Digestive Tract
The primordial gut forms during the 4th week as the folds incorporate the dorsal part of the yolk sac into the embryo.

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Development

Foregut
- Oropharyngeal membrane
- Celiac trunk
  - From oral cavity to duodenum (opening of the bile duct)

Midgut
- Superior mesenteric artery
  - From duodenum to transverse colon

Hindgut
- Cloacal membrane
- Inferior mesenteric artery
  - The rest of colon

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Development

The endoderm of the primordial gut

The epithelium and glands of the digestive tract

The ectoderm of the stomodeum

The epithelium in the cranial part

The ectoderm of the proctodeum

The epithelium in the caudal part
Wall

The wall is made up of four layers

1. Mucosa
2. Submucosa
3. Muscularis
4. Serosa / adventitia

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Mucosa

1. Epithelial lining

2. Lamina propria mucosae
   - Connective tissue
   - Blood vessels, lymphatics, macrophages and lymphocytes, sometimes glands

3. Lamina muscularis mucosae
   - Smooth muscles
   - Movements of the mucosa – better contact with food

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Submucosa

Connective tissue
Blood and lymph vessels, glands, lymphoid tissue

2. Submucosa

Submucosal plexus (Meissner’s plexus) of autonomic nerves
Function: secretion

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3. Muscularis

Smooth muscle cells
2 sublayers

1) Internal – circular
2) External – longitudinal

Myenteric plexus – (Auerbach’s plexus) contraction of the muscularis

Enteric nervous system: submucosal and myenteric plexus,

Plexus – aggregates of nerve cells that form parasympathetic ganglia (contains autonomic neurons)

Origin: neural crest

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Enteric nervous system

**Chagas disease**
Parasite injures the plexuses – dilatations: Megaesophagus, Megacolon

**Hirschprung disease**
Cells from neural crest don’t migrate well: Congenital megacolon

Romaña’s sign

Kissing bug

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Serosa / Adventitia

4. Serosa / adventitia

Serosa
Simple squamous covering epithelium +
Connective tissue rich in vessels and adipose tissue

Is continuous with the mesenterium and the peritoneum

Organs which are inside the abdominal cavity

Adventitia – connective tissue
Organs which are outside the abdominal cavity

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Parts of the digestive tract

oral cavity
pharynx
esophagus
stomach (ventriculus, gaster)
small intestine (intestinum tenue)
large intestine (intestinum crassum)
rectum
liver (hepar)
pancreas
gallbladder (vesica fellea)
Lips (labia oris)

labium superius
labium inferius
rima oris
anguli oris
sulcus nasolabialis
sulcus mentolabialis
philtrum
tuberculum labii superioris

transition to the keratinizing epithelium

pars cutanea, intermedia (sebaceous glands), mucosa
(salivary glands - glandulae labiales)

m. orbicularis oris

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Cheek (bucca)

m. buccinator covered by fascia buccopharyngea

corpus adiposum buccae (buccal fat pad)
  – reaches under ramus mandibulae into fossa infratemporalis

there are glandulae buccales in the mucosa
  – small salivary glands

papilla parotidea
  – at the level of the 2nd upper molar
Cavitas oris (oral cavity)

rima oris (oral fissure) → isthmus faucium (isthmus of fauces)

borders:

ventrally and externally: lips (labia oris) and cheeks (buccae)

roof: palate

floor: m. mylohyoideus and m. geniohyoideus

vestibulum oris (oral vestibule)

fornix vestibuli sup. + inf.

frenulum labii sup. + inf.

cavitas oris propria (oral cavity proper)

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Gum (gingiva)
mucosa covering the alveolar processes of the jaws, firmly grows together with periosteum

margo gingivalis
sulcus gingivalis
papillae gingivales
Teeth (dentes) I

arcus dentalis superior (elipsoid)
arcus dentalis inferior (parabolic)

dentes permanentes (32) + dentes decidui (20)
dens incisivus (cutter) 8/8
dens caninus (cuspid) 4/4
dens premolaris (bicuspide) 8/0
dens molaris (molar) 12/8
teething (eruptio)
  dentes decidui → 6th-30th month
  dentes permanentes → 6th-30th year
dental formula → i1, i2, c, m1, m2
  → I1, I2, C, P1, P2, M1, M2, M3
occlusion: psalidodontia – ”scissors occlusion“
  (labidodontia – ”pincer occlusion“, …)
Dental formula for deciduous teeth

Dental formula for permanent teeth
Teeth(dentes) II

parts of the tooth
  corona dentis (crown) – cuspides
cervix dentis (neck)
radix dentis (root) – apex, canalis
cavitas dentis – pulp (vessels, nerves)

gomphosis
  = dentoalveolar juncture

periodontium
  - ligaments between the alveolus and the tooth, run in many directions, hold the tooth in place
parodontium
  - all structures around the tooth (bone, connective tissue, gum)
Periodontium

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facades (surfaces)
  occlusalis
  vestibularis
  lingualis

directions
  mesialis
  distalis
Oral cavity

Stratified squamous epithelium
Non keratinized
(Keratinized – gingiva, hard palate)

Lips – transition from the oral non–keratinized epithelium to the keratinized skin

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Dentin

Calcified tissue harder than bone

70% calcium hydroxyapatite

Organic matrix: collagen I and glycosaminoglycans

Who makes the organic matrix?

**Odontoblasts** – tall cells that line the pulp cavity

Their long processes (Tomes processes) lie within dentinal tubules

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Enamel

98% hydroxyapatite (fluorid incorporated by the crystals – fluorapatite is more resistant to acidic dissolution caused by microorganism)

Organic matrix: no collagen, proteins: amelogenin, enamelin

Who makes the enamel?

**Ameloblasts** – one ameloblast produces one prism

After finishing the synthesis of enamel, ameloblasts cover the crown until the eruption of the tooth

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Tooth formation

6th week: thickening of the oral ectoderm = dental lamina

Dental lamina

Tooth buds grow into the underlying mesenchyme

Tooth bud

These tooth buds develop into the deciduous teeth

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Tooth formation

1. Bud stage
   - Ectoderm
   - Mesenchyme

2. Cap stage
   - Enamel organ
   - Enamel
   - Dental papilla

3. Bell stage
   - Enamel organ
   - Stellate reticulum
   - Outer enamel epithelium
   - Inner enamel epithelium

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One layer of the mesenchymal cells in the dental papilla differentiates into odontoblasts.

They produce dentin.

Cells of the inner enamel epithelium differentiate into ameloblasts.

They produce enamel – the basal part of the cells produces it.
Cementum covers the dentin of the root. It is similar to bone but has no osteons.

Periodontal ligament connects the cementum and the alveolar bone.

Collagen has an unusually high turnover rate.

Alveolar bone – primary (immature) bone

Gum – mucous membrane bound to the periosteum
Tongue (lingua)
muscle organ covered by r
radix, corpus, apex
dorsum linguae
sulcus medianus
sulcus terminalis
foramen caecum
papillae linguales (spits of the
pp. filiformes
pp. fungiformes
pp. foliatae
pp. vallatae
tonsilla lingualis
margo linguæ
facades inferior
frenulum linguæ (caruncula
plica fimbriata
Muscles of the tongue I

intragnossal muscles:

m. longitudinalis sup. + inf.
m. transversus linguæ
m. verticalis linguæ

aponeurosis linguæ – on the dorsal surface
septum linguæ – incomplete!
Muscles of the tongue II

extraglossal muscles:

- m. genioglossus
- m. hyoglossus
- m. styloglossus
- m. palatoglossus

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Supply of the tongue

arteries:
  a.car.ext-> a. lingualis

veins:
  v. lingualis -> v. jugularis int.

lymph drainage:
  n.l. submentales, submandibulares, cervicales profundi
  contralateral connections!!!

innervation:
  motor: n. hypoglossus (XII), apart from m.palatoglossus (X)
  sensitive: n. lingualis (V₃), IX, X
  senszory: chorda tympani (VII), IX, X
Tongue

Muscle covered by a mucous membrane (lamina propria penetrates the muscles)

NO submucosa

Muscle fibres cross one another in three planes
Tongue

The dorsal surface is covered by eminences called papillae

- **Filiform papillae**: Numerous, rough surface
- **Fungiform papillae**: Mushroom shaped
- **Foliate papillae**: Poorly developed, parallel ridges on the sides
- **(Circum)vallate papillae**: The largest, 7–12, V-shaped line before the terminal sulcus
Taste buds

In all papillae except for the filiform

Most of them in the vallate papillae

Serous salivary glands – von Ebner, empty into the groove around the papilla

They wash food particles
Development of the tongue

Pharynx at the end of the 4th week

1. arch: Median tongue bud (tuberculum impar)
   Distal tongue buds (lateral swellings)

2. arch: Cupola

3., 4. arch: hypopharyngeal eminence

The copula is overgrown by the hypopharyngeal eminence and disappears

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Palate (palatum)

- Hard palate (palatum durum)
- Soft palate (palatum mole)
- Bony base
- Plicae palatinae transversae, raphe palati (seam)
- Uvula palatina (uvula)
- Aponeurosis palatina

Muscles:
- m. tensor veli palatini (n. V3)
- m. levator veli palatini
- m. uvulae
- m. palatoglossus
- m. palatopharyngeus

All innervated by (n. X – plexus pharyngeus)

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Isthmus faucium

arcus palatoglossus
arcus palatopharyngeus
sinus tonsillaris
tonsilla palatina
  – capsula
  – fossulae, cryptae

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Pharynx I

1. pars nasalis = nasopharynx

fornix
  fascia pharyngobasilaris
  sinus Morgagni
  recessus pharyngeus Luschkae (remnant of notochord)

tonsilla pharyngea Luschkae

tuba auditiva Eustachii
  torus tubarius
  tonsilla tubaria Gerlachi

recessus pharyngeus Rosenmülleri

pseudostratified columnar with the cilia

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Pharynx II

2. pars oralis („oropharynx“)
valleculae epiglotticae
plica glossoepiglottica mediana + laterales

3. pars laryngea („hypopharynx, laryngopharynx“)
recessus piriformis
aditus laryngis

both stratified squamous non-keratinizing epithelium

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Pharynx

surrounding spaces

spatium parapharyngeum
spatium prestyloideum
styloid septum
  5 muscles + ligament + proc. styloideus
spatium retrostyroideum
spatium retropharyngeum

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Pharynx muscles

raphe pharyngis, fascia pharyngobasilaris, *Luschka’s space*

**mm. constrictores** /3/
- **m.c. superior** – 4 parts – origin at skull /3/ and tongue /1/
- **m.c. medius** – 2 parts – origin at hyoid bone
- **m.c. inferior** – 2 parts – origin at laryngeal cartilages

**mm. levatores** /3/
- **m. palatopharygeus** (part of soft palate muscles, mounting of the palatopharyngeal arch)
- **m. salpingopharyngeus**
- **m. stylopharyngeus** (!exception! – innervated by n.IX !)

innervation: plexus pharyngeus – n. X
- except m. stylopharyngeus /n. IX/
Pharynx

blood supply

arteries: a. carotis externa
a. pharyngea ascendens
a. facialis \rightarrow a. palatina ascendens
a. lingualis \rightarrow r. dorsales linguae
a. maxillaris \rightarrow a. palatina major, a. canalis pterygoidei.

veins: plexus (venosus) pharyngeus
v. facialis \rightarrow v. jugularis interna.

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Pharynx

**Lymph and Nerves**

**lymph**
- n.l. retropharyngei
- n.l. paratracheales ➔ n.l. cervicales profundi

**nerves**
- form *plexus pharyngeus*
- motor **n.X** (*plexus pharyngeus*), **n.IX** (*m. stylopharyngeus*)
- sensory **n.X + n.IX** (*plexus pharyngeus*), **n.V2** (*n. pharyngeus for nasopharynx*)
- autonomic **n.X** (*plexus pharyngeus*) = *parasympathetic*, **rr. laryngopharyngei** = *sympathetic*
Anulus lymphoideus pharyngis
(Waldeyer lymphatic ring)

„ring“ of the lymphatic tissue
first protective barrier of an organism

tonsilla pharyngea (*Luschkae*)
tonsillae tubariae (*Gerlachi*)
tonsillae palatinae
tonsilla lingualis

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Sites with weakened wall

trigonum Killiani

cranially: m. thyropharyngeus (m. constrictor ph. inf.)

caudally: m. cricopharyngeus (m. constrictor ph. inf.)

diverticulum of Zenker (= pharyngo-oesophageal diverticle; dehiscence of Killian)

trigonum Laimeri

cranially: m. cricopharyngeus

caudally: upper oblique fibres of longitudinal muscle layer of oesophagus

area Killian-Jamieson

at lateral side of oesophagus

diverticulum of Killian-Jamieson

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