Key concepts in Digestion….
GORD module

Overview of digestion

… or, 'our gut reactions to food'

Prof. Barry Campbell

GI Physiology

e-mail: bjcampbl@liv.ac.uk

http://pcwww.liv.ac.uk/~bjcampbl

UNIVERSITY OF LIVERPOOL

Contribution to the following milestone set out for CLC1:

FoP2.1(1) *identify and describe the common/ serious, extrinsic and intrinsic factors that can affect the normal biological processes in individual organs or organ systems, which could affect the level of oral and general health risk, treatment complications and/or outcomes*

You are all experts on digestion…and indigestion!…

Objectives: - To develop an understanding of:

1. **the function of the main regions of the gastrointestinal tract and associated secretory organs**
2. **the cellular origin, composition and function of gastric juice**
3. **the cellular mechanisms and regulation of gastric acid secretion**
4. **how we can control excess acid secretion**
5. **the role of the *Helicobacter pylori* in indigestion, inflammation, ulceration and cancer.**

It is important for every dentist to be aware of the oral manifestations of gut disorders

3 common GI disorders can have a negative effect on oral health!...

- **Gastro-Oesophageal Reflux Disease (GORD):** Commonly known as **heartburn** -experience a burning feeling in the chest or a bad acid taste in the mouth.

Stomach acid enters up to the oral cavity and can erode tooth enamel. Prescription of oral rinse fluoride/remineralization treatment may support strengthening of teeth.

- **Inflammatory Bowel Disease (IBD):** Crohn's disease can manifest in the oral cavity, particularly in children. Oral signs and symptoms include mouth sores, infections, bleeding or swollen gums. Prescriptions for IBD can also affect your dental health.

- **Peptic Ulcers:** Some medications to treat stomach or duodenal ulcers have side effects that can adversely affect dental health - dry mouth, black tongue or change in taste. Over-the-counter medication can make these drug effects worse.

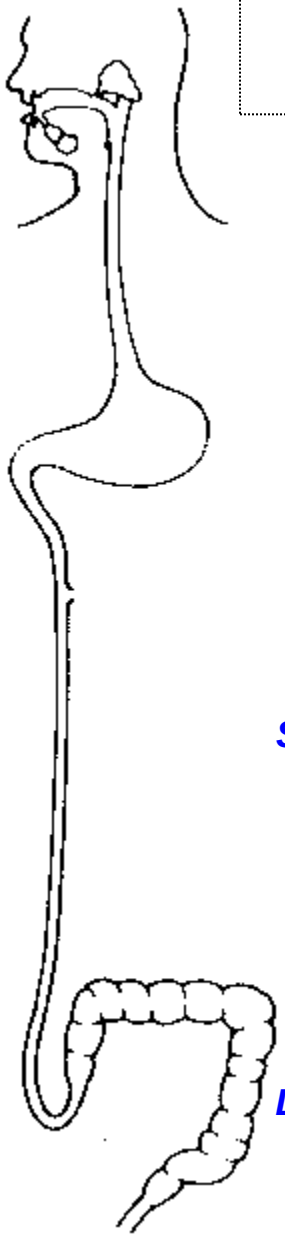
DIGESTION

"The progressive breakdown of food into a form suitable for absorption and the associated transport processes"

Digestion therefore also includes: -

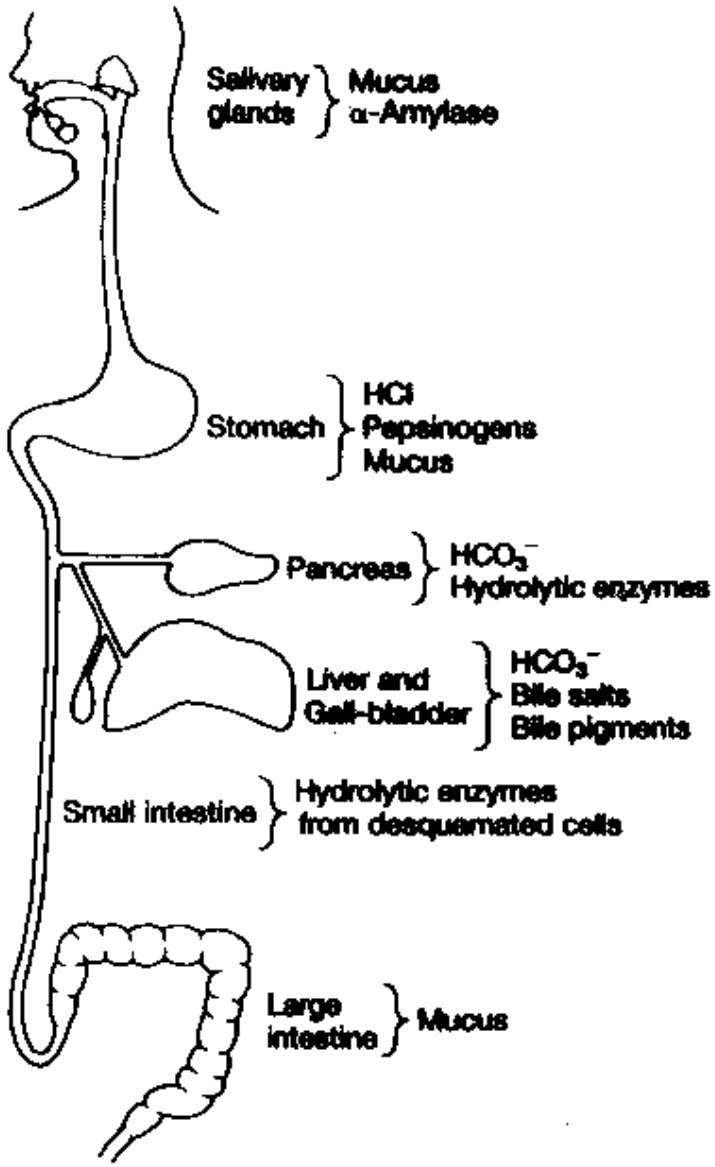
- ***The processes of secretion***
- ***The processes of absorption***
- ***Movement of the gut contents***
- ***growth & differentiation***
- ***The mechanisms protecting the gut from damage or attack, and***
- ***the mechanisms controlling and integrating all of the above***

SCHEMATIC REPRESENTATION OF MAIN REGIONS OF THE GASTROINTESTINAL TRACT



REGION:		FUNCTION:
	Oesophagus	- *Transit*
	Stomach	- *storage, H^+/peptic digestion & intrinsic factor*
Small intestine	duodenum	- *fat, protein, carbohydrate digestion & absorption, Ca^{2+}/Fe^{2+}*
Small intestine	jejunum	- *water and electrolyte transport*
Small intestine	ileum	- *bile salt & vit B12 transport*
Large intestine	Colon	- *Storage* - *water and electrolyte transport*
Large intestine	rectum & anus	- *defaecation*

SECRETIONS OF THE GUT



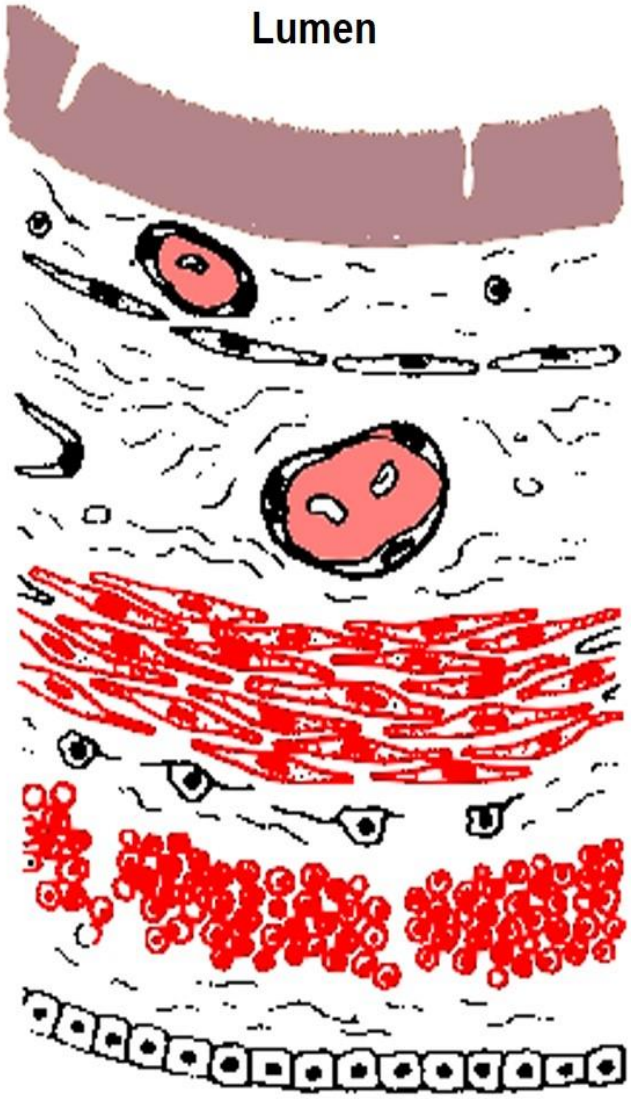
Salivary glands -
synthesis/secretion:
amylase, mucus.
Water, electrolytes

Exocrine pancreas -
synthesis/secretion:
proteases,lipase,amylase.
HCO_3^- , water

Liver -
bile salt synthesis,
bile secretion.

Gall bladder -
storage and concentration of bile

Schematic: the gut wall



epithelium

Lamina propria

Muscularis mucosa

MUCOSA

SUBMUCOSA

Circular muscle

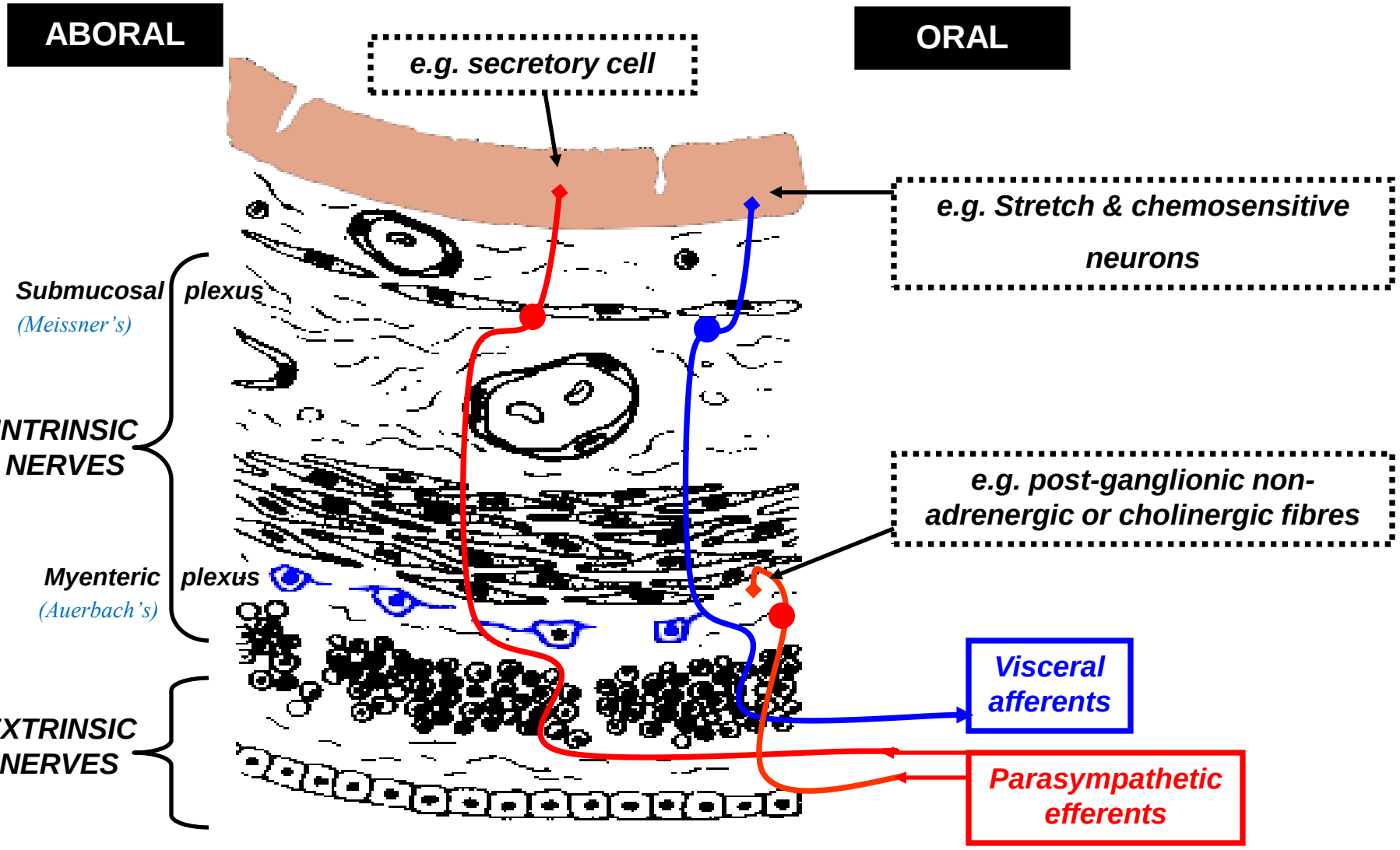
Myenteric plexus

Longitudinal muscle

MUSCULARIS PROPRIA

Mesothelium (SEROSA)

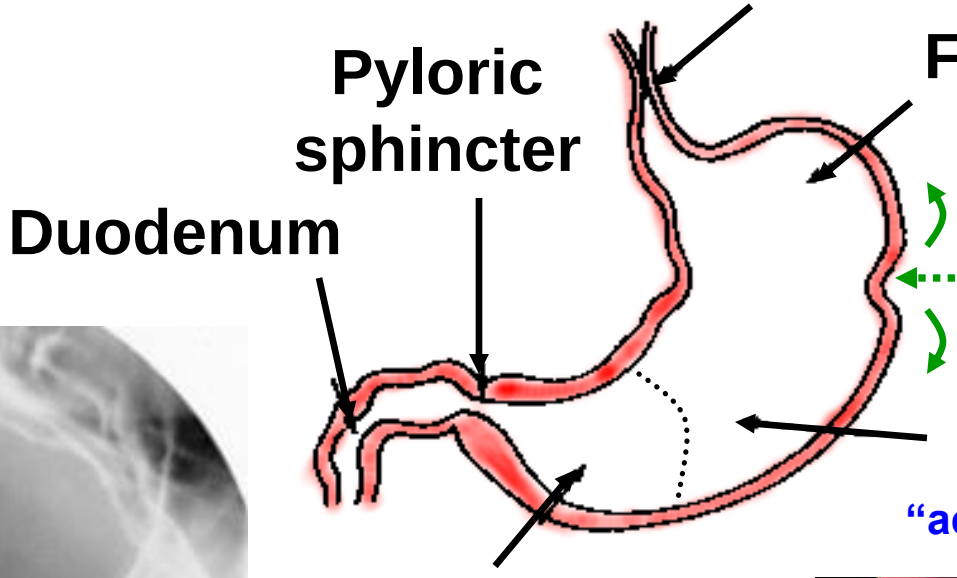
Intrinsic and extrinsic nerves of the digestive tract

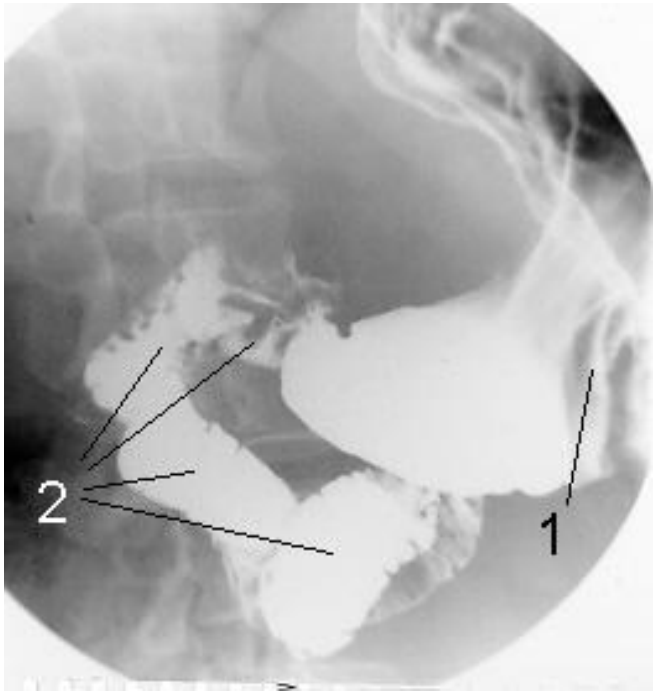


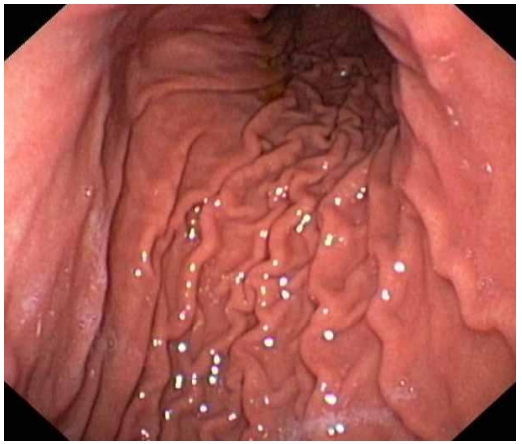
Function & Dysfunction in the GI tract

Physiology	*Pathology*
• Growth/development	- cancer
• secretion	- peptic ulcer, cystic fibrosis
• absorption	- malabsorption
• motility & signalling to CNS	- irritable bowel, oesophagitis, gastroparesis & non-ulcer dyspepsia
• surveillance (immuno/metabolic)	- ulcerative colitis, Crohn's disease, Coeliac disease
• co-ordination (neurons/hormones)	

Regions of the stomach



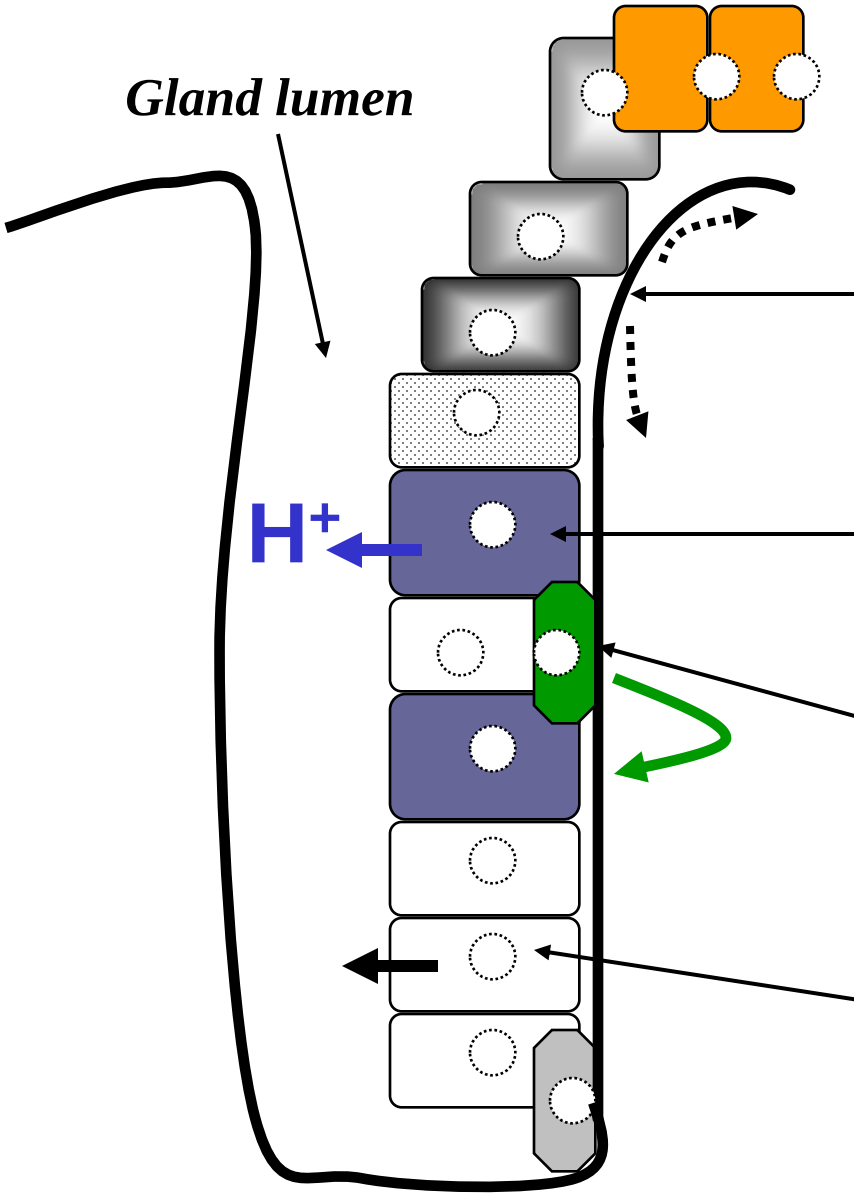




THE GASTRIC MUCOSA

	Major cell types	*Functions*
CORPUS	• surface epithelial	- mucus, HCO_3^-
	• chief (zymogen)	- pepsinogen
	• parietal	- HCl, intrinsic factor
	• enterochromaffin-like (ECL)	- histamine
ANTRUM	• surface epithelial	- mucus, HCO_3^-
	• chief (zymogen)	- pepsinogen
	• G-cells	- gastrin
	• D-cells	- somatostatin

Cells of the gastric (corpus) gland



Surface epithelial cells - *protective role*

Proliferating cells

Parietal cells - *secrete acid to lumen*

Enterochromaffin-like cell (ECL) - *secrete histamine*

Chief cells - *secrete pepsinogen to lumen*

Exocrine cells:

Secrete into the lumen

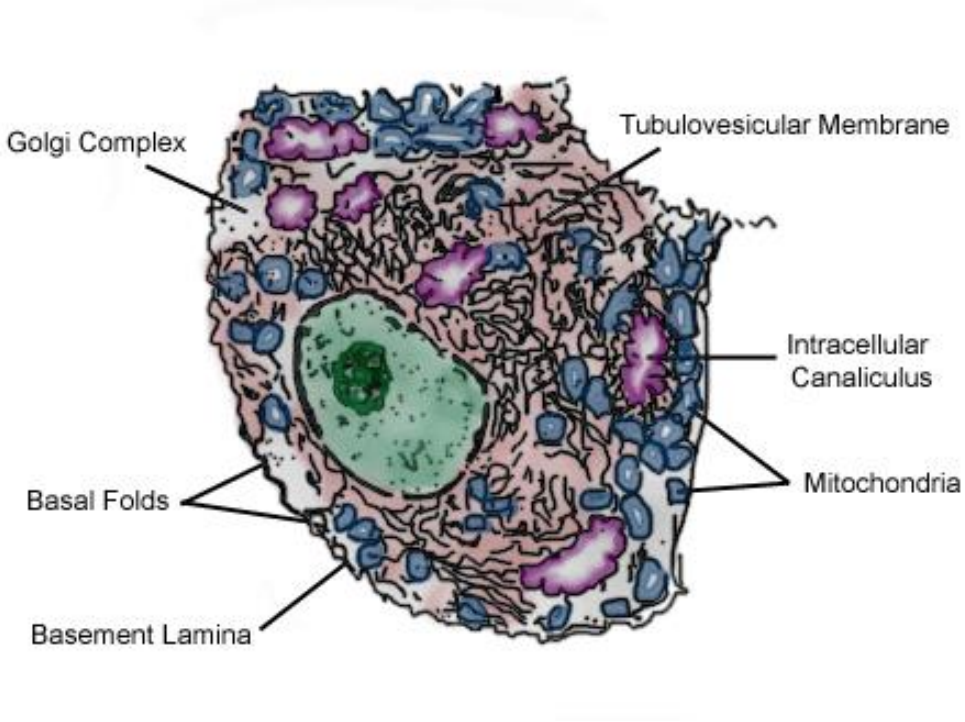
- **Mucus cells**
- **chief (zymogen) cells**
- **parietal cells**

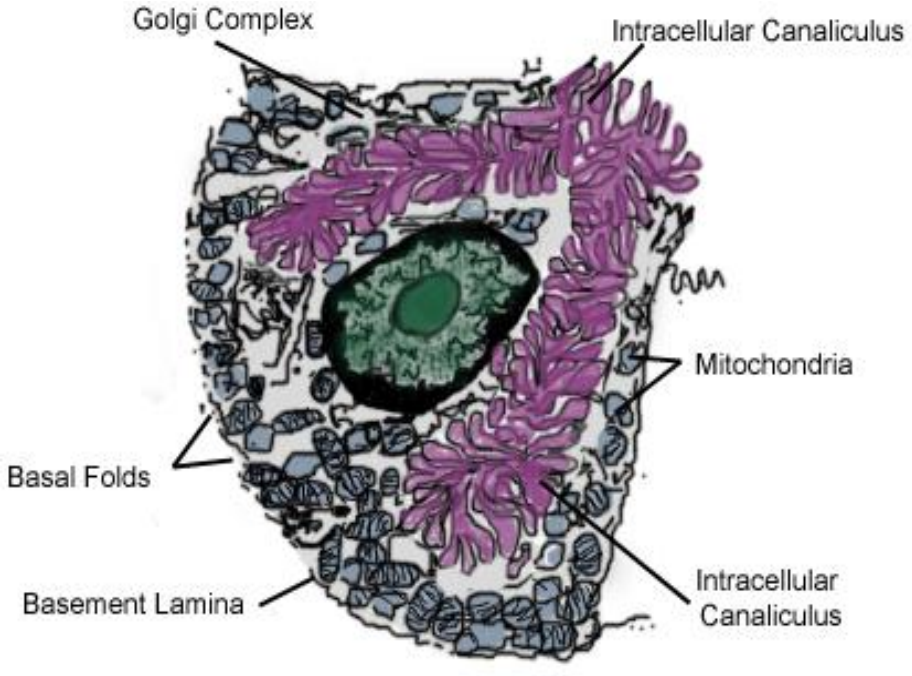
Endocrine cells:

(secrete internally)

- **G-cells**
- **D-cells**
- **enterochromaffin-like (ECL) cells**

The acid(HCl)-secreting parietal cell



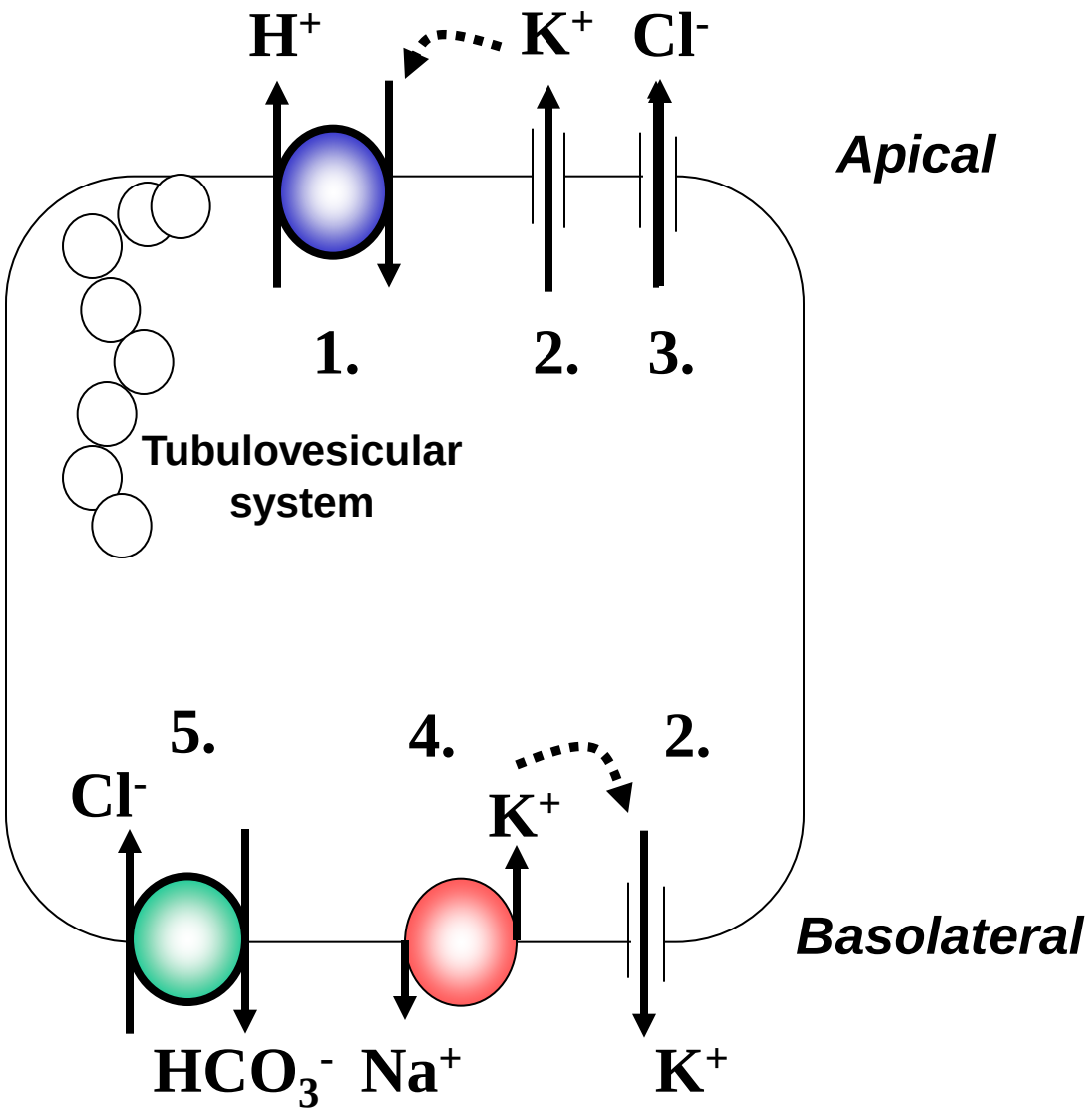


resting

stimulated

Parietal cell transport processes for HCl secretion

1. Proton pump (H^+/K^+ATPase)
2. K^+channel
3. Cl^- channel
4. Sodium pump
5. Cl^-/HCO_3^- exchanger



Carbonic anhydrase

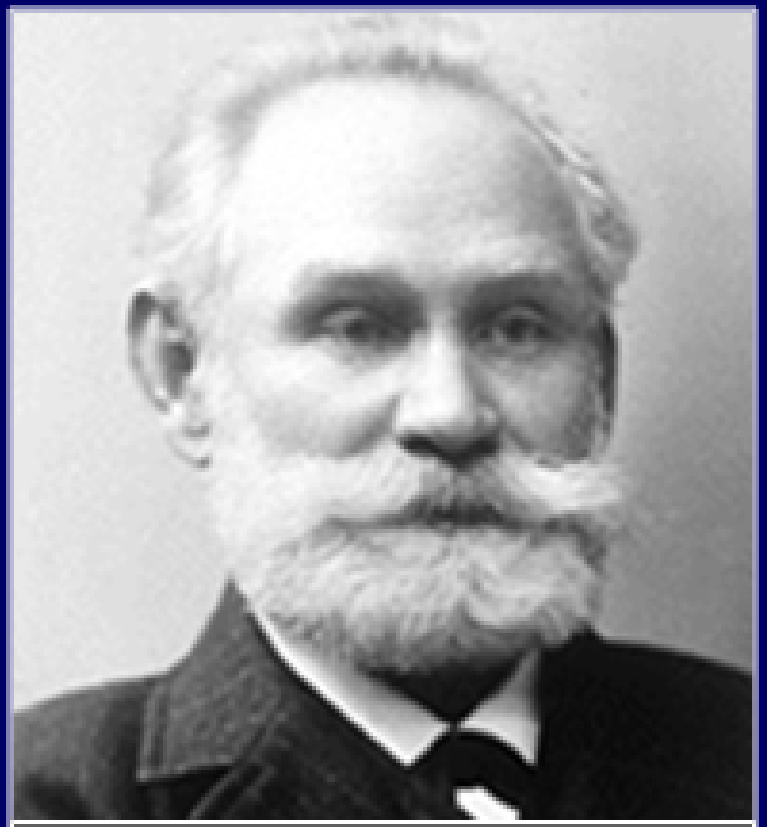
$$H_2O + CO_2 \overset{*}{\rightleftharpoons} H_2CO_3$$

$$\rightleftharpoons HCO_3^- + H^+$$

PHYSIOLOGICAL CONTROL SYSTEMS IN THE GASTROINTESTINAL TRACT

- **Endocrine** - **Gut hormones**
- **Paracrine** - **Local regulators**
- **Neural**
- **Intrinsic** - **Myenteric & submucosal nerve plexuses**
- **Extrinsic** - **Afferent & efferent n.**
  vagal & splanchnic trunks
  (autonomic nervous system)

The vagus nerve, appetite & acid



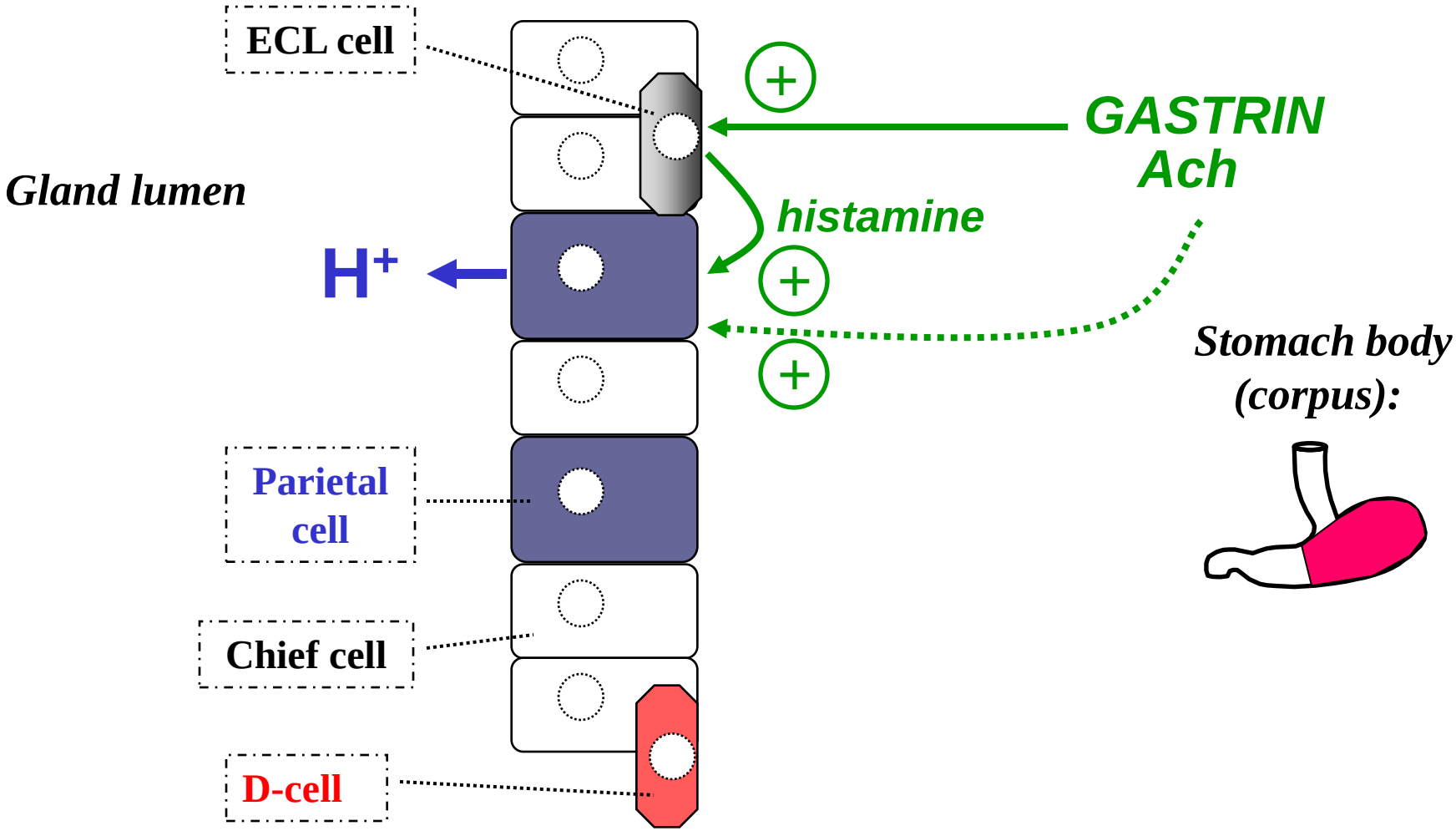
I P Pavlov

Nobel Prize, 1904 ...
in recognition of his work on the physiology of digestion

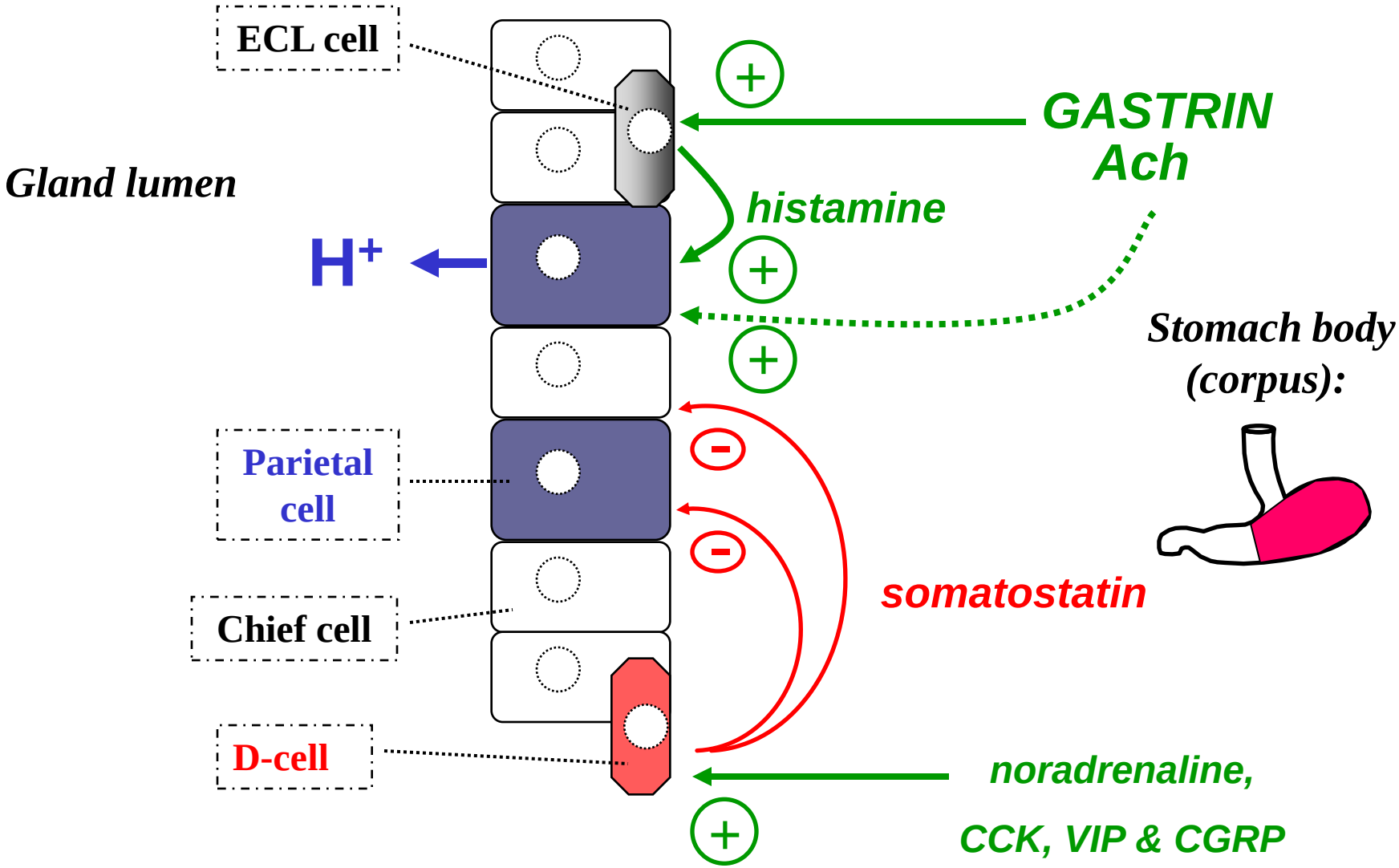
"Appetite spells gastric juice" .....

gastric juice marketed for the stimulation of poor appetite

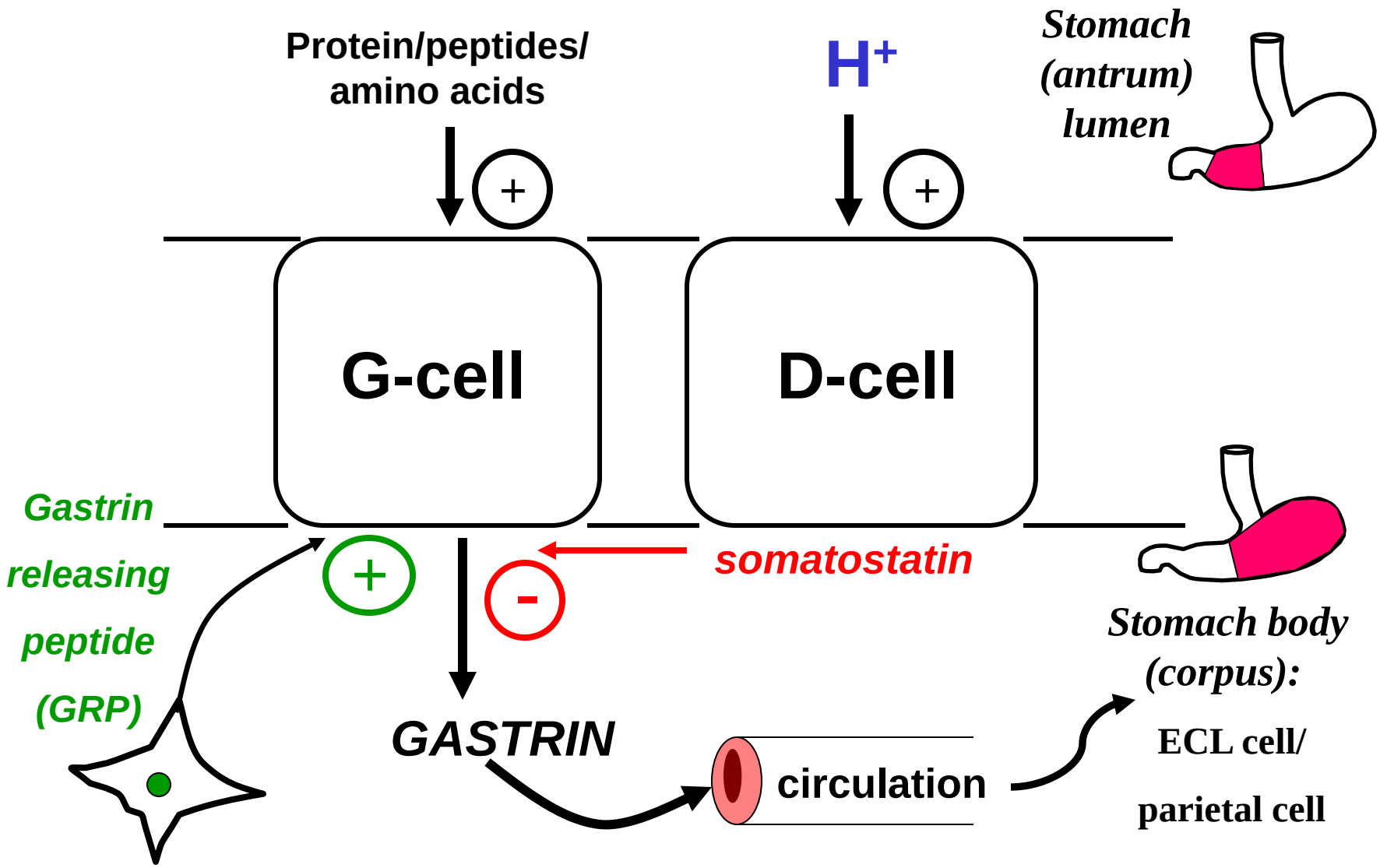
THE CONTROL OF ACID SECRETION



THE CONTROL OF ACID SECRETION



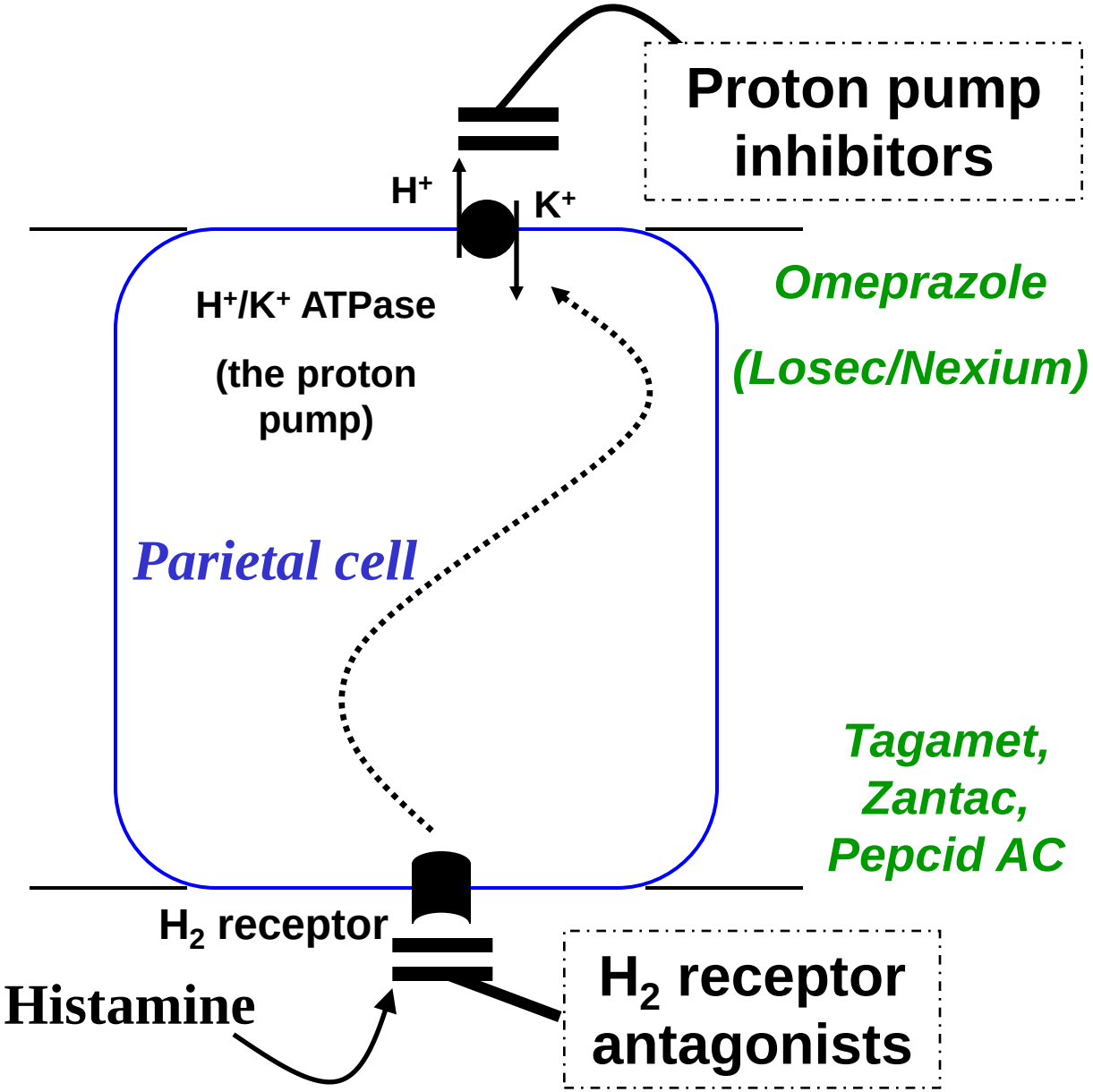
Control of G-cell function



Acid inhibitory therapy

reflux oesophagitis
"heart burn"

Peptic ulcer



Helicobacter pylori

A class 1 biological carcinogen (IARC, 1994)

Helicobacter pylori

A class 1 biological carcinogen (IARC, 1994)

In antrum, associated with;

↓ somatostatin secretion

↑ gastrin (hypergastrinaemia)

↑ acid secretion

duodenal and peptic ulcer disease

In antrum and corpus, associated with

↑ Gastrin (hypergastrinaemia)

↓ acid secretion

atrophic gastritis, gastric cancer

The Nobel Prize in Physiology or Medicine 2005

"for their discovery of the bacterium *Helicobacter pylori* and its role in gastritis and peptic ulcer disease"

3 October 2005

Barry J. Marshall

J. Robin Warren

http://nobelprize.org/medicine/laureates/2005/press.html