **(b):** The corneal epithelium rests firmly on

the thick homogeneous Bowman's membrane (arrow). The stroma is completely avascular and nutrients reach the keratocytes and epithelial cells by diffusion from the surrounding limbus and aqueous humor behind the cornea. X400. H&E. **(c):** The posterior surface of the cornea is covered by simple squamous epithelium (endothelium) that rests on another thick, strong layer of collagen and other extracellular material called Descemet's membrane (arrow). Na/K ATPase of the endothelial cells is responsible for pumping Na^+ and drawing water out of the cornea, maintaining its proper state of hydration. In this state the cornea is perfectly transparent and with its curvature is a major refractive structure of the eye. X400. H&E.

Cornea.



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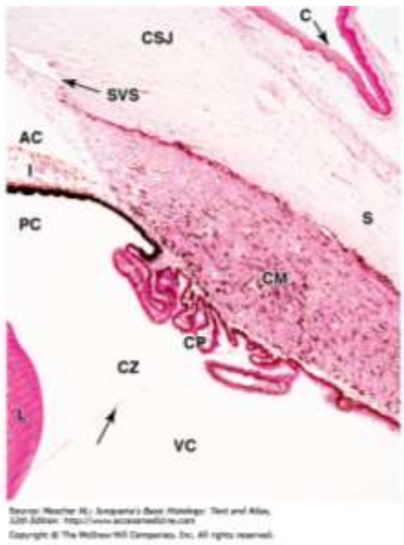


Figure. Corneoscleral junction (limbus) and ciliary body.

At the circumference of the cornea is the limbus or corneoscleral junction (CSJ), where the transparent corneal stroma merges with the opaque, vascular sclera (S). The epithelium of the limbus is slightly thicker than the corneal epithelium, containing stem cells for the latter, and is continuous with the conjunctive (C) covering the anterior part of the sclera and lining the eyelids. The stroma of the limbus contains the scleral venous sinus (SVS), or canal of Schlemm, which receives aqueous humor from an adjacent trabecular meshwork at the surface of the anterior chamber (AC). Internal to the limbus, the middle layer of the eye consists of the ciliary body and its anterior extension, the iris (I). The thick ring of the ciliary body includes loose connective tissue containing melanocytes, smooth ciliary muscle (CM), numerous extensions covered by epithelium called the ciliary processes (CP), and the ciliary zonule (CZ), a system of fibrillin-rich fibers that attach to the capsule of the lens (L) in the center of the ciliary body.

Pieces of one zonular fiber can be seen (arrow). Projecting into the posterior chamber (PC), the ciliary processes produce aqueous humor which then flows into the anterior chamber through the pupil. Changes in tension on the zonular fibers produced by contraction and relaxation of the ciliary muscles change the shape of the lens and allow visual accommodation. Behind the ciliary zonule and lens a thin, transparent membrane (not shown) surrounds the vitreous body and separates the posterior chamber from the vitreous chamber (VC). X12.5. H&E.

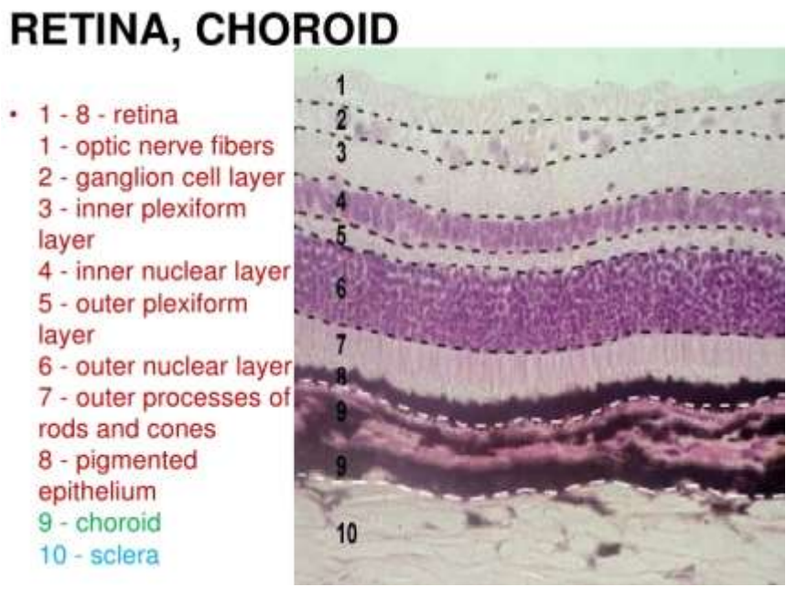
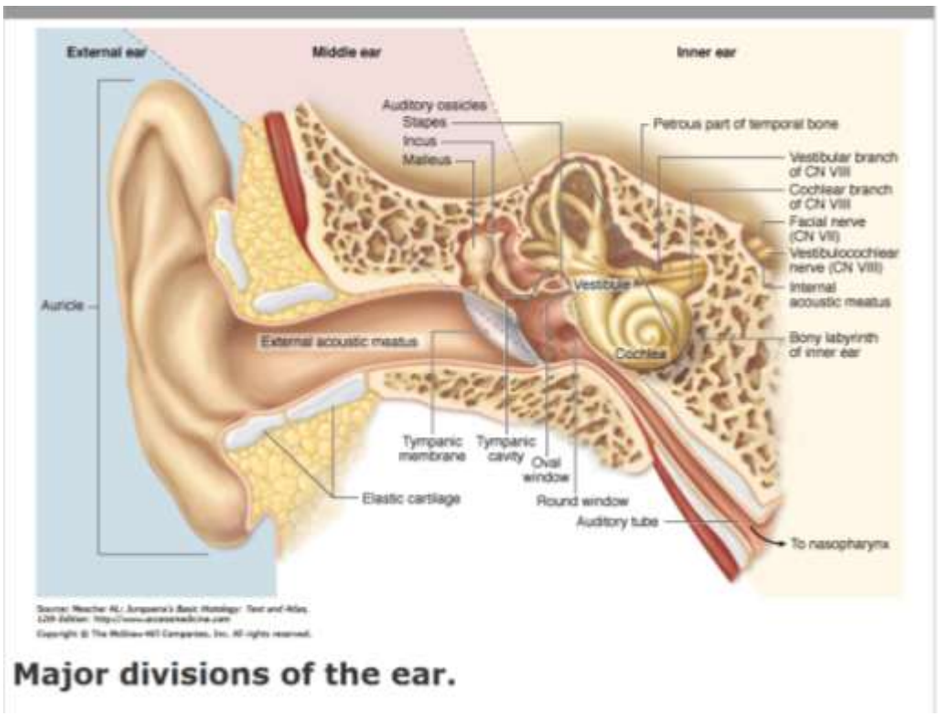


Figure. Sclera, choroid, and retina.

INSTRUCTION : Try to identify ear structure on low magnification, switch to high magnification and draw each structure you find. Give label to your drawing and give an explanation, particularly retina, choroid, and sclera

B. EAR

The functions of the ear are related to both maintaining equilibrium and hearing. Ears consist of three major parts: the **external ear**, which receives sound waves; the **middle ear**, in which sound waves are transmitted from air to fluids of the internal ear via a set of small bones; and the **internal ear,** in which these fluid movements are transduced to nerve impulses that pass via the acoustic nerve to the CNS. In addition to the auditory organ, the internal ear also contains the vestibular organ which allows the body to maintain equilibrium.



Major divisions of the ear.

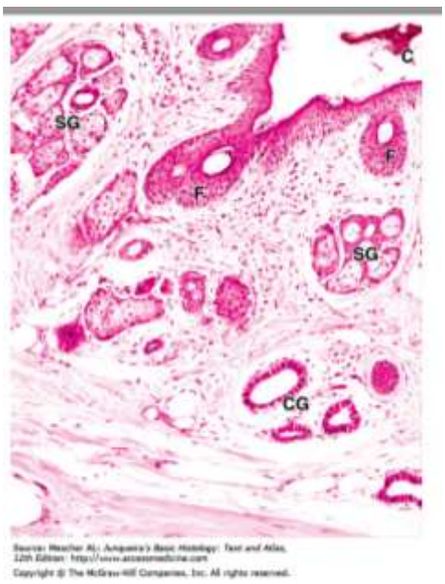


Figure External acoustic meatus

The external acoustic meatus leads from the opening in the auricle to the tympanic membrane (eardrum). This section of the wall in the outer third of the acoustic meatus shows the lining of skin containing small hair follicles (F), sebaceous glands (SG), and modified apocrine sweat glands called ceruminous glands (CG). Secretions from these two glands form a yellowish, oily or waxy product called cerumen (C), which contains antimicrobial factors that help make the meatus uninviting for microorganisms. X50. H&E.

INSTRUCTION : Try to identify external acoustic meatus structure on low magnification, switch to high magnification and draw each structure you find. Give label to your drawing and give an explanation

C. SKIN

The skin is the largest single organ of the body, typically accounting for 15–20% of total body weight and, in adults, presenting 1.5–2 m^2 of surface to the external environment. Also known as the **integument** (L. *integumentum*, covering) or **cutaneous layer**, the skin is composed of the **epidermis,** an epithelial layer of ectodermal origin, and the **dermis,** a layer of mesodermal connective tissue. The junction of dermis and epidermis is irregular, and projections of the dermis called **papillae** interdigitate with evaginations of the epidermis known as **epidermal ridges**. Epidermal derivatives include hairs, nails, and sebaceous and sweat glands. Beneath the dermis lies the **subcutaneous tissue** or **hypodermis** (Gr. *hypo,* under, + *derma,* skin), a loose connective tissue that may contain pads of adipocytes. The subcutaneous tissue binds skin loosely to the underlying tissues and corresponds to the superficial fascia of gross anatomy.

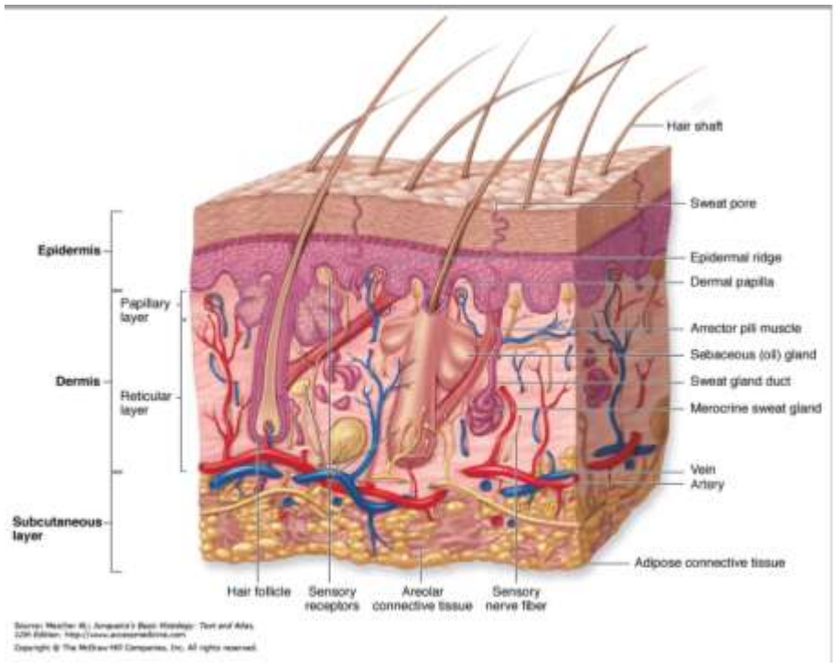
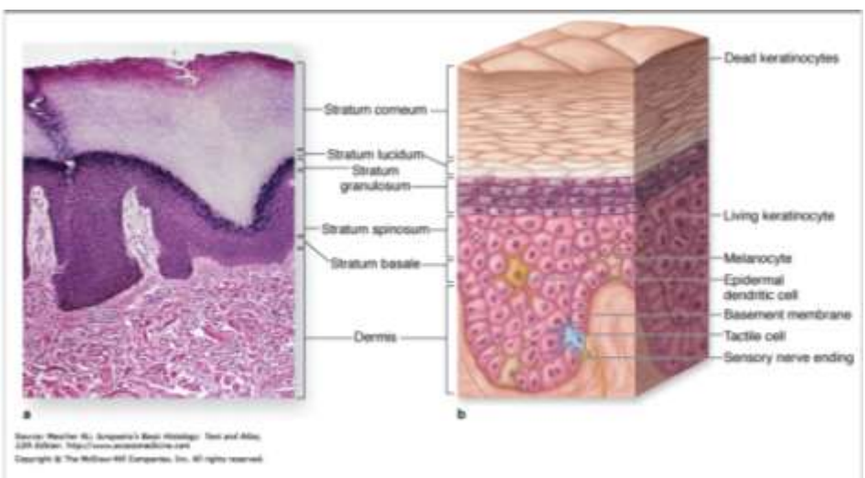


Figure. Diagram of skin layers shows their interrelationships and the locations of the epidermal appendages (hair follicles, sweat and sebaceous glands), the vasculature, and the major sensory receptors.



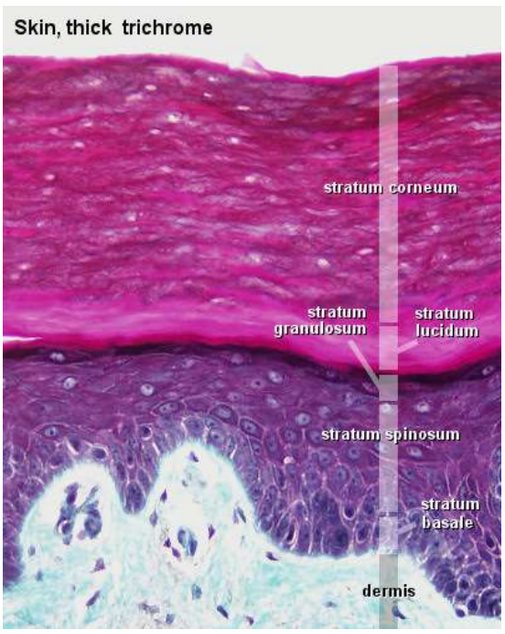


Figure. Epidermis

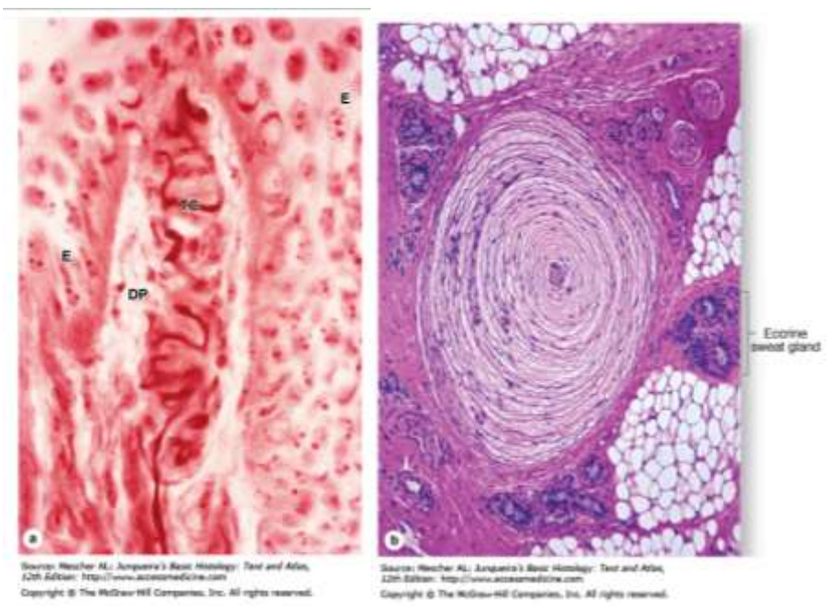


Figure .Tactile and lamellated corpuscles.

Micrographs showing the two most commonly seen sensory receptors of skin. **(a):** Tactile (Meissner) corpuscle. X400. H&E. **(b):** Lamellated (Pacinian) corpuscle. X40. H&E. Tactile corpuscles (TC) are specialized to detect light touch and are frequently located in dermal papillae (DP), very close to the epidermis (E). They are elliptical in shape, approximately 150 μm long, with an outer capsule (from the perineurium) and thin, stacked inner layers of modified Schwann cells, around which course several nerve fibers.

Lamellated corpuscles detect coarse touch or pressure and are much larger oval structures, frequently 1 mm in length, found deep in the reticular dermis near the subcutaneous tissue. Here the outer connective tissue capsule surrounds 15 to 50 thin, concentric layers of modified Schwann cells, each separated by

slightly viscous interstitial fluid. Several axons enter one end of the corpuscle and lie in the cylindrical, inner core of the structure. Movement or pressure of this corpuscle from any direction displaces the inner core, leading to a nerve impulse.

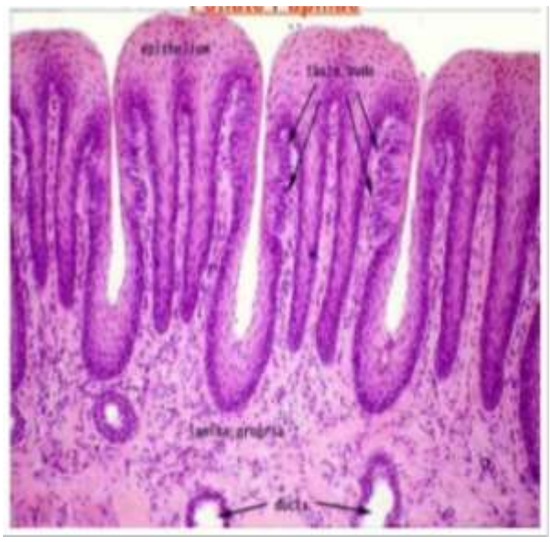
The following *encapsulated* receptors are tactile mechanoreceptors:

- **Tactile corpuscles** (also called **Meissner corpuscles**) are elliptical structures, about 30–75 μm by 150 μm, perpendicular to the epidermis in the dermal papillae (Figure a) and papillary layer of the fingertips, palms and soles. They detect light touch.
- **Lamellated (Pacinian) corpuscles** are large oval structures, approximately 0.5 mm by 1 mm, found deep in the reticular dermis or hypodermis, with an outer capsule and 15 to 50 thin, concentric lamellae of flat Schwann-type cells and collagen surrounding a highly branched, unmyelinated axon (Figure b). Lamellated corpuscles are specialized for sensing coarse touch, pressure (sustained touch), and vibrations, with distortion of the capsule amplifying a mechanical stimulus to the axonal core where an impulse is initiated.
- Krause corpuscles and Ruffini corpuscles are other encapsulated, pressure-sensing mechanoreceptors in dermis, but are more poorly characterized structurally

INSTRUCTION : Try to identify skin structure on low magnification, switch to high magnification and draw each structure you find. Give label to your drawing and give an explanation

D. <u>TONGUE</u>

Foliate papillae are poorly developed in adults, but consist of parallel ridges and furrows on the sides of the tongue, with taste buds.



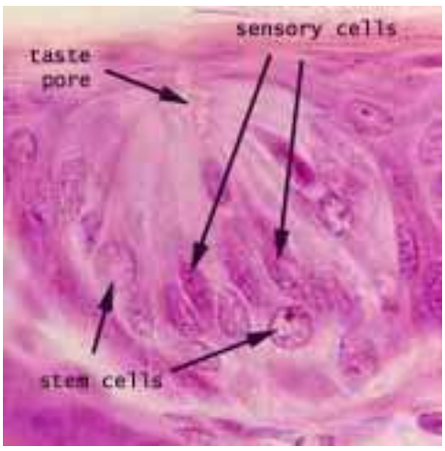


Figure. Tongue and taste bud

INSTRUCTION : Try to identify Foliate Papillae structure on low magnification, switch to high magnification and draw each structure you find. Give label to your drawing and give an explanation, particularly taste bud structure

E. NOSE

The olfactory chemoreceptors are located in the **olfactory epithelium**, a specialized region of the mucous membrane covering the superior conchae at the roof of the nasal cavity. In humans, it is about 10 cm^2 in area and up to 100 μm in thickness. It is a pseudostratified columnar epithelium composed of three types of cells:

- **Basal cells** are small, spherical or cone-shaped and form a layer at the basal lamina. They are the stem cells for the other two types.
- **Supporting cells** are columnar, with broad, cylindrical apexes and narrower bases. On their free surface are microvilli submerged in a fluid layer. Well-developed junctional complexes bind the supporting cells to the adjacent olfactory cells. The supportive role of these cells is not well-understood, but they express abundant ion channels whose function appears to be required to maintain a microenvironment conducive to olfactory function and survival.
- **Olfactory neurons** are bipolar neurons present throughout this epithelium. They are distinguished from supporting cells by the position of their nuclei, which lie between those of the supporting cells and the basal cells. The dendrite end of each olfactory neuron is the apical (luminal) pole of the cell and has a knoblike swelling with about a dozen basal bodies. From the basal bodies emerge long nonmotile cilia with defective axonemes but a considerable surface area for membrane chemoreceptors. These receptors respond to odoriferous substances by generating an action potential along the (basal) axons of these neurons, which leave the epithelium and unite in the lamina propria as very small nerves which then pass through foramina in the cribriform plate of the ethmoid bone to the

brain. There they form cranial nerve I, the olfactory nerve, and eventually synapse with other neurons in the olfactory bulb.

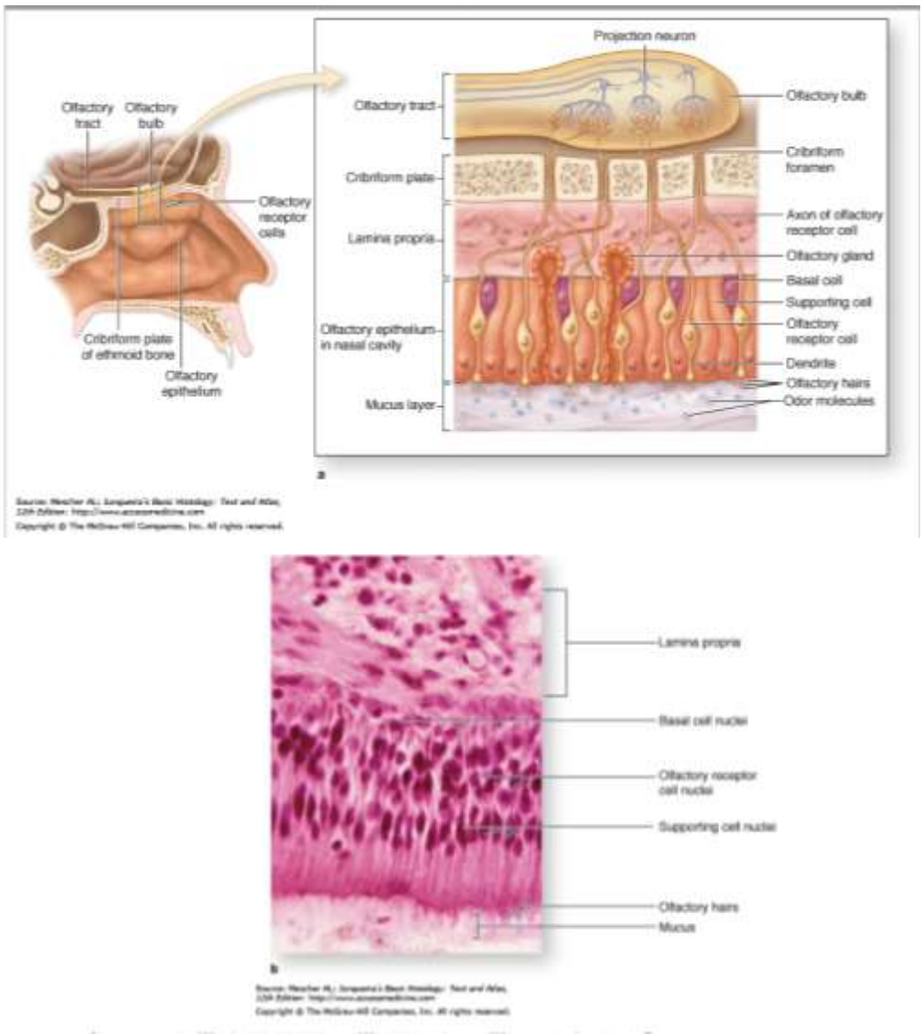


Figure. Olfactory epithelium.

(a, b): The olfactory epithelium covers the superior conchae bilaterally and sends axons from throughout its entire 10 cm^2 area to the brain via small openings in the cribriform plate of the ethmoid bone. It is a pseudostratified epithelium, containing basal stem cells and columnar support cells in addition to the bipolar olfactory neurons. The dendrites of these neurons are at the luminal ends and have cilia specialized with many membrane receptors for odor molecules. Binding such ligands causes depolarization which passes along basal axons to the olfactory bulb of the brain X200. H&E.

INSTRUCTION : Try to identify Pseudostratified epithelium structure on low magnification, switch to high magnification and draw each structure you find. Give label to your drawing and give an explanation.

III.FISIOLOGI

PRAKTIKUM I:

FISIOLOGI SISTEM SARAF TEPI

PRAKTIKUM II:

FISIOLOGI SISTEM INDRA

PERCOBAAN SISTEM SARAF TEPI

A. LANDASAN TEORI

a) Sistem saraf

Sistem saraf adalah salah satu dari dua sistem regulatorik utama tubuh; yang lainnya adalah sitem endokrin. Sel-sel peka rangsang pada sistem saraf dibentuk oleh anyaman interaktif kompleks tiga tipe fungsional dasar sel saraf neuron aferen, neuron eferen dan antarneuron. Dalam mekanisme sistem saraf, lingkungan internal dan stimulus eksternal dipantau dan diatur. Kemampuan khusus seperti iritabilitas, atau sensitivitas terhadap stimulus, dan konduktivitas, atau kemampuan untuk mentransmisi suatu respons terhadap stimulasi, diatur oleh sistem saraf dalm tiga cara utama:

1. **Input sensorik**. sistem saraf menerima sensasi atau stimulus melalui reseptor, yang terletak di tubuh baik eksternal (reseptor somatik) maupun internal (reseptor otonom).
2. **Aktivitas integratif**. Reseptor mengubah stimulus menjadi implus listrik yang menjalar di sepanjang sistem saraf sampai ke otak dan medulla spinalis, yang kemudian akan menginterpretasi dan mengintegrasi stimulus, sehingga respons terhadap informasi bisa terjadi.
3. **Output motorik**. Impuls dari otak dan medulla spinalis memperoleh respons yang sesuai dari otot dan kelenjar tubuh, yang disebut sebagai efektor.

Sistem saraf tersusun menjadi Susunan Saraf Pusat (SSP), yang terdiri dari otak atau medula spinalis, dan Susunan Saraf Tepi (SST), yang terdiri dari serat-serat saraf yang membawa informasi antara SSP dan bagian tubuh lain (perifer). SST dibagi lagi menjadi divisi aferen dan eferen. Divisi aferen membawa informasi ke SSP, memberi tahu tentang lingkungan eksternal dan aktivitas internal yang sedang diatur oleh susunan saraf (*a* berasal dari *ad*, yang berarti "menuju", *feren* berarti "membawa"; karena itu *aferen* artinya "membawa ke").instruksi dari SSP disalurkan melalui divisi eferen ke organ-organ efektor otot atau kelenjar yang melaksanakan perintah agar dihasilkan efek yang sesuai (*e* berasal dari *eks*, yang berarti "dari"; karena itu *eferen* berarti "membawa dari"). Sistem saraf eferen dibagi menjadi sistem saraf somatik, yang terdiri dari serat-serat neuron motorik yang menyarafi otot rangka; dan sistem saraf otonom, yang terdiri dari serat-serat yang menyarafi otot polos, otot jantung, dan kelenjar. Sistem yang terakhir ini juga dibagi menjadi sistem saraf simpatis dan

sistem saraf parasimpatis, di mana keduanya menyarafi sebagian besar organ-organ yang disarafi oleh sistem saraf otonom. Perlu diketahui bahwa semua "sistem saraf" ini sebenarnya adalah subdivisi dari satu sistem saraf terpadu. Sistem-sistem tadi telah terbagi berdasarkan perbedaan struktur, lokasi, dan fungsi berbagai bagian dari sistem saraf keseluruhan. Pada praktikum ini khususnya akan dibahas tentang Sistem Saraf Tepi (SST).

b) Sistem Saraf Tepi (SST)

Secara struktural, sistem saraf tepi vertebrata terdiri atas saraf kranial dan saraf spinal yang berpasangan. Saraf kranial (cranial nerve) berasal dari otak yang menginervasi organ kepala dan tubuh bagian atas.Saraf spinal (spinal nerve) berasal dari sumsum tulang belakang dan menginevarsi keseluruhan tubuh. Mamalia mempunyai 12 pasang saraf kranial dan 31 pasang saraf spinal. Sebagian besar saraf kranial dan semua saraf spinal mengandung neuron sensoris maupun neuron motoris; beberapa saraf kranial hanya memiliki neuron sensoris. Karena pengaturan yang kompleks dari neuron sensoris dan neuron motoris pada saraf kranial dan saraf spinal vertebrata, maka akan lebih mudah untuk membagi sistem saraf tepi menjadi hirarki komponen yang berbeda fungsi. Divisi sensoris sistem saraf tepi tersusun atas neuron sensoris atau neuron aferen yang mengirimkan informasi dari reseptor sensoris ke sistem saraf pusat yang memonitor lingkungan eksternal dan lingkungan internal. Divisi motoris tersusun atas neuron eferen yang mengirimkan sinyal dari sistem saraf pusat ke sel efektor.

Sistem saraf sadar artinya saraf yang mengatur gerakan yang dilakukan secara sadar, di bawah kesadaran. Contoh tangan bergerak karena secara sadar ingin mengambil gelas. System saraf sadar (kraniosspinal) meliputi system saraf kepala (cranial) dan system saraf tulang belakang (spinal). System saraf kepala disusun oleh 12 pasang saraf yang keluar dari otak. Saraf kepala terutama berhubungan dengan reseptor dan efektor untuk daerah kepala. Adapun ke 12 saraf tersebut meliputi:

1. Tiga pasang saraf sensori yaitu saraf nomor 1,2 dan 8
2. Lima pasang saraf motor yaitu saraf nomor 3,4.6,11 dan 12
3. Empat pasang saraf gabungan sensori dan motor yaitu saraf nomor 5, 7, 9, dan 10

Sedangkan saraf spinal disusun oleh 31 pasang saraf yang keluar dari sumsum tulang belakang. Saraf tulang punggung melayani reseptor dan efektor lain (selain reseptor dan efektor yang disarafi oleh otak). Berdasarkan asal saraf tersebut dibedakan atas 8 pasang saraf leher, 12

pasang saraf punggung, 5 pasang sarraf pinggang, 5 pasang sarf piinggul, dan satu pasang saraf ekor. Pada manusia dijumpai adanya pleksus (gabungan yaitu beberapa urat saraf bersatu membentuk jaringan urat saraf. Ada 3 macam pleksus yaitu:

1. Pleksus servikalis
   Merupakan gabungan urat saraf leher yang mempengaruhi bagian leher, bahu dan diafragma.
2. Pleksus bracchialis
   Merupakan gabungan urat saraf lengan atas yang mempengaruhi bagian tangan.
3. Pleksus lumbo sakralis
   Merupakan gabungan urat saraf punggung dan pinggang yang mempengaruhi bagian pinggul dan kaki.

Sistem saraf tepi terdiri dari sistem saraf sadar dan sistem saraf tak sadar (sistem saraf otonom). Sistem saraf sadar mengontrol aktivitas yang kerjanya diatur oleh otak, sedangkan saraf otonom mengontrol aktivitas yang tidak dapat diatur otak antara lain denyut jantung, gerak saluran pencernaan, dan sekresi keringat.

1. Sistem Saraf Sadar

Sistem saraf sadar disusun oleh saraf otak (saraf kranial), yaitu saraf-saraf yang keluar dari otak, dan saraf sumsum tulang belakang, yaitu saraf-saraf yang keluar dari sumsum tulang belakang.

2. Sistem saraf tak sadar

Sistem saraf otonom disusun oleh serabut saraf yang berasal dari otak maupun dari sumsum tulang belakang dan menuju organ yang bersangkutan. Dalam sistem ini terdapat beberapa jalur dan masing-masing jalur membentuk sinapsis yang kompleks dan juga membentuk ganglion. Urat saraf yang terdapat pada pangkal ganglion disebut urat saraf *pra ganglion* dan yang berada pada ujung ganglion disebut urat saraf *post ganglion.*

Sistem saraf otonom dapat dibagi atas sistem saraf *simpatik* dan sistem saraf *parasimpatik.* Perbedaan struktur antara saraf simpatik dan parasimpatik terletak pada posisi ganglion. Saraf simpatik mempunyai ganglion yang terletak di sepanjang tulang belakang menempel pada sumsum tulang belakang sehingga mempunyai urat *pra ganglion pendek,* sedangkan saraf parasimpatik mempunyai urat *pra ganglion* yang *panjang* karena ganglion menempel pada organ yang dibantu.

Parasimpatik	Simpatik
• mengecilkan pupil • menstimulasi aliran ludah • memperlambat denyut jantung • membesarkan bronkus • menstimulasi sekresi kelenjar pencernaan • mengerutkan kantung kemih	• memperbesar pupil • menghambat aliran ludah • mempercepat denyut jantung • mengecilkan bronkus • menghambat sekresi kelenjar pencernaan • menghambat kontraksi kandung kemih

c) Refleks

Refleks adalah setiap respon yang terjadi secara otomatis tanpa upaya sadar. Terdapat dua jenis refleks: pertma refleks sederhana atau dasar, yaitu respons inheren, tanpa dipelajari, misalnya menarik tangan dari benda panas yang membakar; dan kedua refleks didapat atau terkondisi, yang terjadi karena latihan dan belajar, misalnya seorang pemain piano yang menekan tuts tertentu setelah melihat sebuah lambang nada di buku lagunya. Musisi tersebut membaca dan memainkannya secara otomatis, namun hanya setelah latihan yang cukup intens.

Jalur-jalur saraf yang terlibat dalam melaksanakaqn aktivitas refleks dikenal sebagai lengkung refleks (arkus refleks), yang biasanya mencakup lima komponen dasar:

1. Reseptor
2. Jalur aferen
3. Pusat integrasi
4. Jalur eferen
5. Efektor

Reseptor berespons terhadap rangsangan, yaitu perubahan fisik atau kimiawi dalam lingkungan reseptor yang dapat dideteksi. Sebagai respon dari rangsangan tersebut, reseptor menghasilkan potensial aksi yang dipancarkan oleh jalur aferen ke pusat integrasi (SSP) untuk diolah. Medula spinalis dan batang otak mengintegrasikan refleks dasar, sementara pusat-pusat yang lebih tinggi di otak memproses refleks didapat. Pusat integrasi memproses informasi yang tersedia kemudian "mengambil keputusan" mengenai respon yang sesuai. Intruksi kemudian disalurkan melalui jalur eferen ke efektor otot atau kelenjar yang melaksanakan respon yang

diinginkan. Tidak seperti prilaku sadar, di mana terdapat sejumlah kemungkinan respons, respons refleks dapat diprediksi karena jalur antara reseptor dan efektor selalu sama.

B. TUJUAN PRAKTIKUM

Mempelajari cara-cara pemeriksaan refleks pada manusia dan melihat ada tidaknya gangguan pada sistem saraf tersebut.

C. ALAT DAN BAHAN

- Parfum, minyak angin, dan baby cologne
- Pensil, penggaris, atau alat tulis lainnya
- Garpu tala
- Flashlight pen

D. CARA KERJA

Praktik ini dikerjakan perkelompok, salah satu dari praktikan dipilih untuk menjadi Objek Praktikan (OP) dan teman lainnya melakukan "perlakuan" kepada OP dan mencatat hasilnya, apabila hasil yang didapatkan sama dengan yang tertera dibawah ini maka OP dapat dikatakan normal.

No.	Saraf-Saraf Otak	Perlakuan	Hasil Normal	Hasil Pengamatan Pada OP
1.	N I-N. Olfactorius	Dilakukan cara memberikan 3 odoran kepada praktikan, misalkan parfum, minyak angin, atau sesuatu yang berbau khas	OP dapat mengenali bau dari masing-masing sample yang diberikan	
2.	N II-N. Opticus	Menggerakan sebuah benda (alat tulis) ke	OP dapat mengikuti kemana arah	

		arah atas, bawah, kanan, dan kiri di depan mata OP	benda di gerakkan, maksimal 180^{o}	
3.	N III-N. Oculamatorius N IV-N. Trochealis N V-N. Abducens	Memberikan cahaya kepada mata OP sekilas Menggerakkan benda ke 8 sisi OP Cek nistagmus (menggerakan benda secara cepat dan lambat di depan OP)	Pupil mata OP akan mengecil (ukuran diperkirakan karena tidak dapat dengan jelas menghitung jarak pupil OP dapat mengikuti gerakan benda tersebut ke 8 sisi (0^{o}, 45^{o}, 90^{o}, 135^{o}, 180^{o}, 225^{o}, 270^{o}, 315^{o}) OP dapat melihat benda baik dalm keadaan cepat maupun lambat	
4.	N Vi-N. Trigeminus	OP membuka mulut, kemudian mandibula OP diketuk	Mulut OP masih sama seperti saat sebelum diketuk, apabila ada reaksi berlebih maka dikatakan tidak normal atau	

			ada gangguan	
5.	N VII-N. Facialis	OP menutup mata, dan praktikan lain mencoba membuka mata OP OP tersenyum, dilihat apakah simetris atau tidak	OP tetap menutup mata dan tidak mudah membuka, jika mudah ada gangguan Senyum OP simetris, artinya baik sisi kanan maupun sisi kiri mulut OP sama sudutnya	
6.	N VIII-N. Vestibulo-cochlearis	Garpu tala diketuk di bagian lunak, misalkan tangan. Kemudian didengarkan oleh OP	OP dapat mendengar dengan baik dan selaras (pada saat garpu tala masih bergetar dan masih terdengar, ketika berhenti bergetar, hilang juga suara getarannya)	
7.	N IX-N. Glossopharyngeus N X-N. Vagus	OP mengucapkan kata "ah"	Ketika mengucapkan kata "ah", ovula terlihat lurus	
8.	N XI-N. Accesorius	OP mengangkat bahunya sekencang mungkin, dan praktikan lainnya menekan bahu	OP tetap mempertahankan posisinya, dan tidak mudah turun dengan tekanan yang diberikan dari praktikan lain	

		OP sekuat mungkin		
9.	N XII-N. Hypoglossus	OP melipat lidah	OP dapat melipat lidahnya, membentuk U, atau bergelombang	

PERCOBAAN KESEIMBANGAN PADA MANUSIA

I. DASAR TEORI

Keseimbangan adalah kemampuan untuk mempertahankan kesetimbangan tubuh ketika di tempatkan di berbagai posisi. Definisi menurut O'Sullivan, keseimbangan adalah kemampuan untuk mempertahankan pusat gravitasi pada bidang tumpu terutama ketika saat posisi tegak. Selain itu menurut Ann Thomson, keseimbangan adalah kemampuan untuk mempertahankan tubuh dalam posisi kesetimbangan maupun dalam keadaan statik atau dinamik, serta menggunakan aktivitas otot yang minimal.

Keseimbangan juga bisa diartikan sebagai kemampuan relatif untuk mengontrol pusat massa tubuh (center of mass) atau pusat gravitasi (center of gravity) terhadap bidang tumpu (base of support). Keseimbangan melibatkan berbagai gerakan di setiap segmen tubuh dengan di dukung oleh sistem muskuloskleletal dan bidang tumpu. Kemampuan untuk menyeimbangkan massa tubuh dengan bidang tumpu akan membuat manusia mampu untuk beraktivitas secara efektif dan efisien.

Keseimbangan terbagi atas dua kelompok, yaitu keseimbangan statis : kemampuan tubuh untuk menjaga kesetimbangan pada posisi tetap (sewaktu berdiri dengan satu kaki, berdiri diatas papan keseimbangan); keseimbangan dinamis adalah kemampuan untuk mempertahankan kesetimbangan ketika bergerak.

Keseimbangan merupakan interaksi yang kompleks dari integrasi/interaksi sistem sensorik (vestibular, visual, dan somatosensorik termasuk proprioceptor) dan muskuloskeletal (otot, sendi, dan jar lunak lain) yang dimodifikasi/diatur dalam otak (kontrol motorik, sensorik, basal ganglia, cerebellum, area asosiasi) sebagai respon terhadap perubahan kondisi internal dan eksternal. Dipengaruhi juga oleh faktor lain seperti, usia, motivasi, kognisi, lingkungan, kelelahan, pengaruh obat dan pengalaman terdahulu.

Fisiologi Keseimbangan

Kemampuan tubuh untuk mempertahankan keseimbangan dan kestabilan postur oleh aktivitas motorik tidak dapat dipisahkan dari faktor lingkungan dan sistem regulasi yang berperan dalam pembentukan keseimbangan. Tujuan dari tubuh mempertahankan keseimbangan adalah : menyanggah tubuh melawan gravitasi dan faktor eksternal lain, untuk mempertahankan pusat massa tubuh agar seimbang dengan bidang tumpu, serta menstabilisasi bagian tubuh ketika bagian tubuh lain bergerak.

Komponen-komponen pengontrol keseimbangan adalah :

Sistem informasi sensoris

Sistem informasi sensoris meliputi visual, vestibular, dan somatosensoris.

a. Visual

Visual memegang peran penting dalam sistem sensoris. Cratty & Martin (1969) menyatakan bahwa keseimbangan akan terus berkembang sesuai umur, mata akan membantu agar tetap fokus pada titik utama untuk mempertahankan keseimbangan, dan sebagai monitor tubuh selama melakukan gerak statik atau dinamik. Penglihatan juga merupakan sumber utama informasi tentang lingkungan dan tempat kita berada, penglihatan memegang peran penting untuk mengidentifikasi dan mengatur jarak gerak sesuai lingkungan tempat kita berada. Penglihatan muncul ketika mata menerima sinar yang berasal dari obyek sesuai jarak pandang.

Dengan informasi visual, maka tubuh dapat menyesuaikan atau bereaksi terhadap perubahan bidang pada lingkungan aktivitas sehingga memberikan kerja otot yang sinergis untuk mempertahankan keseimbangan tubuh.

b. Sistem vestibular

Komponen vestibular merupakan sistem sensoris yang berfungsi penting dalam keseimbangan, kontrol kepala, dan gerak bola mata. Reseptor sensoris vestibular berada di dalam telinga. Reseptor pada sistem vestibular meliputi kanalis semisirkularis, utrikulus, serta sakulus. Reseptor dari sistem sensoris ini disebut dengan sistem labyrinthine. Sistem labyrinthine mendeteksi perubahan posisi kepala dan percepatan perubahan sudut. Melalui refleks vestibulo-occular, mereka mengontrol gerak mata, terutama ketika melihat obyek yang bergerak. Mereka meneruskan pesan melalui saraf kranialis VIII ke nukleus vestibular yang berlokasi di batang otak. Beberapa stimulus tidak menuju nukleus vestibular tetapi ke serebelum, formatio retikularis, thalamus dan korteks serebri.

Nukleus vestibular menerima masukan (input) dari reseptor labyrinth, retikular formasi, dan serebelum. Keluaran (output) dari nukleus vestibular menuju ke motor neuron melalui medula spinalis, terutama ke motor neuron yang menginervasi otot-otot proksimal, kumparan otot pada leher dan otot-otot punggung (otot-otot postural). Sistem vestibular bereaksi sangat cepat sehingga membantu mempertahankan keseimbangan tubuh dengan mengontrol otot-otot postural.

c. Somatosensoris

Sistem somatosensoris terdiri dari taktil atau proprioseptif serta persepsi-kognitif. Informasi propriosepsi disalurkan ke otak melalui kolumna dorsalis medula spinalis. Sebagian besar masukan (input) proprioseptif menuju serebelum, tetapi ada pula yang menuju ke korteks serebri

melalui lemniskus medialis dan talamus.

Kesadaran akan posisi berbagai bagian tubuh dalam ruang sebagian bergantung pada impuls yang datang dari alat indra dalam dan sekitar sendi. Alat indra tersebut adalah ujung-ujung saraf yang beradaptasi lambat di sinovia dan ligamentum. Impuls dari alat indra ini dari reseptor raba di kulit dan jaringan lain , serta otot di proses di korteks menjadi kesadaran akan posisi tubuh dalam ruang.

Adaptive systems

Kemampuan adaptasi akan memodifikasi input sensoris dan keluaran motorik (output) ketika terjadi perubahan tempat sesuai dengan karakteristik lingkungan.

Lingkup gerak sendi (Joint range of motion)

Kemampuan sendi untuk membantu gerak tubuh dan mengarahkan gerakan terutama saat gerakan yang memerlukan keseimbangan yang tinggi.

Faktor-faktor yang mempengaruhi keseimbangan

a. Pusat gravitasi (Center of Gravity-COG)

   Pusat gravitasi terdapat pada semua obyek, pada benda, pusat gravitasi terletak tepat di tengah benda tersebut. Pusat gravitasi adalah titik utama pada tubuh yang akan mendistribusikan massa tubuh secara merata. Bila tubuh selalu ditopang oleh titik ini, maka tubuh dalam keadaan seimbang. Pada manusia, pusat gravitasi berpindah sesuai dengan arah atau perubahan berat. Pusat gravitasi manusia ketika berdiri tegak adalah tepat di atas pinggang diantara depan dan belakang vertebra sakrum ke dua.

   Derajat stabilitas tubuh dipengaruhi oleh empat faktor, yaitu : ketinggian dari titik pusat gravitasi dengan bidang tumpu, ukuran bidang tumpu, lokasi garis gravitasi dengan bidang tumpu, serta berat badan.

b. Garis gravitasi (Line of Gravity-LOG)

   Garis gravitasi merupakan garis imajiner yang berada vertikal melalui pusat gravitasi dengan pusat bumi. Hubungan antara garis gravitasi, pusat gravitasi dengan bidang tumpu adalah menentukan derajat stabilitas tubuh.

c. Bidang tumpu (Base of Support-BOS)

   Bidang tumpu merupakan bagian dari tubuh yang berhubungan dengan permukaan tumpuan. Ketika garis gravitasi tepat berada di bidang tumpu, tubuh dalam keadaan seimbang. Stabilitas yang baik terbentuk dari luasnya area bidang tumpu. Semakin besar bidang tumpu, semakin tinggi stabilitas. Misalnya berdiri dengan kedua kaki akan lebih stabil dibanding berdiri dengan satu kaki. Semakin dekat bidang tumpu dengan pusat gravitasi, maka stabilitas tubuh makin tinggi.

Keseimbangan Berdiri

Pada posisi berdiri seimbang, susunan saraf pusat berfungsi untuk menjaga pusat massa tubuh (center of body mass) dalam keadaan stabil dengan batas bidang tumpu tidak berubah kecuali tubuh membentuk batas bidang tumpu lain (misalnya : melangkah). Pengontrol keseimbangan pada tubuh manusia terdiri dari tiga komponen penting, yaitu sistem informasi sensorik (visual, vestibular dan somatosensoris), central processing dan efektor.

Pada sistem informasi, visual berperan dalam contras sensitifity (membedakan pola dan bayangan) dan membedakan jarak. Selain itu masukan (input) visual berfungsi sebagai kontrol keseimbangan, pemberi informasi, serta memprediksi datangnya gangguan. Bagian vestibular berfungsi sebagai pemberi informasi gerakan dan posisi kepala ke susunan saraf pusat untuk respon sikap dan memberi keputusan tentang perbedaan gambaran visual dan gerak yang sebenarnya. Masukan (input) proprioseptor pada sendi, tendon dan otot dari kulit di telapak kaki juga merupakan hal penting untuk mengatur keseimbangan saat berdiri static maupun dinamik

Central processing berfungsi untuk memetakan lokasi titik gravitasi, menata respon sikap, serta mengorganisasikan respon dengan sensorimotor. Selain itu, efektor berfungsi sebagai perangkat biomekanik untuk merealisasikan renspon yang telah terprogram si pusat, yang terdiri dari unsur lingkup gerak sendi, kekuatan otot, alignment sikap, serta stamina.

Postur adalah posisi atau sikap tubuh. Tubuh dapat membentuk banyak postur yang memungkinkan tubuh dalam posisi yang nyaman selama mungkin. Pada saat berdiri tegak, hanya terdapat gerakan kecil yang muncul dari tubuh, yang biasa di sebut dengan ayunan tubuh. Luas dan arah ayunan diukur dari permukaan tumpuan dengan menghitung gerakan yang menekan di bawah telapak kaki, yang di sebut pusat tekanan (center of pressure-COP). Jumlah ayunan tubuh ketika berdiri tegak di pengaruhi oleh faktor posisi kaki dan lebar dari bidang tumpu.

Posisi tubuh ketika berdiri dapat dilihat kesimetrisannya dengan : kaki selebar sendi pinggul, lengan di sisi tubuh, dan mata menatap ke depan. Walaupun posisi ini dapat dikatakan sebagai posisi yang paling nyaman, tetapi tidak dapat bertahan lama, karena seseorang akan segera berganti posisi untuk mencegah kelelahan.

II. TUJUAN :

1. Mendemonstrasikan kepentingan kedudukan kepala dan mata dalam mempertahankan keseimbangan badan pada manusia.
2. Mendemonstrasikan dan menerangkan pengaruh percepatan sudut :
   a. Dengan kursi barany terhadap : gerakan bola mata

b. Dengan berjalan mengelilingi statif

III. ALAT YANG DIPERLUKAN :

Kursi Brany + Tongkat/statif yang panjang

IV. PELAKSANAAN PRAKTIKUM

A. Percobaan dengan kursi Barany 1

1. Tata Kerja

Nistagmus

a. Suruh orang percobaan duduk tegak dikursi Barany dengan kedua tangannya memegang erat tangan kursi.
b. Tutup kedua matanya dengan sapu tangan dan tundukkan kepala o.p 30 derajat kedepan.
   P.VIA.9. Apa maksud tindakan penundukan o.p 30 derajat kedepan?
c. Putarlah kursi ke kanan 10 kali dalam 20 detik secara teratur dan tanpa sentakan
d. Hentikan pemutaran kursi tiba-tiba
e. Bukalah sapu tangan dan suruhlah o.p melihat jauh kedepan
f. Perhatikan adanya nistagmus
   Tetapkanlah arah komponen lambat dan cepat nistagmus tersebut

B. Tes Penyimpangan Penunjukkan (Pas Pointing Test of Barany)

1. Tata Kerja

a. Suruh OP duduk tegak dikursi Barany dan tutuplah kedua matanya dengan sapu tangan
b. Periksa sendiri tepat dimuka kursi Barany sambil mengulurkan tangan ke arah OP
c. Suruhlah OP menunjulurkan lengan kanannya ke depan sehingga dpt menyentuh jari tangan pemeriksa yang telah diulurkan sebelumnya
d. Suruhlah OP mengangkat lengan kanannya ke atas dan kemudian dengan cepat menurunkan kembali sehingga dapat menyentuh jari pemeriksa lagi. Tindakan no 1-4 merupakan persiapan untuk tes yang berikut :
e. Suruhlah sekarang OP dengan kedua tangannya memegang erat tangan kursi
f. Putarlah kursi ke kanan 10 kali dalam 20 detik secara teratur tanpa sentakan.

C. Kesan sensasi

1. Tata Kerja

a. Gunakan o.p. yang lain
b. Suruh o.p duduk di kursi Barany dan tutuplah kedua matanya dengan sapu tangan
c. Putarlah kursi barany ke kanan dengan kecepatan yang berangsur-angsur bertambah dan kemudian kurangilah kecepatan putarannya secara berangsur-angsur sampai berhenti.
d. Tanyakan kepada o.p arah perasaan berputar
    1) sewaktu kecepatan putar masih bertambah
    2) sewaktu kecepatan menetap
    3) sewaktu kecepatan dikurangi
    4) segera setelah kursi dihentikan
e. Berikan keterangan tentang mekanisme terjadinya arah perasaan berputar yang dirasakan o.p

D. Percobaan sederhana untuk kanalis semisirkularis horisontalis

1. Tata Kerja

a. Suruhlah o.p. dengan mata tertutup dan kepala ditundukkan 30^{o} , berputar sambil berpegangan pada tongkat atau statif, menurut arah jarum jam, sebanyak 10 kali dalam 30 detik
b. Suruhlah o.p. berhenti, kemudian membuka matanya dan berjalan lurus ke muka
c. Perhatikan apa yang terjadi
d. Ulangi percobaan ini dengan berputar menurut arah yang berlawanan dengan arah jarum jam

BIOKIMIA

PRAKTIKUM I :

MODEL DNA & KARYOTYPE KROMOSOM

KROMOSOM

1. Konsep Dasar

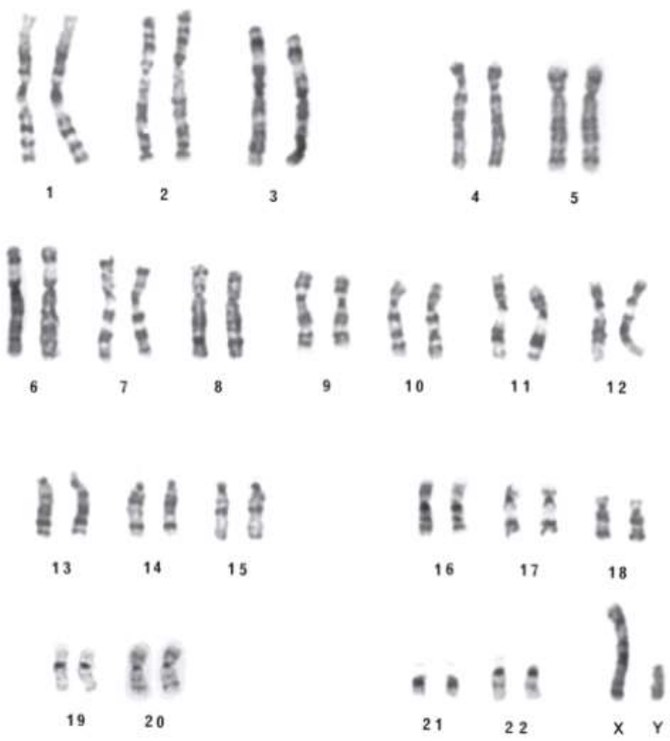
Makhluk hidup terdiri atas jutaan sel. Setiap sel megandung informasi genetik yang kemudian akan diwariskan pada generasi selanjutnya. Materi genetik tersebut berupa makromolekul yang terdiri atas susunan asam nukleat yang berurutan. Asam nukleat terdiri atas susunan mikromolekul yang disebut nukleotida. Asam nukleat ditemukan oleh Friedrich Miescher pada tahun 1868. Molekul ini awalnya dinamakan "nuclein" karena diisolasi dari nukleus sel darah putih, saat ini lebih dikenal dengan sebutan *Deoxyribonucleic acid* (DNA). Selain DNA, sebagian besar asam nukleat adalah *Ribonucleic acid* (RNA). Perbedaan antara DNA dan RNA yaitu pada Tabel 1.

Tabel 1. Perbedaan DNA dan RNA

No	Objek	DNA	RNA
1	Letak	Inti sel	Inti sel, sitoplasma, ribosom
2	Bentuk	Pita spiral ganda	Pita tunggal
3	Komponen gula	Deoksiribosa	Ribosa
4	Ukuran	Sangat panjang	Pendek
5	Basa nitrogen	Purin: Adenin, Guanin Pirimidin: Citosin, Timin	Purin: Adenin, Guanin Pirimidin: Citosin, Urasil
6	Kadar	Tidak dipengaruhi oleh kecepatan sintesis protein	Berubah-ubah menurut kecepatan sintesis protein
7	Fungsi	Mengendalikan faktor keturunan dan sintesis protein	Sintesis protein

DNA dan RNA disusun oleh mikromolekul yang dikenal dengan nukleotida. Secara biokimia, nukeotida terdiri atas gula pentosa, fosfat, dan basa nitrogen. DNA disusun oleh dua rantai polinukleotida yang memiliki empat macam subunit yang bersifat antiparallel. Dua rantai polinukleotida duhubungkan oleh ikatan hydrogen pada basa nitrogen (Gambar1). Organisme eukariot menyimpan DNA sebagai materi genetik di dalam nukleus. Ketika sel mempersiapkan diri untuk membelah, molekul DNA akan

memendek dan menebal membentuk kromosom (Gambar 2). Manusia memiliki 23 pasang kromosom yang terdiri atas 22 pasang autosom (kromosom tubuh) dan sepasang gonosom (kromosom seks). Susunan kromosom berdasarkan ukuran, bentuk dan letak sentromer dibeut karotipe.



2.

Gambar 2. Kariotipe manusia laki-laki normal

Komposisi dan kombinasi genetik menghasilkan variasi genetik yang dikespresikan dalam bentuk fenotipe yang beragam. Pada tahun 1865, Mendel merumuskan dua hukum yang berkaitan dengan genetika yaitu mengenai segregasi bebas (Hukum Mendel I) dan pemilihan secara bebas (Hukum Mendel II). Prinsip hukum tersebut digunakan untuk memprediksi kemungkinan transmisi alel mutan yang diduga berkaitan dengan polawa pewarisan penyakit dalam dari satu generasi ke generasi selanjutnya. Pola pewarisan tersebut dapat ditelusuri dari diagram pedigree dengan symbol-simbol seperti di bawah ini:

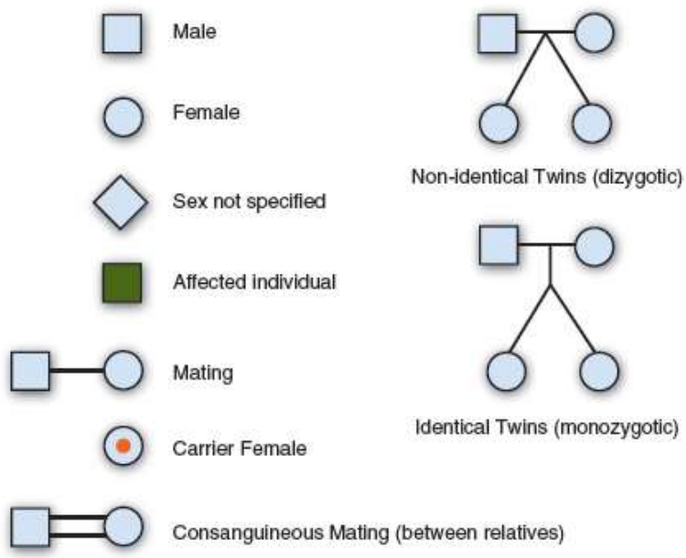


FIGURE 10.2. The symbols used in pedigrees.

3. Tujuan Praktikum

Mahasiswa mampu memahami dan menjelaskan struktur DNA sebagai materi genetic dan menjelaskan struktur dan susunan kromosom manusia serta belajar menganalisis kelainan kromosom berdasarkan hasil kariotipe serta memahami pola pewarisan sifat genetic.

4. Metode Ringkas

a. Model DNA

Merangkai kit model DNA sesuai dengan urutan nukleotida

b. Kariotipe

Mencocokan gambar kromosom dalam keadaan acak. Masing-masing gambar dilengkapi dengan studi kasus yang berbeda.

c. Pola Pewarisan Sifat

Membuat diagram pedigree pola pewarisan sifat sesuai dengan scenario yang diberikan.

5. Alat dan Bahan

a. Alat

Kit model DNA, alat tulis, gunting, penggaris

b. Bahan

Tiga kertas yang berisikan gambar kromosom dalam keadaan acak, kertas HVS kosong,, lem kertas, pensil warna.

6. Langkah Kerja

a. Model DNA dan RNA

Prosedur Kerja:

1. Mahasiswa membuat urutan nukleotida sebanyak 16 bp secara acak (8 bp A/T dan 8 bp G/C)
2. Merangkai kit model DNA sesuai dengan urutan nukleotida yang telah dibuat.

Hasil

Gambar DNA

b. Kariotipe

Prosedur Kerja:

a) Persiapkan kertas dengan gambar kromosom dalam keadaan acak. Masing-masing gambar dilengkapi dengan studi kasus yang berbeda.

Kasus A:

Pasien A adalah seorang perempuan berusia 35 tahun. Pasien tersebut sedang dalam proses program memperoleh keturunan dan ingin mengetahui penyebab mengapa dia belum memiliki anak hingga sekarang. Kromosom diambil dari darah pasien.

Kasus B:

Pasien B adalah bayi yang meninggal sesaat setelah dilahirkan dengan beberapa kelainan yaitu bibir sumbing, tanpa alis, dan

polidaktili. Kromosom diperoleh dari plasenta pasien.

Kasus C:

Pasien C adalah seorang balita perempuan berusia 2 tahun. Bayi tersebut belum dapat berjalan normal karena mengalami kelemahan otot, memiliki wajah yang khas, dan terdapat celah lebih lebar antara jari kaki pertama dan kedua. Kromosom diperoleh dari sel epitel mulut pasien.

b) Potong masing-masing gambar kromosom dengan menggunakan gunting.
c) Pasangkan masing-masing kromosom dengan homolognya
d) Tempelkan pengelompokan kariotipe kromosom berdasarkan bentuk kromosom dan urutan nomor. Pada lembar kertas kosong
e) Buat analisa dari hasil kariotipe tersebut.

c. Pola Pewarisan Sifat

Posedur Kerja:

a) Pahami skenario di bahwah ini. Lalu jawablah pertanyaan beserta diagram pedigree pola pewarisan genetic yang sesuai dengan masing-masing skenario.

Skenario 1:

Seorang laki-laki 22 than memiliki impian untuk menjadi seorang pilot. Akan tetapi dia tidak lulus tes Kesehatan mata karena mengidap buta warna.

Berapa persen kemungkinan saudara laki-laki kandungnya mengalami hal yang sama?

Jika dia menikah dengan perempuan normal homozigot dan memiliki seorang anak perempuan. Bagaimana kemungkinan anak perempuannya mengalami buta warna?

Seknario 2:

Seorang laki-laki 27 tahun memeriksakan dirinya ke dokter. Dia mengalami gangguan pengelihatan yaitu bagian tengah pengelihatannya gelap. Ia memiliki dua orang saudara laki-laki

kandung dengan keluhan yang sama. Keduanya mengalami gangguan pengelihatan tersebut pada usia 26 dan 28 tahun. Saudara peremupannya juga mengalami hal serupa pada usia 24 tahun.

Apakah pola pewarisan yang mungkin terjadi pada kasus tersebut?

Jika laki-laki tersebut menikah dan memiliki anak. Bagaimana kemungkinan anaknya akan mengalami kelainan yang serupa?

Jika saudara perempuannya memikah dan memiliki anak. Bagaimana kemungkinan anaknya akan mengalami kelainan yang serupa?

7. Interpretasi dan Aplikasi Klinis

Metode karyotype bisa digunakan untuk analisis kromosom seseorang dalam menentukan kelainan genetik.

8. Kesesuaian Blok

BIOMEDIK 1.3

DAFTAR PUSTAKA

ANATOMI :

1. Paulsen F. & J. Waschke. 2018. Sabotta Atlas of Anatomy General Anatomy & Musculoskeletal Sistems 16th edition. Elsevier

HISTOLOGI:

2. Mescher, L. A. 2009. *Junqueira's Basic Histology Text and Atlas*. English: McGrawHill Medical

FISIOLOGI:

3. President's Council on Physical Fitness and Sports: Physical Fitness Research Digest. Series 1, No. 1. Washington, DC, 1971.
4. Exercise Testing and Prescription Lab Manual, 2nd Ed. 2011.

BIOKIMIA:

5. Albert B. et al. Molecular biology of the cell 6th ed. 2008. New York. Garland Science, Taylor & Francis Group, LL
6. Lieberman M and Ricer R. Biochemistry, molecular biology, and genetics. 6th ed. 2014. Philadelphia. Lippincott Williams & Wilkins, a Wolters Kluwer business.