‘Worries are the worst poison for the stomach.’

Alfred Nobel (1880)

‘When one eats, one should fill one-third of one's stomach with food, one-third with drink, and leave the rest empty.’

Talmud

5. GASTER

5.1. LEARNING CONTENT GASTER

This chapter Gaster covers the components of the stomach and osteopathic diagnosis and treatment of the Gaster. The Gaster is part of the Tractus Gastro-Intestinalis (TGI), which usually refers to the entire gastrointestinal tract, although the Colon, in Dutch and Latin, is not mentioned in name. In English, however, it is spoken of small Intestine and Large Intestine (Colon). Gaster belongs to place the visceral aspect in its context of the total holistic approach.

We cover anatomy (micro & macro), embryology, brief physiology and pathology and the osteopathic dysfunction mechanism of the stomach. The diagnostic skills and therapeutic intervention of the stomach and thus the role of the stomach in its clinical significance are described.

Each organ occupies a separate space, including the stomach. As an exception, the stomach has an additional muscular layer: tunica Muscularis Obliquus, which will be described, also in relation to the Bursa Omentalis. Stomach-acid (HCL) is an essential and extremely acidic product of the stomach. Reasoning to why many people suffer from heartburn (gastric acid) is explained in this chapter, but will be understood further with anatomic and physiologic knowledge of the small intestine and Pancreas.

Operational learning objectives Gaster

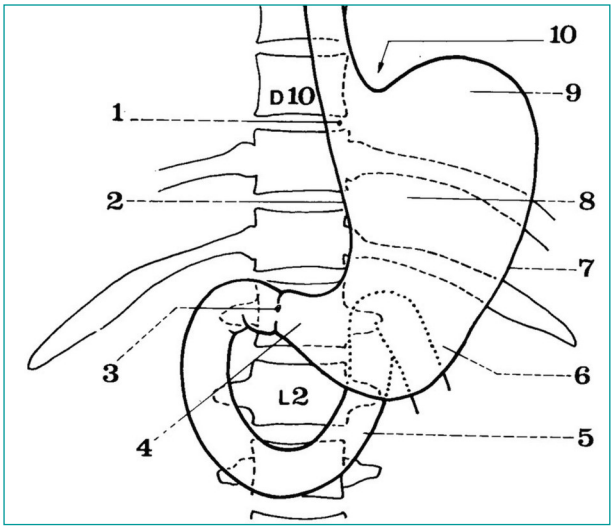
- describe the anatomic margins of the stomach;
- describe the structure of the stomach wall;
- describe the anatomic 'fixations' of the stomach (how the stomach nis suspended);
- show the embryological development of the stomach;
- describe the proportions of the stomach in relation to its surrounding structures;
- explain the vascularization of the stomach, both arterial, venous and lymphatic;
- explain the innervation of the stomach;
- describe the stomach's visceral motion and biomechanics / Mobility and Vitality (motility);
- describe the microanatomy of the stomach;
- Explain the concise physiology of the stomach with regard to stomach acid (formation, secretion and function), pepsin, intrinsic factor and motor skills;
- Explain the concise pathology of the stomach with regard to gastritis, peptic ulcer, gastric carcinoma, pyloric stenosis;
- Explain the osteopathic dysfunction mechanism of the stomach with regard to diaphragmatic mobility, hiatus hernia and gastroptosis;
- Take an anamnesis of the stomach;
- Perform a percussion on Traube's sonorous space;
- Recognize the reflex zones of the stomach;
- Palpate the stomach in different facets;
- To recognize the significance of aortic pulsations in the epigastrica region;
- Perform a mobilization of the stomach;
- Perform the mobilization of the Bursa Omentalis technique in relation to the stomach;
- Perform the torsion technique of the stomach;
- Perform the technique to treat a Hiatus hernia presenting hypertension and hypotension.

5.2. MACRO-ANATOMY GASTER

The stomach resembles an inflated part of the esophagus, with the hollowing occurring on the left side. The stomach is located in the region hypochondrica sinistra. In fact, the stomach is an embryological diverticulum of the intestinal tract: Tractus Gastro-Intestinalis (TGI) also called Tractus Digestivus.

Components Gaster

- Cardia
- Curvatura minor (Magenstrasse)
- Pylorus, stomach exit
- Antrum
- Duodenum
- Tuberculum minor
- Curvatura major
- Corpus
- Fundus, tuberculum major
- Incisura cardia, angle of His.



Structure of the stomach wall

The stomach wall has a number of characteristics of its own compared to the general construction of the digestive tract.

The stomach wall consists of four layers, from superficial to deep:

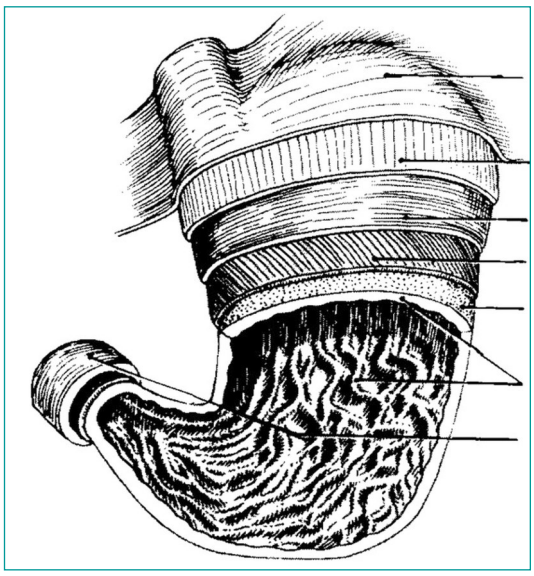
a. **tunica serosa:** peritoneum visceralis.
b. **tunica musculosa**: three layers of muscle.
   ◊ superficial: longitudinal fibers.
   ◊ middle: circular fibers
   ◊ deep: oblique fibers.
c. **tunica submucosa:** blood vessels and nerves.
d. **tunica mucosa:** mucous membrane with two zones of secretion:
   ◊ acid: vertical part (fundus and corpus)
   ◊ alkaline: horizontal part (Antrum and tuberculum minor)

The tunica mucosa is strongly folded with an empty stomach. The folds become less when the stomach is filled. In the depth between the folds (crypts) we find the outlet for the glands that secrete gastric fluid.

The tunica mucosa forms two important folds:

- Valvula cardio-oesophagicus of Gubaroff, at the entrance, the Cardia. This is a mucosal valve (not a sphincter) and is therefore subject to mucosal damage.
- Valvula Pylorica, at the exit, the pylorus. This is a sphincter, a thickening of the tunica muscularis circularis with a mucous membrane thickening on site.

Osteopathic perspective: *all muscle layers are important and we pay particular attention to the 'exception' of the stomach: the tunica muscularis obliquus. The existence of such a structure is important for understanding the function: kneading the food that enters and mixing it with HCL, Pepsin and others. For this kneading of the food mash, the stomach in all its facets and environment must be free in its mobility. We should also take into account that the stomach needs the time and rest to be able to perform this kneading function; especially the first hour after the meal.*



tunica serosa

tunica muscularis longitudinalis

tunica muscularis circularis

tunica muscularis obliquus

tunica submucosa

tunica mucosa

pylorus sphincter.

Structure of the stomach wall, with different layers.
(Netter atlas of Anatomy) & (Perlemutter, L.,Prof. Walligora, J. Cahiers d'anatomie)

5.3. SURROUNDING GASTER

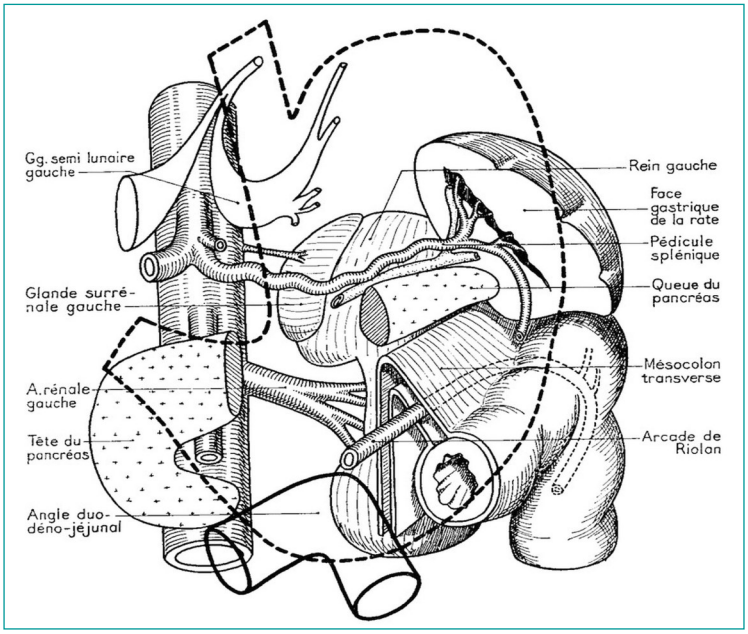
Anterior

a. subthoracal:
- left hemithorax Costae V-IX.
- Space of Traube.

b. abdominal:
- Triangle of Labbé.

c. relation Diaphragm:
- recessus Costo-diaphragmaticus.
- base left lung.
- Pericardium.

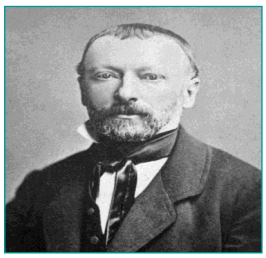
d. relation Hepar (liver):
- lig. Triangulare sinistrum.



History Traube & Labbé:

Ludwig Traube *(1818 – 1876) was a Polish physician and co-founder of experimental pathology in Germany. Some names are associated with Ludwig Traube and describe clinical phenomena of auscultation, palpation and percussions: double tone, dyspnea, space and Traube-Hering-Mayer waves.*

Léon Labbé *(1832 – 1916) was a French surgeon and politician. The triangle of Labbé is the region where the stomach makes contact with the abdominal wall. The horizontal portion of the triangle extends from the border of the 9th rib to the midline next to the liver.*



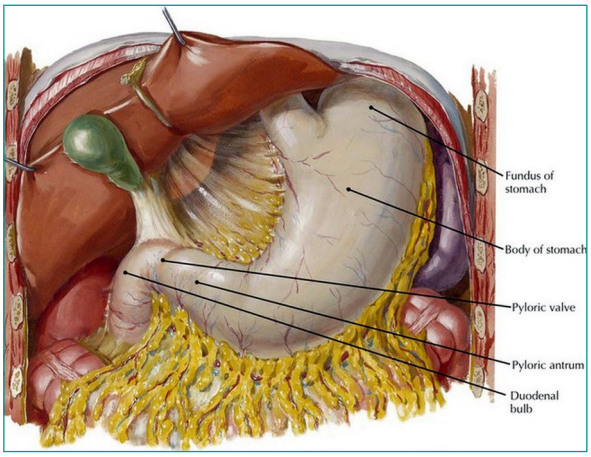
Source: Osler, W., et al, ‚Traube, the man and his space', Arch Internal Med. 1992, 152: 701-703
Leslie Pace, J. Anatomical triangles. Chest-piece, Malta Medical Students Ass. (1966) 2(6), 43-49

Posterior

- Lig. Phreno-gastricum and crus sinistrum.
- Bursa Omentalis and foramen of Winslow.
- Submesocolisch: spleen, kidney, Pancreas.
- Mesocolic: colon Transversum, Duodenum.
- Curvatura minor: via Omentum minor with liver.
- Curvatura major:
  - fundus via lig. Gastro-phrenicum with Diaphragm
  - middlke via lig. Gastro-lienale with spleen-hilus.
  - inferior via lig. Gastro-colicum: colon Transversum, Trandforms into Omentum major.
- Pylorus: lies at the height of L_2.
- Vv. Portae and A. Hepatica, Omentum minor, Pancreas.

Superior

- Diaphragm
- Hiatus oesophagale with gaine of Treitz & Leimer
- Mm. of Rouget & Juvara



Inferior

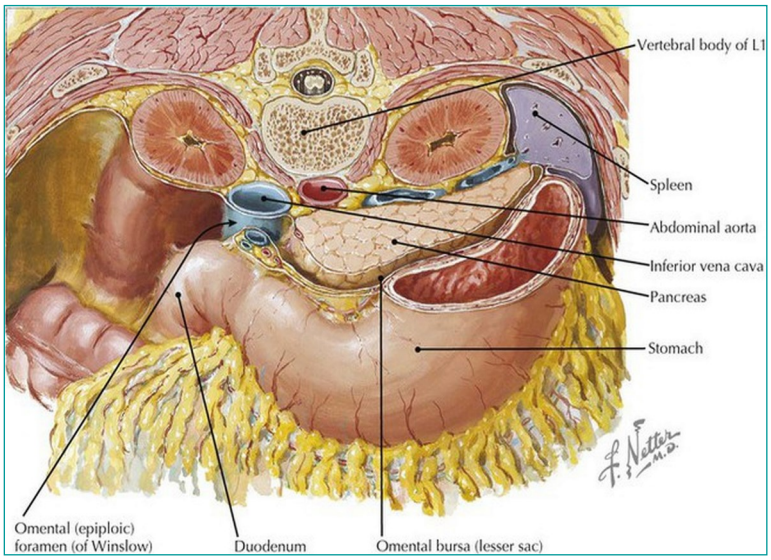
- Mesocolon Transversum
- Connection with Colon transversum (lig. Gastro-colicum), originally Omentum Major.

Lateraal

- Lien (spleen)
- Flexura coli sinistra (FCS)

Mediaal

- Hepar (liver)



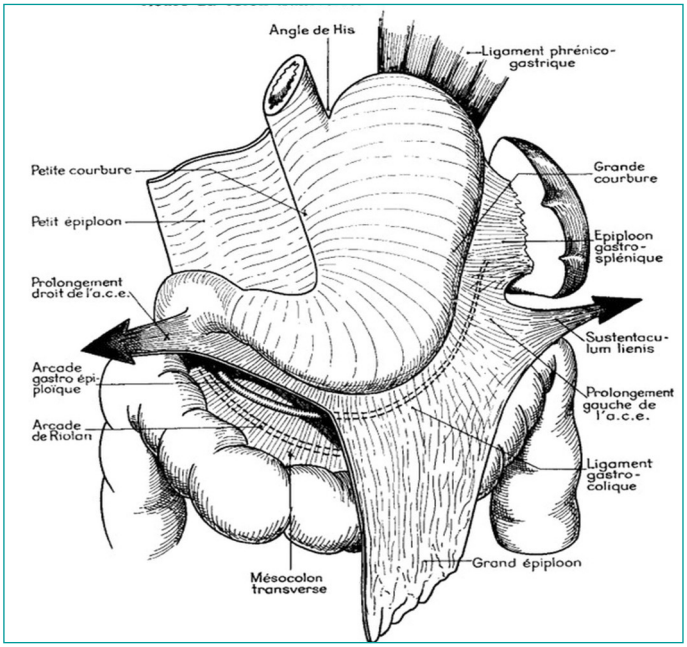
From an osteopathic perspective, *the location of the stomach is important, given the influence of the Diaphragm on mobility with respiration, the influence of other organs (liver and spleen) on the motion of the stomach. The stomach is rather 'sandwiched' between Diaphragm and mesocolon Transversum, creating a pressure system on the stomach when breathing.*

Source: Netter, Frank H. MD, The Netter Collection of Medical Illustrations, Volume 9, part 1, Digestive System: Upper Digestive Tract. Ciba-collection. ISBN: 9780914168010, 1966.

5.4. FASCIA & LIGAMENTS GASTER

a. Ligamentum Gastro-Phrenicum.
b. Omentum minor. (from Mesogastricum anterius.
c. Omentum major. (from Mesogastricum posterius), differentiated to ligamentum Gastro-colicum
d. Ligamentum Gastro-Lienale.
e. Mm. Rouget and Juvara.
f. Vascular falx's around the A. Gastrica sinister and the A. Hepatica.

The stomach itself is not fixated, but rather suspended to its environment. The connections guarantee a certain preservation of position and provide a freedom in mobility. However, the most important 'fixation' is provided by the tension in the stomach itself (see paragraph physiology) and the support from Glenard's compartments (see chapter concept visceral).

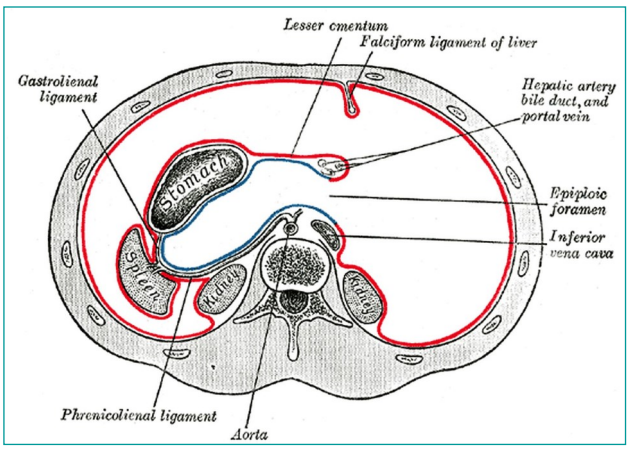


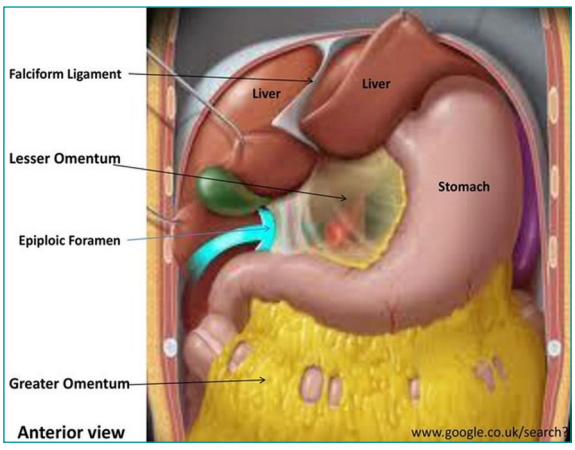
From an osteopathic perspective: *the ligaments of the viscera are extensions of the peritoneum. They are double-layered with loose connective tissue in between, containing fluid (vascular, lymphatic) and nerval structures. We see the multiple connections between the stomach and surrounding organs or parietal structures, such as Diaphragm, Costae, abdominal wall. It is important for the osteopath to develop a detailed visual of the peritoneal connections of the stomach, to determine the position, motion, and tensional / pressure forces brought upon the stomach with palpation.*

Tunica serosa

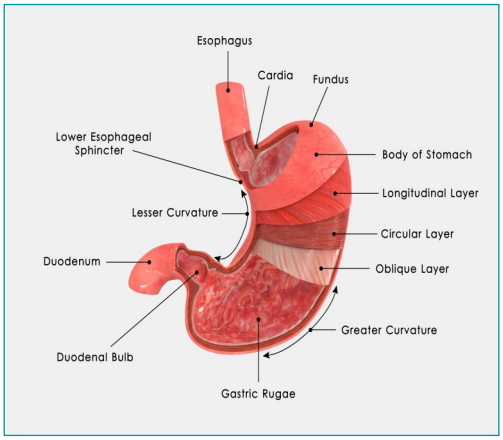
The tunica serosa is the peritoneum around the stomach, the visceral peritoneum. This peritoneum is in continuity (as a whole) with the entire peritoneum, including the peritoneum parietalis. The connections between the two form the ligaments. It is the packaging, but also the sliding surface for the stomach.

From an osteopathic perspective *the stomach must be completely free in its movements in order to perform its function; after all, the structure directs the function. Fixations within the peritoneal connections obstruct the function, which can elicit to endocrine and neurocrine response (compensations). In general, the compensations are presented via symptoms within the patient and vice versa.*





5.5. MICRO-ANATOMY GASTER



Tunica muscularis

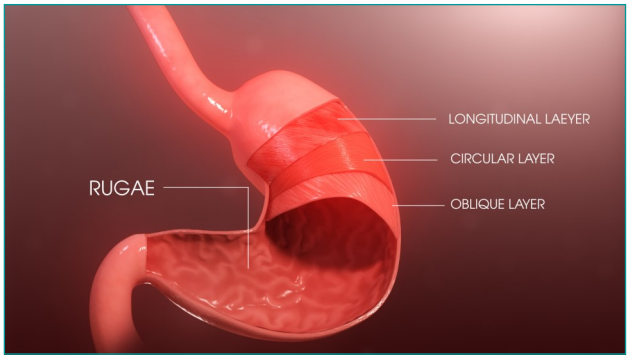
- Circular layer (internal) —> forms the pylorus through two circular loops. Separated from the tunica muscularis Duodeni by a fibrous septum. As a result, a separate sphincter.
- Longitudinal layer (external) mainly at the Curvatura major and minor.
  - ◊ regulates the length-expansion of the stomach.
  - ◊ boundary between two portions of the stomach: Incisura angularis
    top of left: involved more with digestion
    bottom or right: involved more with emptying.
- Oblique layer from angle from His to corpus and tuberculum minor, so obliquely from Cardia to Curvatura major) and not presence at Pylorus and Curvatura minor.

Nota Bene obligue:

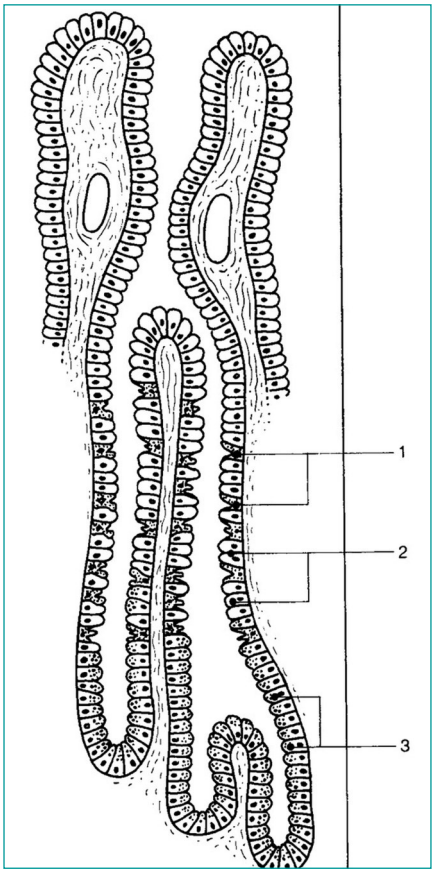
The obligue layer is necessary for kneading, in example the mixing of the food mash with HCL-enriched gastric juice. In order to knead, free mobility of the stomach is necessary, as well as of the surrounding structures.

Intermezzo M. Obliquus:

The following example represents the contraction of the tunica muscularis obliquus: place the right carpal on your own Cardia of the stomach, approximately at the level of the Processus Xyphoïdeus. The fingers point to latero-caudal, to the Curvatura major. Now when you make a fist with your hand, you mimic the contraction of the oblique muscle layer. With this we see the function: kneading.



Tunica mucosa

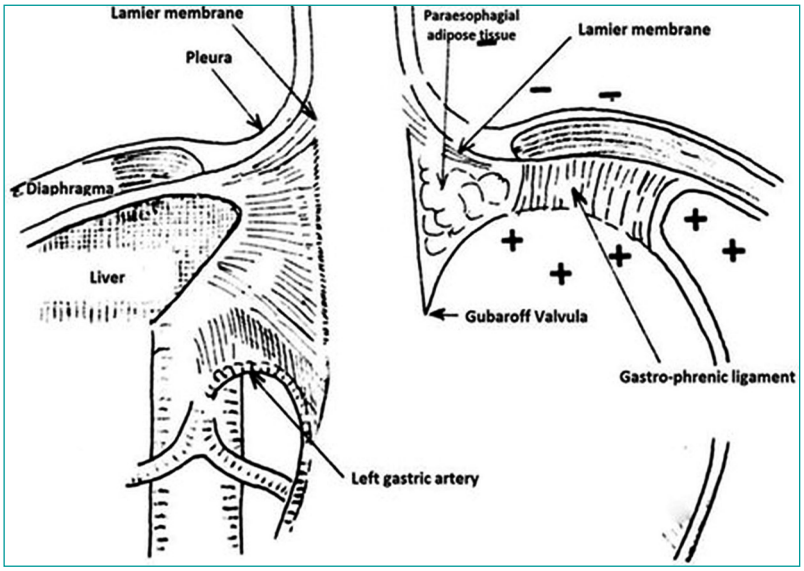


- Strongly folded (less with gastric filling);
- Contains Crypts (Foveolae) with glands (glandulae Gastricae).
  - ◊ Glands in the corpus / fundus:
    - * Chief cells (3): pepsinogen. (zymogencells);
    - * Parietal cells (1): HCL: gastric acid and Intrinsic Factor (IF);
    - * Mucous cells (2): mucus secretion;
    - * EC-cells: Serotonin.
  - ◊ Glands in the Cardia: produce only mucus.
  - ◊ Glands in the Pylorus:
    - * mucous-producing cells.
    - * neuro-endocrine cells G-cells: Gastrin, Extrinsic Factor.
      D-cells: Somatostatin.

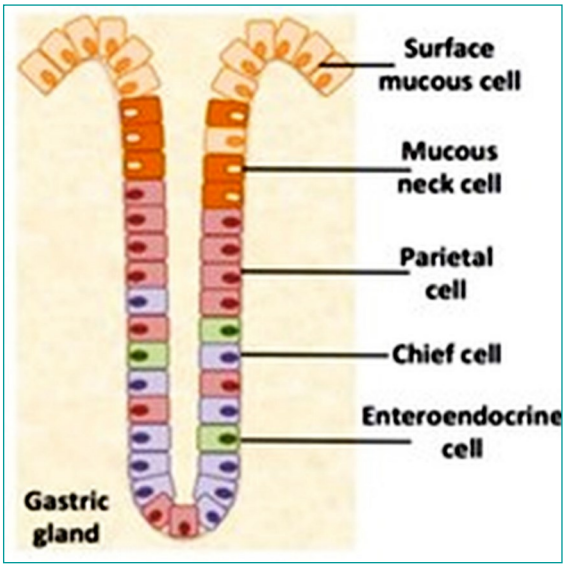
The mucosa is attached to the tunica muscularis in the Curvatura minor, here we also find no oblique fibers, so that water passes directly along the valvula of Gubaroff, via the Curvatura minor (gastric street) through the stomach.

De facto *is the function of an intact Valvule of Gubaroff: allows the passing of pure water through the 'gastric street', directly into the small intestine. This allows the mucous membranes of the small and large intestine to:*

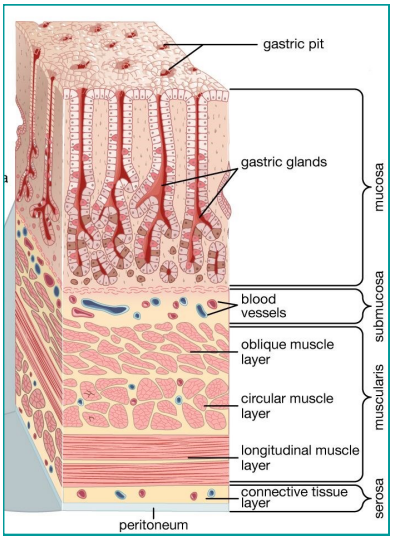
- *Staying moisture;*
- *Become the reproduction (breeding) side for the intestinal flora;*
- *Providing water for the cleavage of proteins and carbohydrates.*



The valvule of Gubaroff, mucus fold.

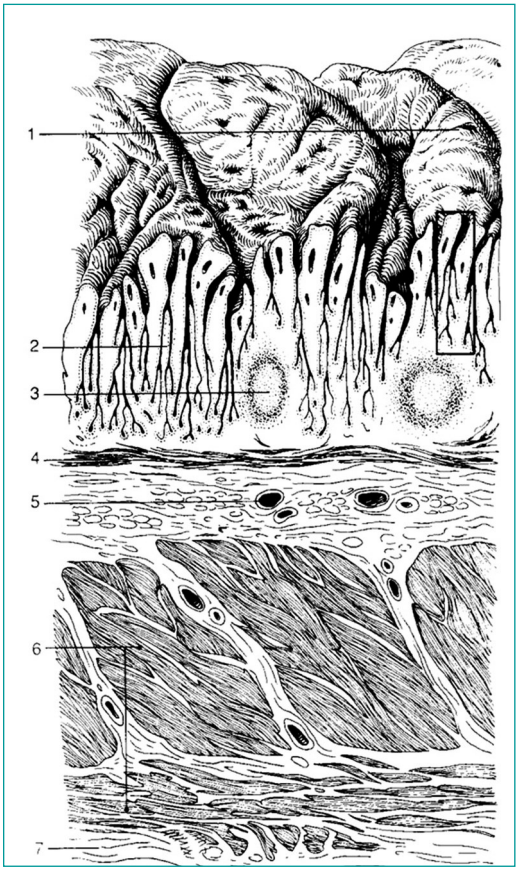


Detail of a gastric gland



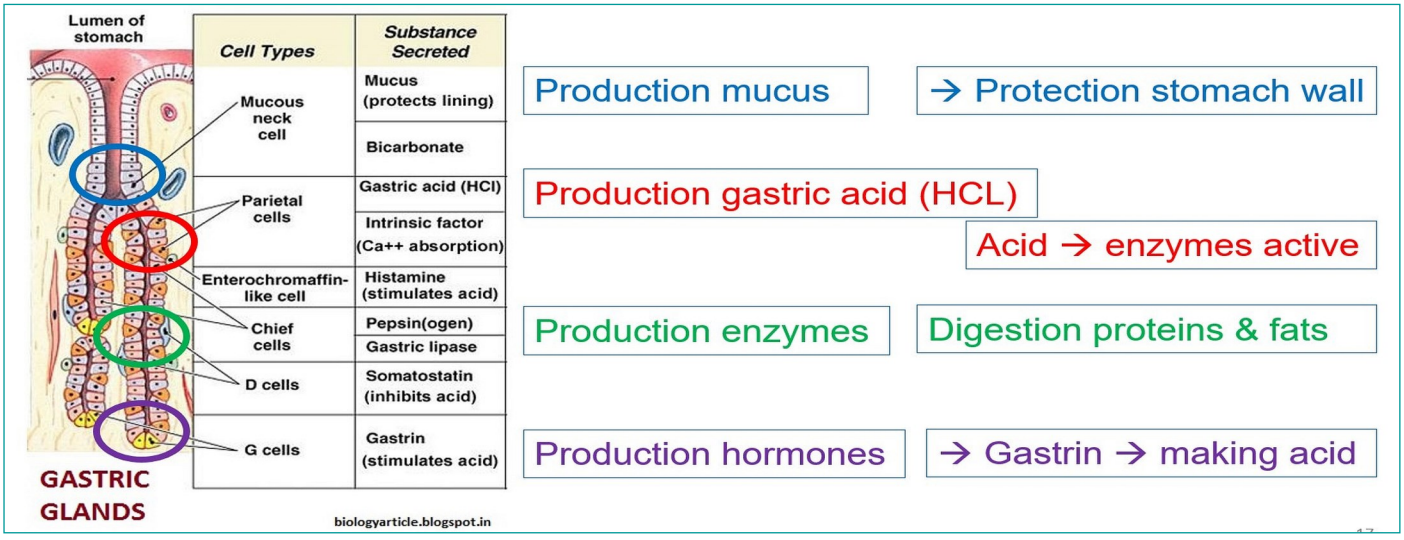
Cross section through the stomach wall:

1. *Mucus fold*
2. *Crypt with gland tissue*
3. *Lymphatic tissue*
4. *Muscularis Mucosa*
5. *Submucosa with blood vessels*
6. *Muscle layers*
7. *Tunica Serosa*



When we study the microanatomy of the stomach wall a little more closely, we see a number of different cells, each with its own function:

- Mucous neck cells: take care of mucus production (mucus), but also make bicarbonate (neutralization).
- Parietal cells: take care of the stomach acid production (HCL) and the Intrinsic factor.
- Enterochromaffin cells: produce histamine, which triggers stomach acid production.
- Chief cells: these make pepsinogen (as the pre-stage of pepsin: protein) and gastric lipase (fat).
- D-cells: production of somatostatin, an inhibition factor for stomach acid.
- G-cells: production of gastrin.



***From an osteopathic perspective**, the dynamics and physiological function of these muscle layers shows kneading to mix the food slurry with the gastric acid (HCL and enzymes). This normally takes 0.5 – 1 hour.*

It is therefore important to sit up straight for at least half an hour after eating. Give the stomach its time to knead. This is especially true for dinner: good conversation and after-dinner dining.

5.6. BRIEF EMBRYOLOGY GASTER

The stomach develops from the primitive foregut, already in the fourth week of the embryonic period. The primitive foregut consists of the Oesophagus, Gaster and the first two parts of the Duodenum.

Meso-Gastrium anterior:

This part of the Meso-Gastrium Is tightened and brought through the rotation of the liver and to the right, dorsal and cranial. This creates the Omentum minor.

Meso-Gastrium posterior:

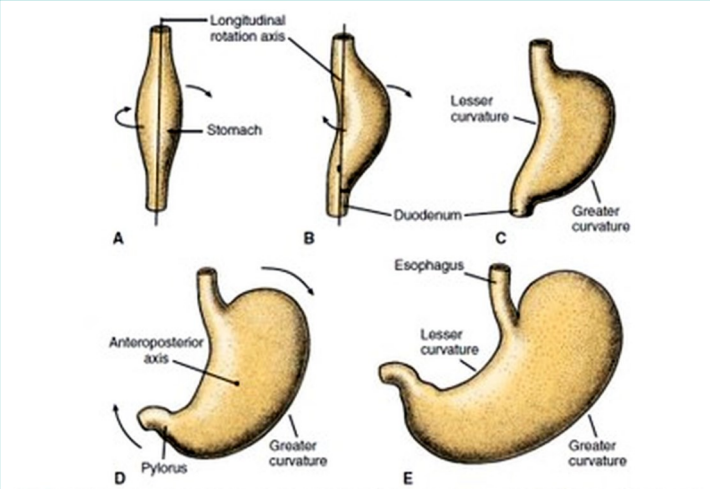
The stomach is brought to the left under the diaphragm by liver development (growth) and spleen development (traction). The Pancreas grows underneath the stomach and forms the Duodenum. Between Curvatura major, or rather the posterior side of the stomach, and PPP a space arises: the bursa Omentalis. This bursa forms the primary sliding surface of the stomach for its function: kneading and mixing the food with gastric excretions.

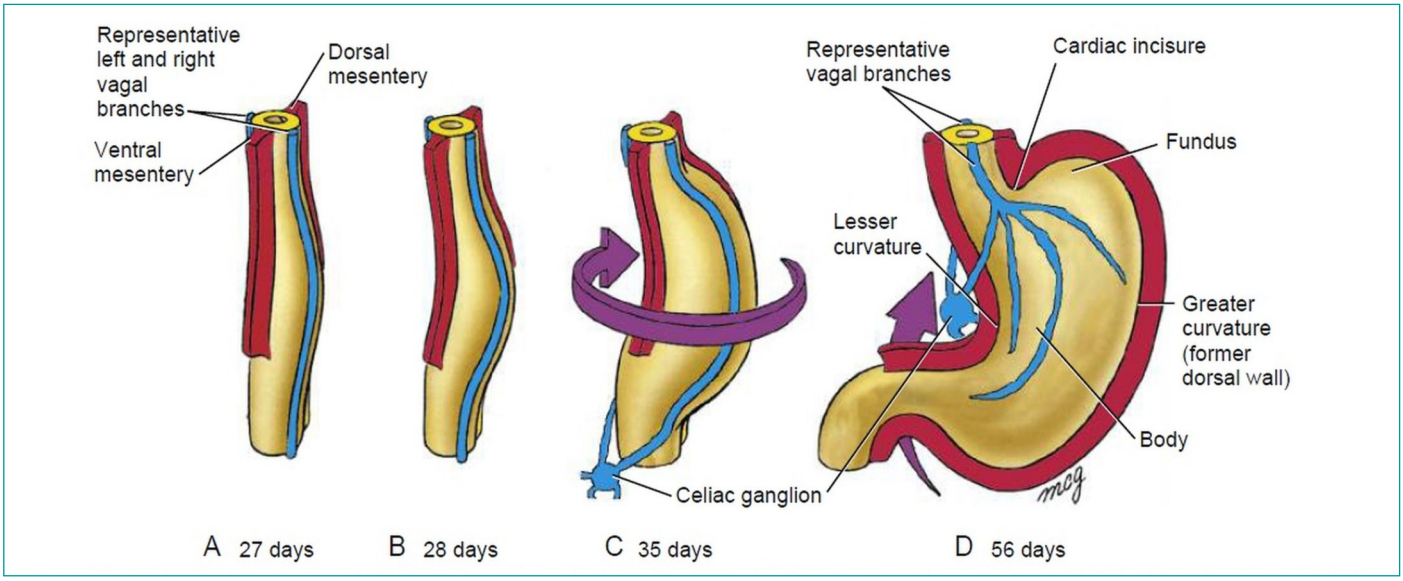
Then the stomach undergoes a Clockwise rotation around an A-P (Anterior-Posterior) axis.
Thus, the total embryonic rotation is:

- Rotation anterior and to the right ('resulting pull from the liver')
- Translation from the center to the left. ('pressure from outgrowth of the liver, traction from the spleen')
- Rotation Clockwise (Cw). around an A-P axis.

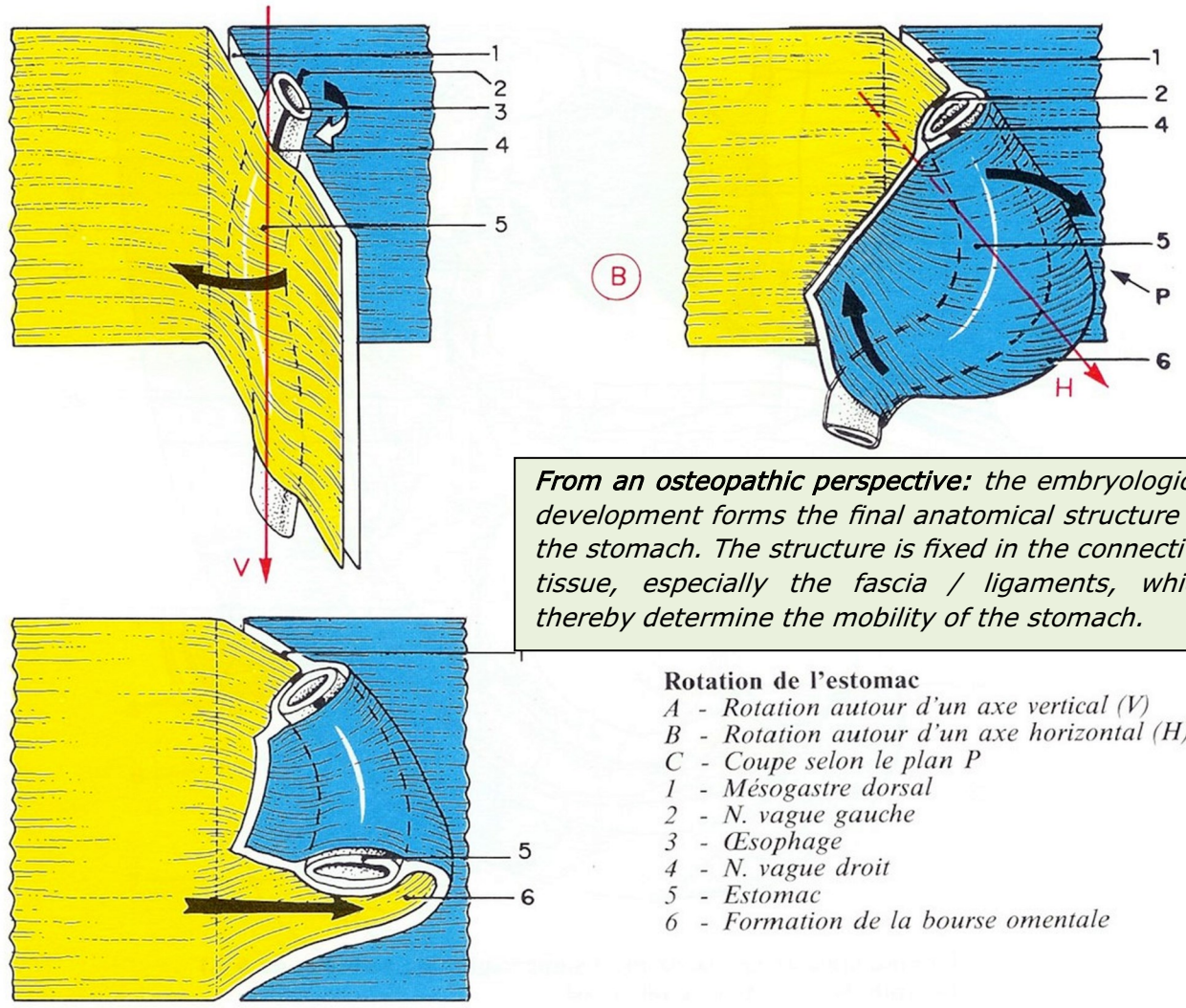
From the Meso-Gastrium anterior en posterior the ligaments arise; in other words: the fascial connections to other visceral/parietal structures.

For detailed embryology we refer to the many literature.





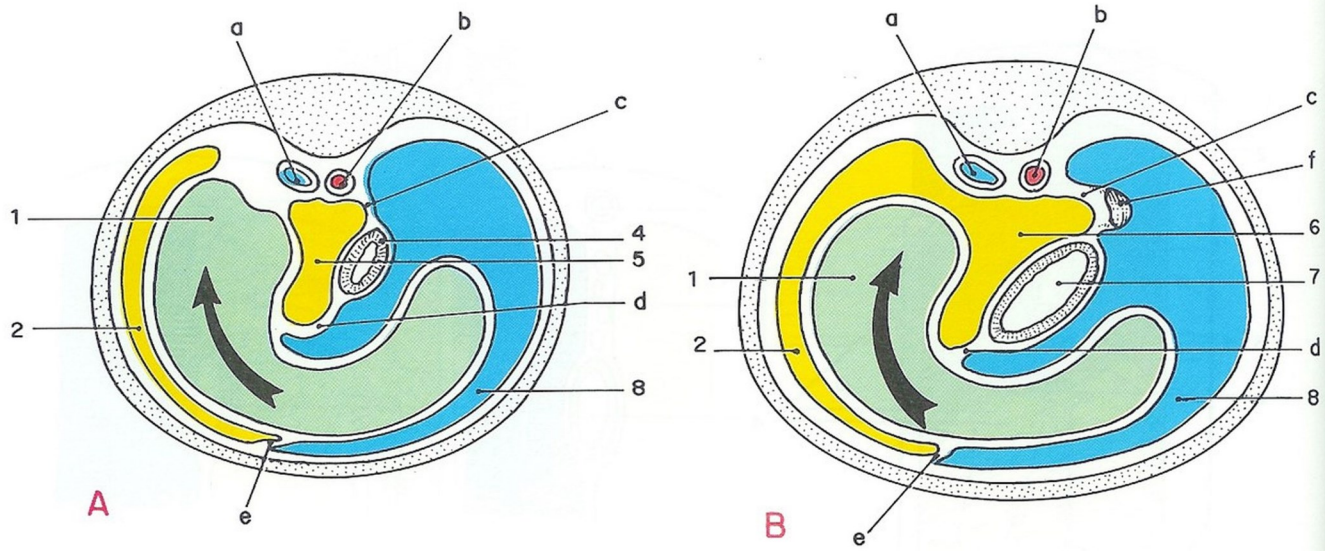
Sources:
- Langmans Medical Embryology, chapter 15, figure 15.8., page 236, fourteenth edition, 2019.
- Larsen: Human Embryology, chapter 14, figure 14.7. , page 350. Fifth edition, 2015.
- Kamminga, Dictionary Atlas d'anatomie, Mailoine S.A., Paris, 1984.



From an osteopathic perspective: *the embryological development forms the final anatomical structure of the stomach. The structure is fixed in the connective tissue, especially the fascia / ligaments, which thereby determine the mobility of the stomach.*

Rotation de l'estomac

A - Rotation autour d'un axe vertical (V)
B - Rotation autour d'un axe horizontal (H)
C - Coupe selon le plan P
1 - Mésogastre dorsal
2 - N. vague gauche
3 - Œsophage
4 - N. vague droit
5 - Estomac
6 - Formation de la bourse omentale



a - V. cave inférieure
b - Aorte
c - Mésogastre dorsal
d - Lig. gastro-hépatique
e - Lig. falciforme
f - Rate

Coupe horizontale schématique passant au niveau de l'œsophage (A) et de l'estomac (B)

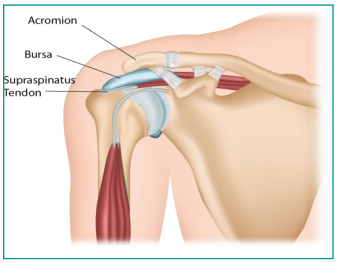
1 - Foie
2 - Cavité péritonéale droite
3 - Œsophage
4 - Septum transversum
5 - Récessus pneumato-entérique
6 - Bourse omentale
7 - Estomac
8 - Cavité péritonéale gauche

Bursa Omentalis

The Bursa Omentalis gains significant importance for the mobility of the stomach and therefore for all its functions. This Bursa forms a large sliding surface on the posterior side of the stomach.

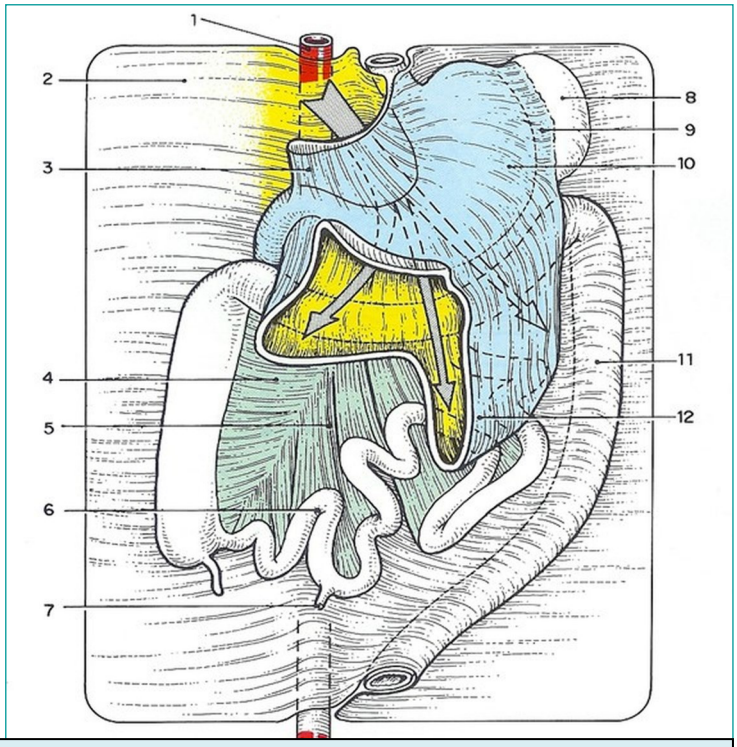
Intermezzo bursa:

A bursa is a fluid-filled 'cushion' between a tendon and the underlying bone structure at a joint, close to the tendon's attachment to the bone. The bursa minimizes friction in the mobility of the joint, preventing the tendon to rub over the bone or skin. Also with the Bursa Omentalis the meaning is: fluid filled sliding surface.



To the right side of the stomach, a coeloma (secondary body cavity) develops embryologically, with a recessus leading to the right lung and later separated by the septum Transversum (Diaphragm). Here the lobus Caudatus of the liver develops.

Inferiorly develops a recessus with the blood vessels of the truncus Coeliacus in the Mesogastrium posterius. Both recessi turn 90° to the left and orientate a frontal plane. Thus develops on the left the Bursa Omentalis, with the foramen of Winslow (Foramen of Huschke, foramen Epiploicum). The inferior Recessus is stretched from the stomach with the Curvatura Major and thus the Omentum Major is created. On the superior side, on the Curvatura Minor, the Omentum Minor develops.



Source: Kamina, P. Prof., Dictionary Atlas d'anatomie, Mailoine S.A., Paris, 1984.

The Bursa Omentalis:

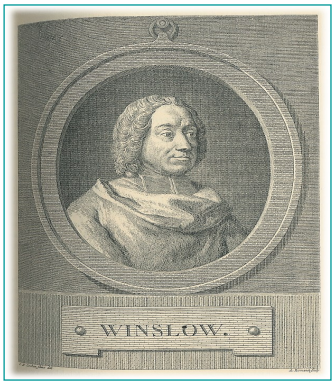
1. *Aorta*
2. *Peritoneum Parietalis*
3. *Omentum Minor*
4. *Mesocolon Ascendens*
5. *Mesenterium*
6. *Intestinum*
7. *Ductus Vitellinus*
8. *Spleen*
9. *Lig. Gastro-Lienale*
10. *Gaster*
11. *Colon Descendens*
12. *Inferior Recessus of the Bursa Omentalis.*

History Winslow:

Foramen of Winslow, is also called Foramen Omentalis or Foramen Epiploicum (lat.). Named after the anatomist Jacob B. Winslow. He called it Foramen Spinosum.

***Jacob Benignus Winslow** (1669–1760) was a French anatomist.*

His most important work was 'Exposition anatomique de la structure du corps humain', published in 1732. He described anatomy with physiological significance and hypothetical explanations.



5.6. VLAN GASTER

Because the atlases often only describe the arteries, these are also more extensively described.

From an osteopathic perspective *the veins are 'more important' than the arteries, as they are less subject to blood pressure and therefore 'susceptible' to obstruct in their flow. The same applies to lymph.*

Veins contain less muscular / elastic tissue and have thinner walls than arteries. They expand much more easily accommodating much larger volumes of blood for venous return (Tucker, WD et al 2023). If the integrity of the venous vascular walls decrease, the valves within veins lose their ability for proper venous return leading to congestion within the tissues reducing proper fluidal exchange. Fluids that become stagnant allow impurities / microorganisms within the tissues / cells to transpire.

Arteries Gaster

All originating from the truncus Coeliacus, forming two arterial circles with the Curvaturae.

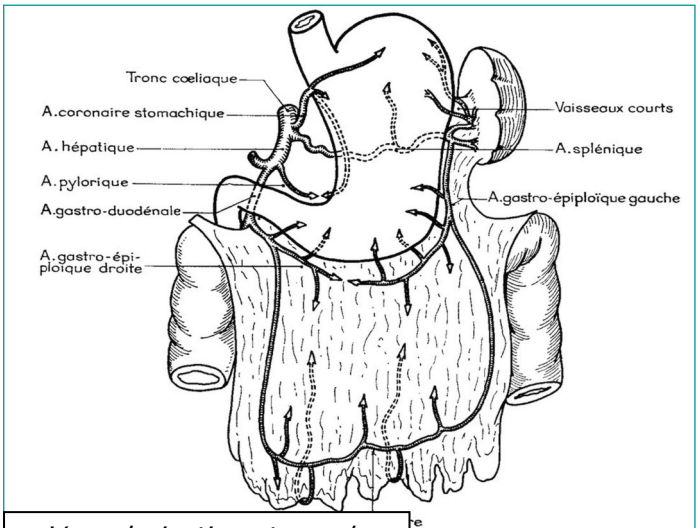
a. Curvatura minor: - A. Gastrica sinistra: - anterior branch.
- posterior branch.
- A. Pylorica. from A. Hepatica propria.
anastomose between both arteries anterior and posterior.

b. Curvatura major: A. Gastro-epiploica dextra (A. Gastro-omentalis dextra), from A.Gastro-duodenalis
A. Gastro-epiploica sinister (or A. Gastro-omentalis sinistra), from A. Lienalis.
anastomose between both arteries.

In addition, the A. Gastricae brevis, mainly intended for the fundus, supplies branches from A. Lienalis and A. Gastro-epiploica sinistra.

Veins Gaster

Run parallel to the arteries and drain into the Vv. Portae. In the Cardia there are connections between the portal vein and the plexus Venosus of the Oesophagus.



Vascularisation stomach.
Source: Perlemutter & Walligora.

Intermezzo vascular circulus:

Vascular circles are formed on both the Curvatura minor and the Curvatura major, due to the anterior and posterior anastomoses. The circles are important for the direct action of, among other things, the hormone Gastrine on the stomach itself.

From an osteopathic perspective, *obstruction of the blood vessels will therefore not happen quickly, except for the Curvatura minor. Here the blood vessels are located in the Omentum Minor. With a Gastroptosis, this Omentum is stretched and thus the blood flow is greatly reduced.*

Lymph Gaster

Along the arcades of the Curvaturae, and drain into the cisterna Chyli, posterior from the Pancreas.

There are three groups ganglia, along the A. Gastrica sinistra, the A. Lienalis and the A. Hepatica.

Innervation (Nerval) Gaster

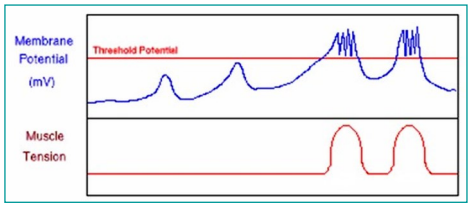
Enteric Nervous System (ENS)

The autonomic innervation of the stomach is formed by the:

- plexus Myentericus (plexus of Auerbach): muscles.
- plexus Submucosa (plexus of Meissner): mucosa.

Both plexuses surround the gastrointestinal tract like a trap (fishnet) and they start at the stomach. The Enteric nervous system works mainly with the neurotransmitter / hormone: Serotonin. The system controls smooth muscles and the glands of the TGI. The stomach represents similar to a pacemaker for peristalsis. The following lists the different wace cycles within the TGI:

- MMC: Migrating Myoelectral Complex; a continuous peristaltic 'squeeze' throughout the intestine, with different frequencies:
  - ◊ Duodenum I & II: circa 20 cycli / min;
  - ◊ Duodenum III & IV: circa 18 cycli / min;
  - ◊ Jejunum: from circa 17 up to 14 cycli / min;
  - ◊ Terminaal Ileum: 12 cycli / min.
- SWA: Slow Wave Activity; an automatic movement of the smooth musculature:
  - ◊ 10 – 20 cycli per minute in the Gaster;
  - ◊ 03 – 08 cycli per minute in the Colon.

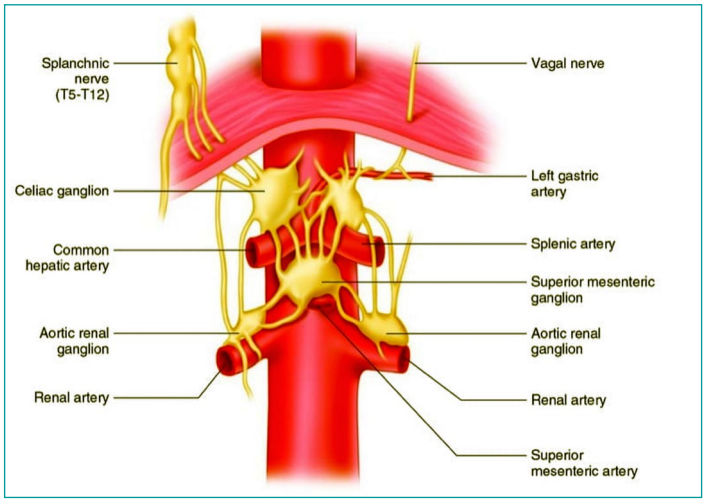


From an embryologic perspective, there is no cause or motor of peristalsis, but movements occur simultaneously and complexly. However, food intake is an important stimulus.

Parasympathetic Nerve System

The right N. Vagus takes care of the posterior side of the stomach, the left Vagus nerve takes care of the anterior side.

This is due to the embryological rotation of 90° of the stomach. But not only of the stomach itself, also the descensus and counterclockwise rotation of Cor, Lien, Hepar play an important role.



Sympathic Nerve System

N. Splanchnicus Major: T_{5-9}

Intermezzo peristalsis:

- *The MMC can be imagined as squeezing a tube, with one hand taking over the other.*
- *The SWA can be imagined as a pendulum movement of the tube.*