

Normal functions of the stomach II

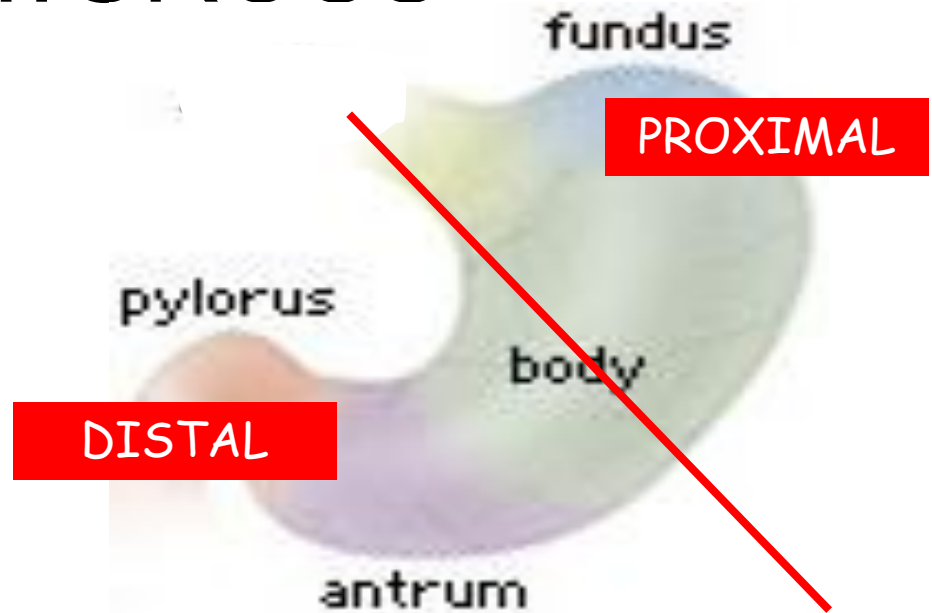
Motor function of stomach

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Functional anatomy of the stomach...GROSS

- Anatomically 4 parts:

- fundus
- corpus
- antrum
- pylorus



- Functionally divided in to two parts

- Proximal stomach – upper 2/3 of the body
 - Has storage function
- Distal stomach – lower 1/3 of the body and antrum
 - Mechanical and chemical digestion, and propulsion

Function of the stomach

1. Motor function

- stores food
- secretes and mixes food with acid, mucous and pepsin
- participates in digestion (mechanical & chemical)
- releases food at a controlled, steady rate into the duodenum

2. Secretory function

- pepsinogen: digestion
- acid: digestion & protective function
- intrinsic factor: vitamin B12 absorption
- gastrin: endocrine function

3. Protective function

Lecture objectives

- The student should be able to
 - describe main motor activities of the stomach
 - describe how these motor activities are regulated

Adaptations for motor functions

1. Storage of food

- fundal accommodation & receptive relaxation (motility of proximal stomach)

2. Mechanical digestion

- fasting & fed motor activity
- gastric myoelectrical activity

3. Controlled gastric emptying

- motility of distal stomach
- antro-pyloro-duodenal coordination

Motility of proximal stomach

- Storage function –

- proximal stomach (fundus & upper body) has a high compliance
- can accommodate a high volume with small increase in pressure – ACCOMODATION
- called RECEPTIVE RELAXATION
- Mediated by vagal fibres releasing VIP to inhibitory neurons of the myenteric plexus – vago-vagal reflexes

Motility of proximal stomach

- Storage function cont

- Proximal stomach can store approximately 0.8-1.5L of food. But minimal increase in pressure – **Lag phase**
- Food stored in layers. As a result food remains unmixed for up to an hour - Allows salivary amylase to digest carbohydrates

Motility of the distal stomach

- Mixing contraction -

- Weak peristaltic contractions
- More frequent (80%)
- Begins in mid portion of stomach – moves towards antrum
- Rate approximately 3/min. Regulated by BER
- Contractions increase in velocity and force towards pylorus

Motility of the distal stomach

- Mixing contraction – cont...

- Push contents at higher pressure towards pylorus
- But pylorus is a small opening. Only little chyme can escape in to small intestine
- Rest – Retropulsion
- This is important in mixing and grinding

Mixing contractions

Video

<https://www.youtube.com/watch?v=-hU8xnGNeYE>

Motility of the distal stomach

- Pyloric pump -

- Very powerful peristaltic contractions – occur 20% of time
- More towards later stages of GE
- Gradually digs deeper in to stored food than normal mixing contractions
- Pinches off food
- Causes mixing and grinding of food and emptying of chyme
- Solids are broken down into particles less than 2 mm (CHYME) before entering the small intestine

Pyloric pump

Video

<https://www.youtube.com/watch?v=pJCjDtfhsCI>

In fasting state.....

- *migrating motor complexes (MMC)* occur from proximal to distal stomach
- Will be discussed later



Regulation of stomach motility

Stomach motility depend on ---

1. Myogenic factors

- Myoelectrical activity of gastric smooth muscle

2. Neurogenic factors

- Enteric nervous system
- Autonomic nervous system
- Central nervous system – brain-gut-axis

3. Humoral factors

Innervation of stomach

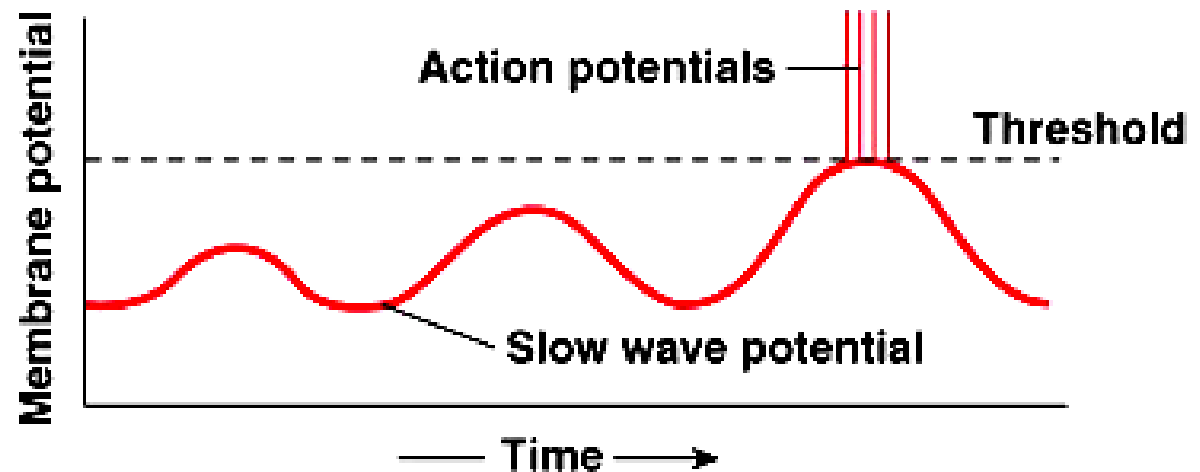
- Parasympathetic input from vagus nerve
 - Excitatory : cholinergic
 - Inhibitory : NANC
- Sympathetic input from coeliac plexus
 - Noradrenaline
- Enteric nervous system
 - Myenteric plexus
 - Output to smooth muscles cells & secretory and endocrine cells of mucosa
 - Sub mucosal plexus
 - Output to secretory and endocrine cells of mucosa

Gastric myoelectrical activity

- Starts from the 'gastric pacemaker'
 - a region of rapid spontaneous depolarization
 - along the greater curvature of the stomach
 - interstitial cells of CAJAL
- Determines the rate of gastric contractions
- 2 types of electrical activity
 - Slow waves
 - Spikes

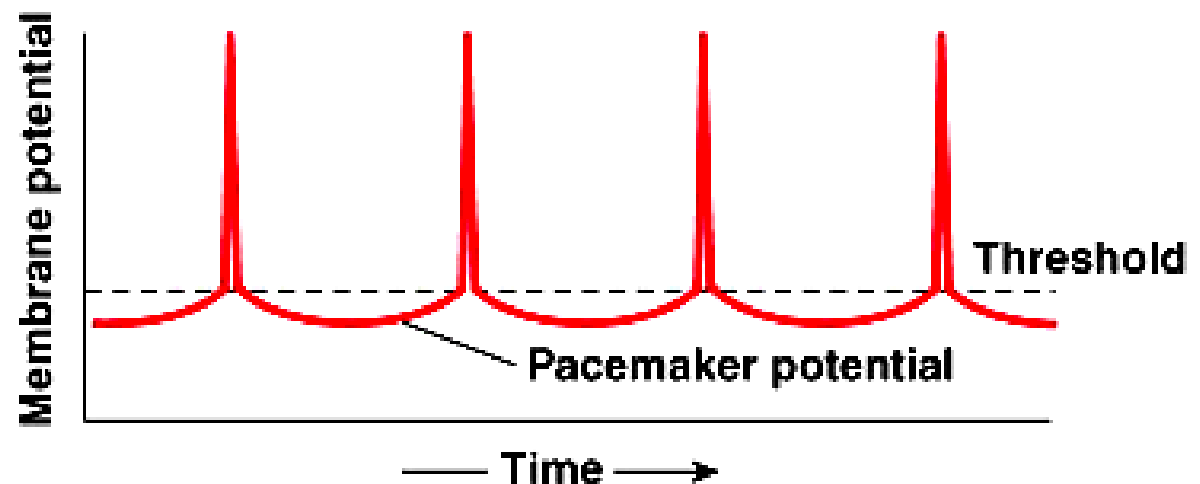
Electrical activity of gastrointestinal smooth muscle

(a) Slow wave potentials fire action potentials when they reach threshold.



Intrinsic electrical activity originate in the pace maker cells

(b) Pacemaker potentials always depolarize to threshold.



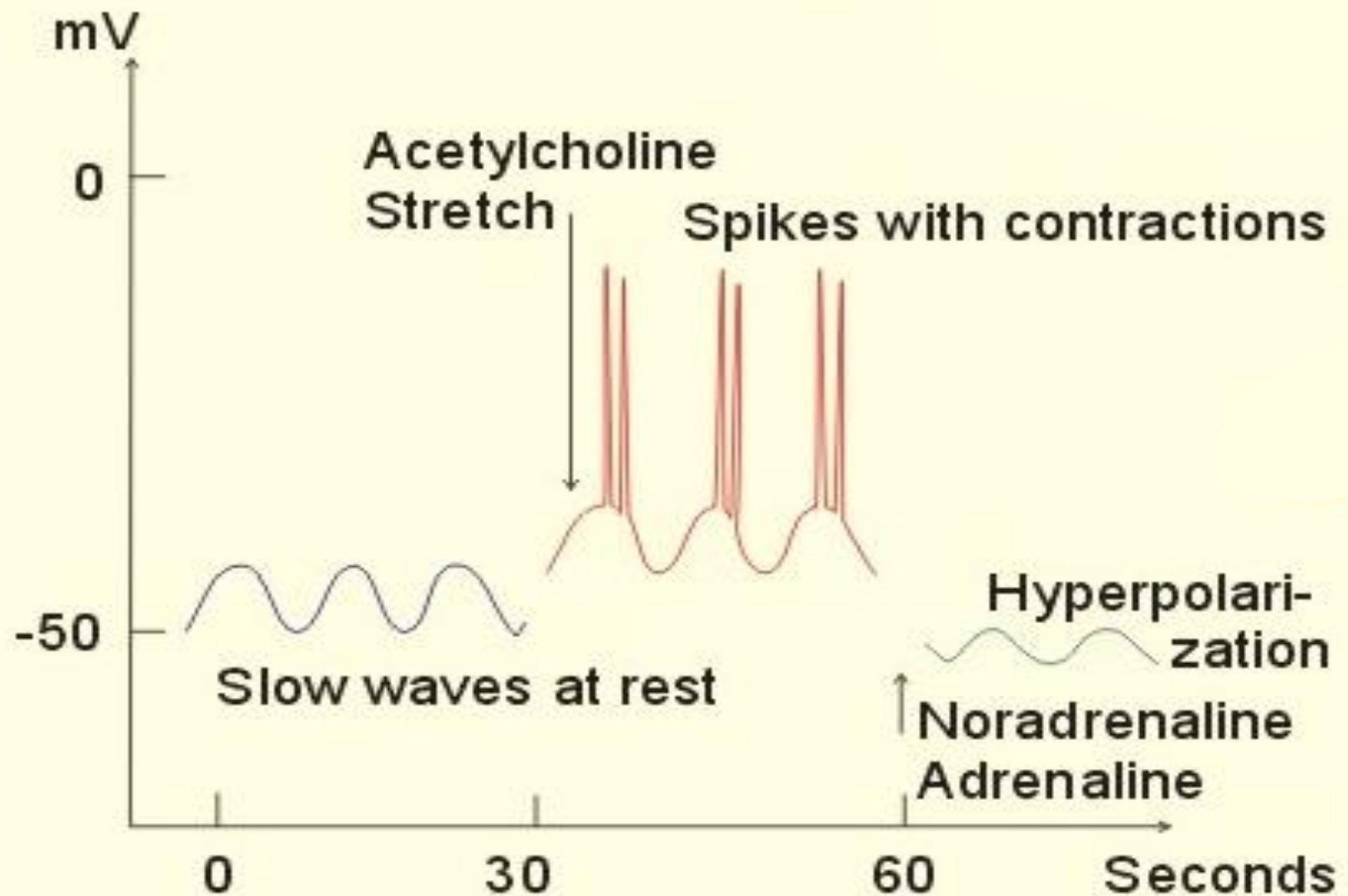
Slow waves (basic electrical rhythm)

- Are SLOW oscillations of the resting membrane potential
- Frequency of 3/ min the stomach
- NOT TRUE ACTION POTENTIALS
- Slow waves begin in body and fundus and spread to the antrum
- As they approach the antrum, spike potentials may appear

Spike potentials

- Occur when RMP becomes more positive $> -40\text{mV}$ (depolarized)
- TRUE ACTION POTENTIALS - initiate gastric contractions
- Mediated by Ca^{2+} influx through voltage-gated Ca^{2+} -channels - entry of Ca^{2+} helps contraction
- Increase in no of spikes: increased strength of contractions
- Frequency of spikes are \uparrow by factors that favour depolarization and \downarrow by those that favour hyperpolarization - READ

Electrical activity in gastric smooth muscles



Gastric emptying

- Process of release of chyme into duodenum
- Regulated by antro-pyloro-duodenal coordination
 - antrum, pylorus & duodenum function as a unit
- Gastric emptying rate (GER) depends on
 - force and frequency of antral contractions
 - chemical and physical properties of chyme

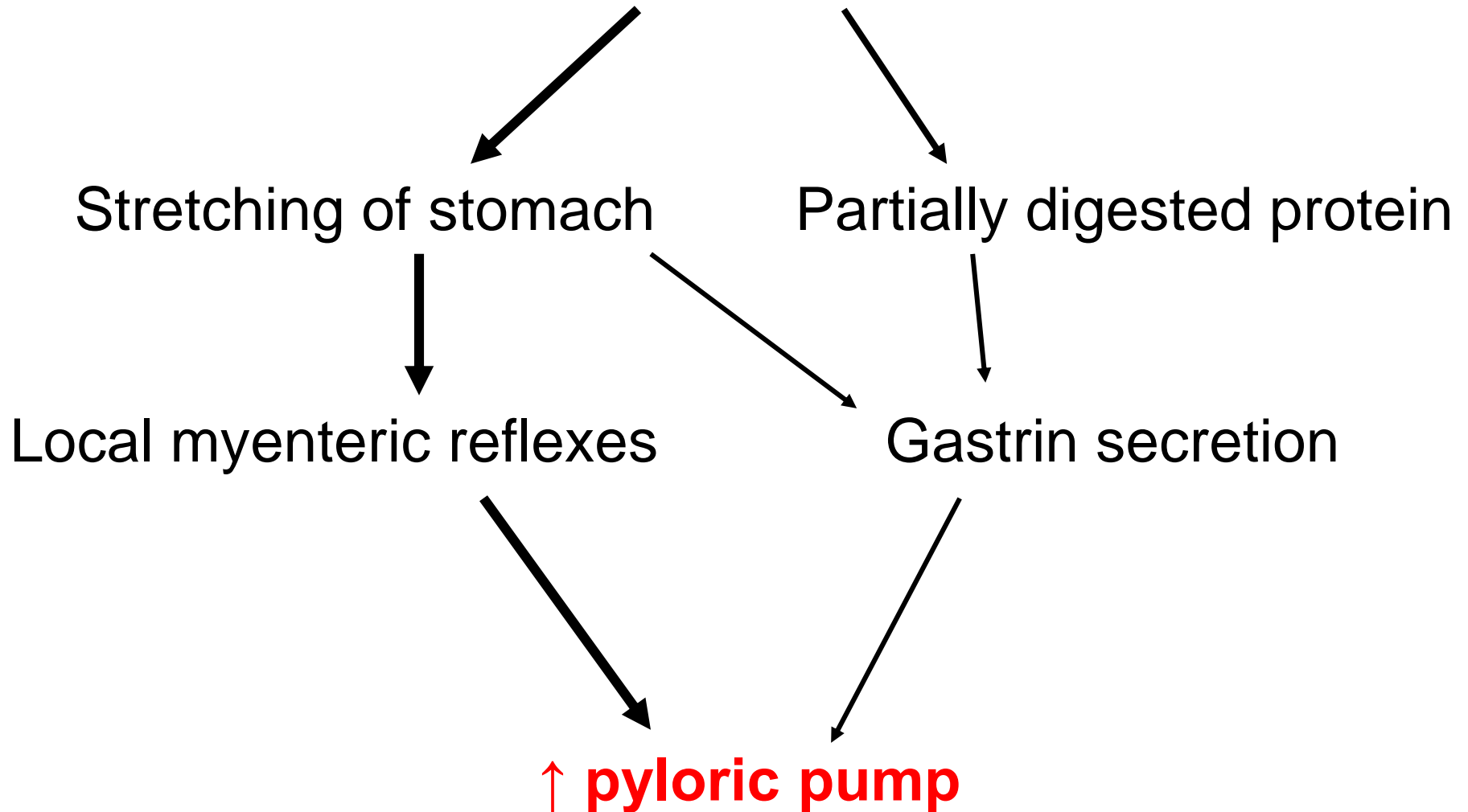
Regulation of gastric emptying

- Gastric emptying is regulated by
 1. Gastric factors - Stimulatory
 2. Duodenal factors - Inhibitory

1. Gastric factors

- Local myenteric reflexes
- Gastrin

Presence of food in stomach

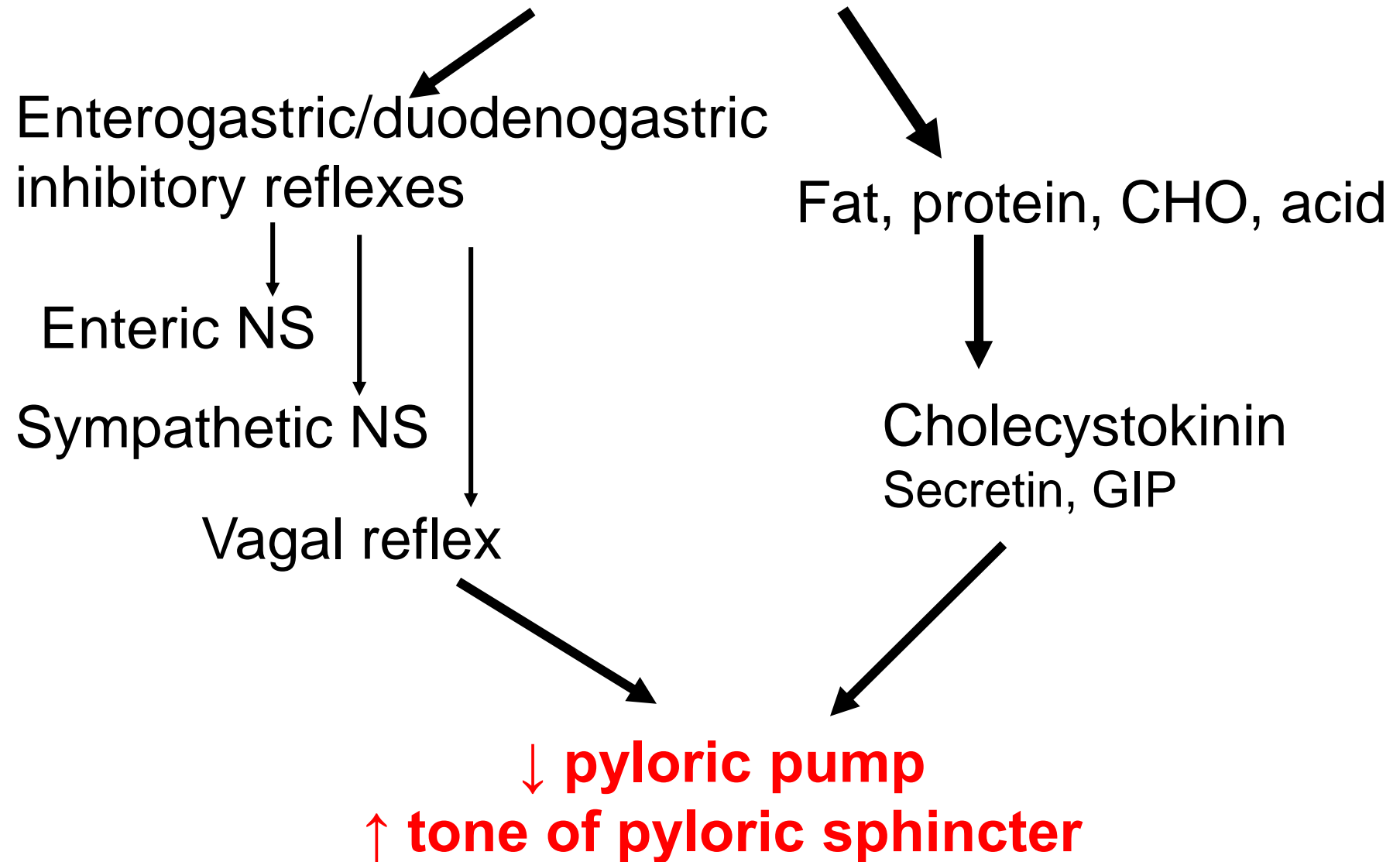


Factors operating in duodenum

- Negative feedback by
 - neural (entero-gastric/ duodeno-gastric reflex)
 - hormonal reflexes
- Stimuli are
 - Volume – Degree of distention
 - concentration of substrates – Presence of fat (protein, CHO)
 - Decreased pH – Presence of acid
 - tonicity of chyme – Hyper or hypo-osmolar chyme
 - Irritation

- Detected by duodenal receptors
 - chemoreceptors (acid, concentrations of fat, CHO, proteins)
 - osmoreceptors (osmolality)
 - stretch receptors (volume)
- Effect is inhibition of antral contractions and contraction of pyloric sphincter

Presence of food in duodenum

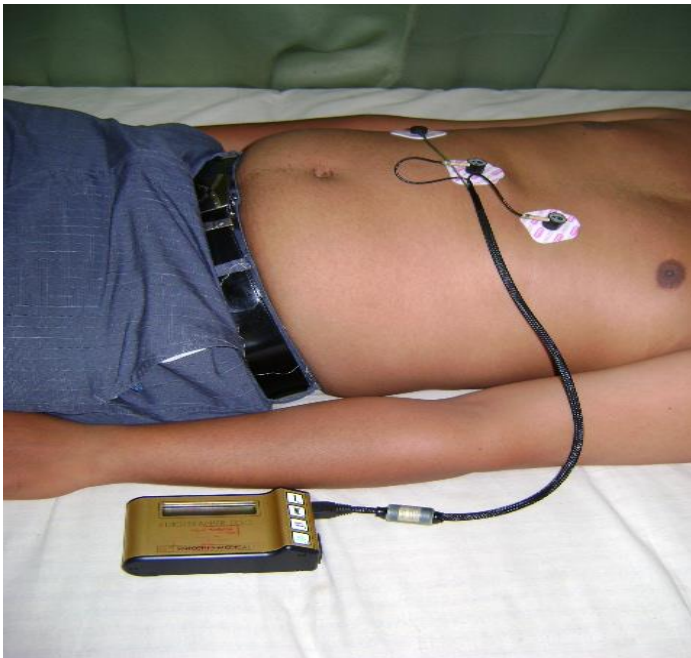


Assessment of motor activity of stomach

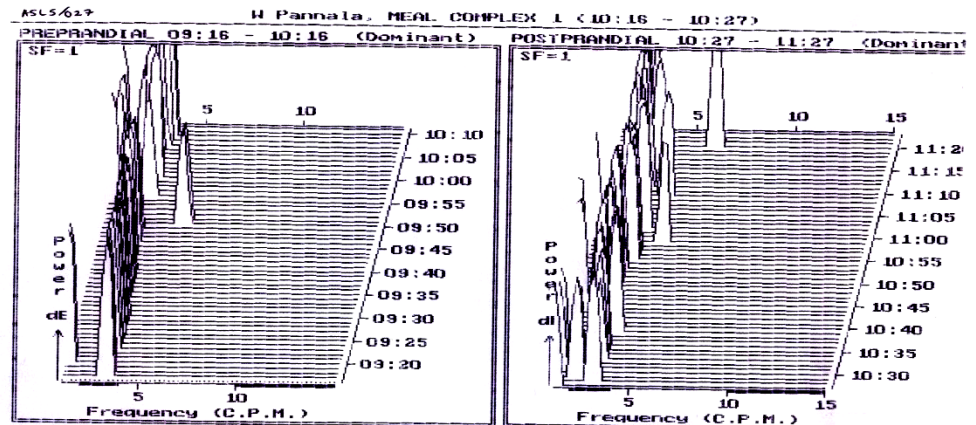
- Gastric myoelectrical activity
 - cutaneous electrogastrography (EGG)
- Gastric motility
 - Manometry
 - Ultrasound methods
 - Proximal stomach accommodation – barostat
- Gastric emptying
 - Scintigraphy – radiolabelled substance
 - Ultrasound methods
 - Barium contrast studies
 - Radio-opaque markers

Measuring gastric myoelectrical activity in our unit

Cutaneous electrogastrography EGG



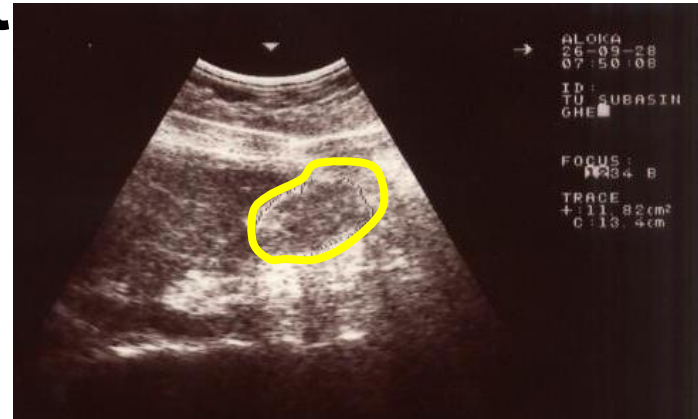
Normal activity



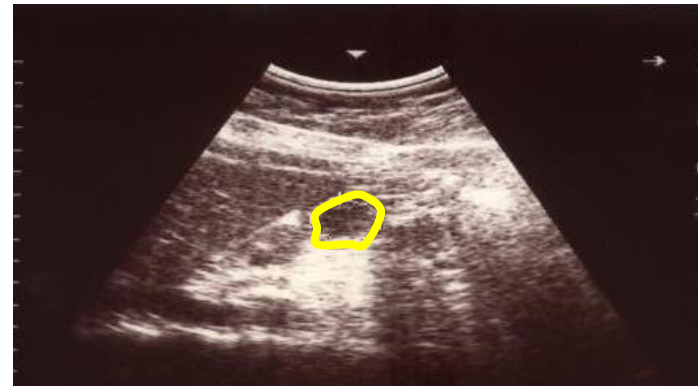
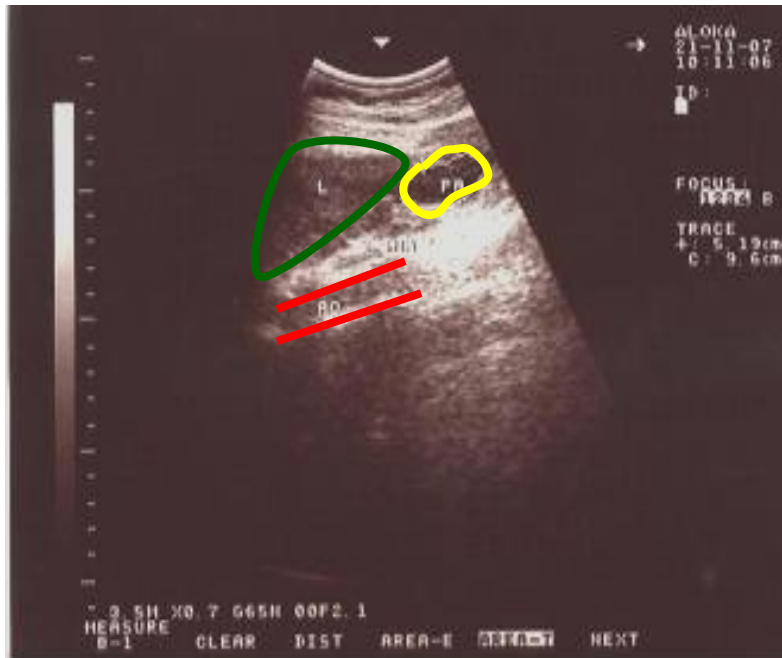
Disordered activity – note irregularity

Measuring gastric emptying in our unit

Real time- Ultrasonography



Start of meal



End of meal

Motor disorders of stomach

- Delayed gastric emptying
 - Impaired motility – gastroparesis (e.g. DM)
 - Outlet obstruction – e.g. pyloric stenosis
- Rapid gastric emptying – Dumping syndrome
 - e.g. gastrectomy

The dumping syndrome

- Uncontrolled emptying of gastric contents into the duodenum
- Rapid emptying
 - chyme has ↓ pH and ↑ tonicity
 - increased speed through intestine
- Results in
 - incomplete digestion and absorption of fats and protein: steatorrhoea
 - increased osmolality: diarrhoea
 - increased bacterial activity on undigested products: cramping, gas and bloating