KHARKOV NATIONAL MEDICAL UNIVERSITY
Physiology department

WORKBOOK

FOR INDIVIDUAL STUDENTS' WORK

PHYSIOLOGY OF VISCERAL SYSTEMS:

RESPIRATION

DIGESTION & NUTRITION

ENERGY METHABOLISM & THERMOREGULATION

EXCRETION

Name_____

Faculty_____

Group_____ course_____

2017

МИНИСТЕРСТВО ЗДРАВООХРАНЕНИЯ УКРАИНЫ
Харьковский национальный медицинский университет

Physiology of visceral systems

Respiration
Digestion & Nutrition
Energy metabolism & Thermoregulation
Excretion

Manual for individual work of
second-year students (English-medium)

Физиология висцеральных систем:
Дыхание. **Пищеварение и питание.**
Энергетический обмен и терморегуляция. Выделение
Методические рекомендации для индивидуальной работы
студентов 2-го курса с английской формой обучения

Харьков
ХНМУ
2017

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D.I. Marakushin
I.N. Isaeva
I.S. Karmazina
R.V. Alexeenko
N.S. Hloba

Introduction

This Workbook combines information about physiology of following functional systems which are crucial to control homeostatic parameters of our organism: 1) respiration, 2) digestion and nutrition, 3) energy metabolism, 4) thermoregulation, 5) excretion.

The life is impossible without making up for the nutrients in the organism which are continuously consumed by the cells in the metabolism process. The most of the nutrients enter into the food composition but they are in the condition that is not ready for assimilation. Utilization of proteins, lipids and carbohydrates for satisfaction of energetic and plastic organism necessities becomes possible just only after their physical and chemical processing in the gastro-intestinal tract. As a result these substances are transformed into the rather simple water-soluble chemical compounds – *nutrients* which don't have the species specificity, but they keep the energetic and plastic value.

Metabolism and energy exchange is a complex of biochemical reactions and connected with them energetic processes that supply the vital functions of living beings. The energy released during metabolic reactions then is used to exert various processes in an organism such as maintenance of body temperature, blood circulation, respiration, muscles contraction, etc.

Excretion is also significant feature of living beings as nutrition and respiration and its impairment inevitably leads to disbalance of homeostatic parameters, violation of metabolism and vital functions.

Creation of this manual is an attempt of physiology department teachers to help students to make out the tremendous amount of information from different textbooks and Internet sites, because we have chosen key questions which are essential for understanding of physiology of respiration, nutrition and excretion, mechanisms of thermoregulation and excretion as well as their disorders.

Good luck!

Recommended publications

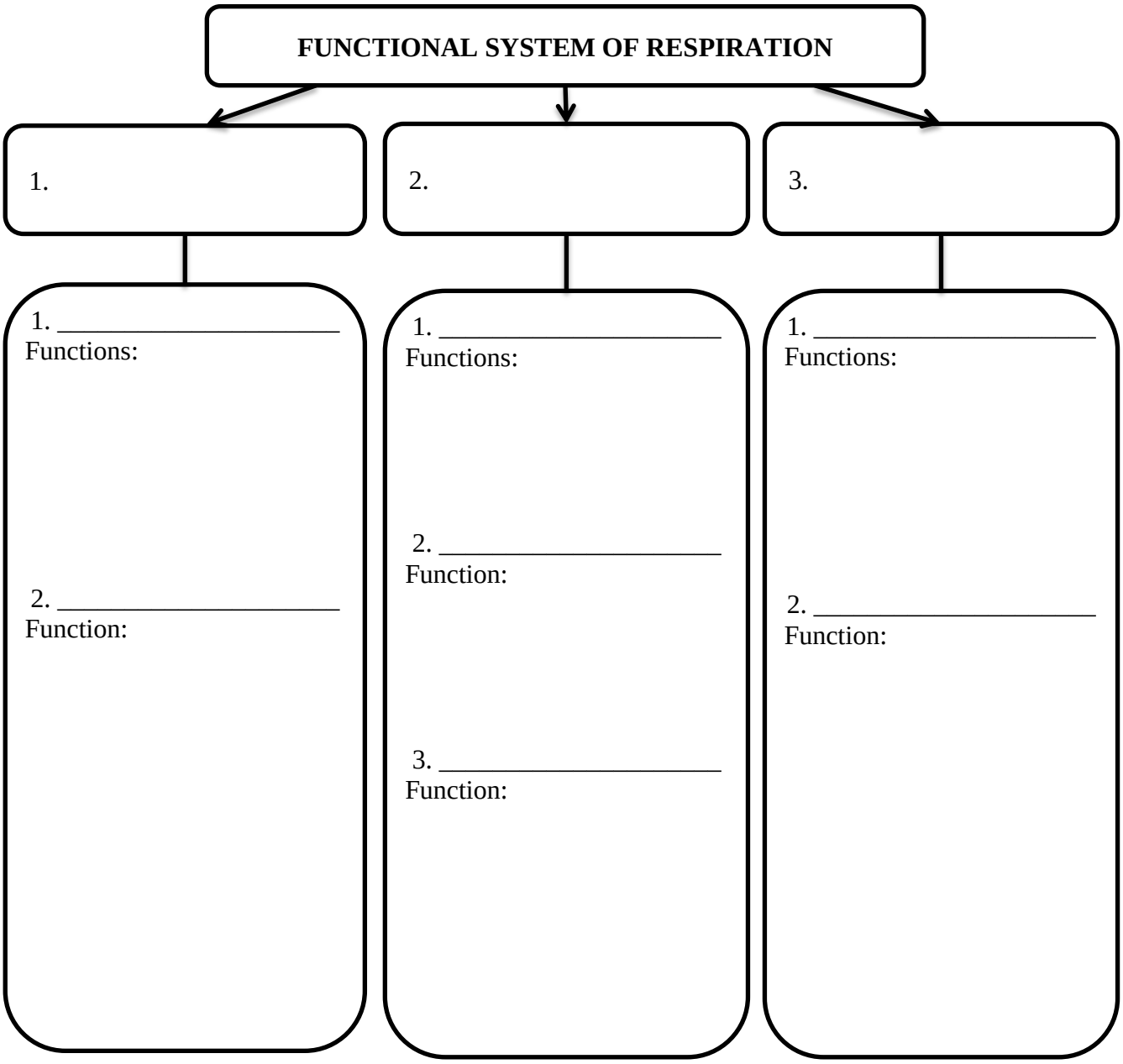
1. *Physiology of visceral systems: manual for second-year students of medical faculty (English-medium)/ D.I. Marakushin, L.V. Chernobay, I.S. Karmazina etc. – Kharkov: KhNMU, 2016 – 330 p.*
2. *Human physiology volume II / G.I. Kositsky.-Medicine, 1990.*
3. *Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006.*
4. *Medical physiology: principles for clinical medicine / edited by Rodney A. Rhoades, David R. Bell. – 4th ed. - © Lippincott Williams & Wilkins, a Wolters Kluwer business, 2013.*
5. *Ganong's review of medical physiology (23rd edition) / Kim E. Barrett, Susan M. Barman, Scott Boitano, Heddwen L. Brooks. – McGrawHill Lange, 2010.*
6. *Human Physiology / E. Babsky, B. Khodorov, G. Kositsky, A. Zubkov,. Moskow: Mir Publishers, 1975.*
7. *Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. - © The McGraw−Hill Companies, 2003.*
8. *Human physiology volume I (tenth edition) / C.C. Chatterjee.-Medical Allied Agency, Calcutta, 1985.*
9. *Human physiology (twelfth edition) / Stuart Ira Fox.- McGraw-Hill, 2011.*
10. *Human anatomy and physiology (seventh edition) / Elaine N. Marieb, Katja Hoehn.- Person Education.Inc. publishing as Benjamin Cummings, 2007.*

PHYSIOLOGY OF RESPIRATION

1. GENERAL CHARACTERISTICS OF SYSTEM OF RESPIRATION. EXTERNAL RESPIRATION.

Task 1.1. *Give definition of respiration.*
Respiration is _____
_____
_____

Task 1.2. *Complete the scheme "Functional system of respiration" and define functions of all of its components.*



Task 1.3. *List the functions of respiratory system:*

- _____
- _____
- _____
- _____

Task 1.4. *List non respiratory functions of lungs:*

- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____

Task 1.5. *Complete the schemes showing the structure of cough and sneezing reflexes.*

1) Cough reflex

Stimulus	Receptors	Afferent nerve	Nerve center	Efferent nerve	Target organ	Response

2) Sneezing reflex

Stimulus	Receptors	Afferent nerve	Nerve center	Efferent nerve	Target organ	Response

Task 1.6. *Respiration occurs in **3 stages** and **5 processes**. Name them and explain the events of everyone.*

I. _____**:**

1) _____

2) _____

II. _____**:**

*3)*_____

4) _____

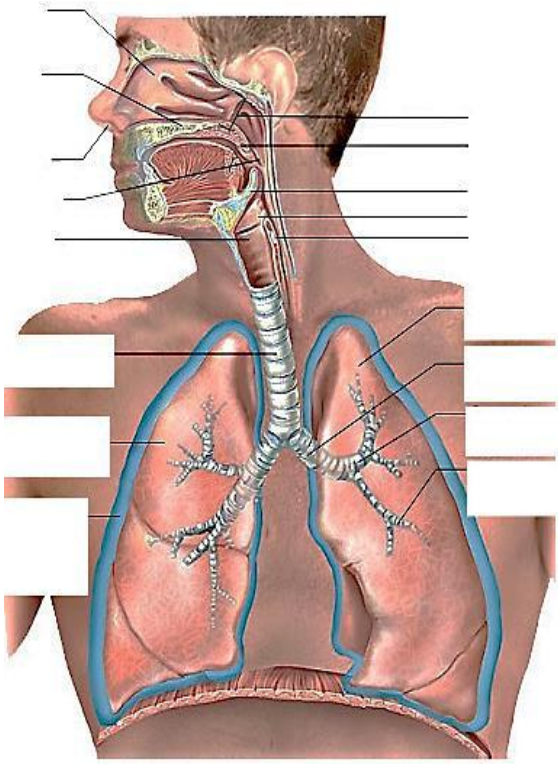
III. _____**:**

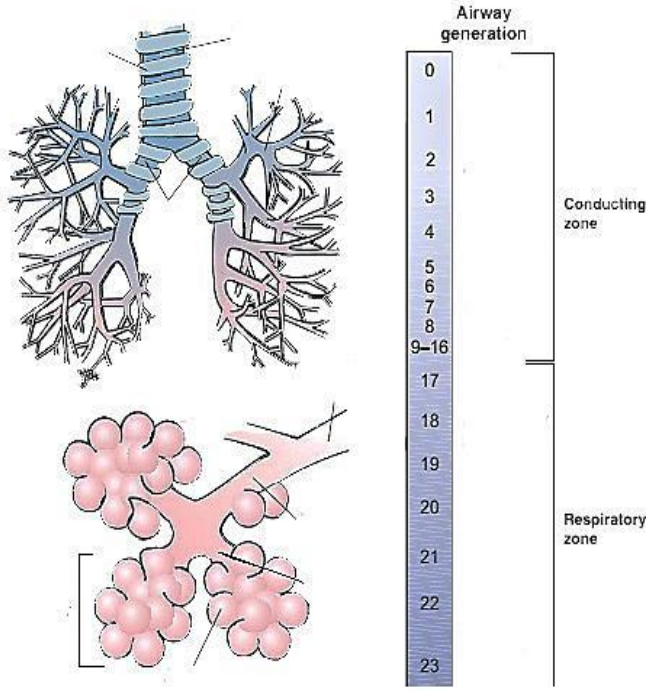
5) _____

Task 1.7. *Complete the table "Respiratory chain of oxygen and carbon dioxide"*

Oxygen respiratory chain	Carbon dioxide respiratory chain

Task 1.8. *Fill the illustration "Functional anatomy of respiratory system"*





Task 1.9. *List the functions of airways:*

- _____
- _____
- _____

Task 1.10. *List the types of alveolar cells and define their functions:*

1. _____

Function:_____

2. _____

Function:_____

3. _____

Function:_____

Task 1.11. *Define pleural cavity and its functions*

_____
_____
_____
_____

Task 1.12. *List the physical properties of lungs which determine pulmonary ventilation:*

- _____
- _____
- _____

Task 1.13. *Explain the significance and dependence of lungs' compliance.*
Compliance is _____
_____
_____
_____

$$\mathbf{C = \frac{x}{y};}$$ where C – compliance

x –

y –

Task 1.14. *Give the definition of elasticity of lungs and define its importance.*

Elasticity is _____
_____
_____
_____

Task 1.15. *Explain the significance of surface tension in promotion of expiration:*

_____
_____
_____

Task 1.16. *Give the definition of surfactant and list its functions.*

_____
_____
_____
_____
_____

Task 1.17. *Define the values of P_{AL}, P_{pl} and P_L relating to the phase of respiration.*

	P_{AL}, mmHg	**P_{pl},** mmHg	**P_L,** mmHg
Quite inspiration			
Forced inspiration			
Quite expiration			
Forced expiration			

Task 1.18. *The movement of air into and out of the lungs depends upon several factors. Name them and show their significance.*

1. **Boyle's law** – _____
_____
_____
_____

2. **Gradient of P_{in} and P_{out}:**
   - **$P_{in} = P_{out}$** _____
   _____
   _____
   - **$P_{in} \geq P_{out}$** _____
   _____
   _____
   - **$P_{in} \leq P_{out}$** _____
   _____
   _____

Task 1.19. *Quiet inspiration is provided by contraction of several muscles. List them:*

- _____
- _____

Task 1.20. *Forced inspiration is provided by contraction of several muscles. List them:*

- _____
- _____
- _____
- _____

Task 1.21. *List the events that occur in quiet inspiration:*

- _____
- _____
- _____
- _____
- _____
- _____

Task 1.22. *List the events that occur in quiet expiration:*

- _____
- _____
- _____
- _____
- _____

Task 1.23. *Forced expiration involves contraction of following muscles:*

- _____
- _____
- _____
- _____

Task 1.24. *Give the definition of following methods of pulmonary function examination and name the purposes of their usage.*

1. ***Spirography*** *is* _____
_____
_____

   Spirogram *is* _____
_____
_____

2. ***Pneumotachography*** *is* _____
_____
_____

Task 1.25. *Complete the table "Main indexes of external respiration"*

№	Index	Definition	Normal value
1			
2			
3			
4			
5			

6			
7			
8			
9			
10			
11			

Task 1.26. *Give the definition of dead space.*
Anatomic dead space is _____
Physiologic dead space is _____
_____

Task 1.27. *There are 2 types of ventilation disorders that can cause problems with air movement in and out of lungs. Name them and briefly explain their mechanisms by filling the table.*

Obstructive disorders	Restrictive disorders

2. GASES EXCHANGE AND TRANSPORT OF GASES BY BLOOD.

Task 2.1. *Give the definition of partial pressure of gas in gas mixture.*
Partial pressure of gas is _____
_____
_____

Task 2.2. *Fill the table "Partial pressures of individual respiratory gases"*

Gas	***Inspired air***		***Alveolar air***		***Expired air***	
	%	***mm Hg***	***%***	***mm Hg***	***%***	***mm Hg***
O_2						
CO_2						
N_2						
H_2O						

Task 2.3. *Calculate the partial pressure of oxygen and carbon dioxide in alveolar air.*

Po_2 = ——————— =

Pco_2 = ——————— =

Task 2.4. *Alveolar gaseous mixture differs from that of the atmosphere because of the following reasons:*

1) _____
2) _____
3) _____
4) _____

Task 2.5. *Partial pressures of oxygen and carbon dioxide are the driving force for diffusion of these gases across the respiratory membrane. Fill the table and show by arrows the direction of O_2 and CO_2 diffusion.*

Gas	***In the alveoli***		***In the tissue***	
	Alveolar air	**Venous blood**	**Arterial blood**	**ECF**
O_2				
CO_2				

Task 2.6. *Diffusion rate depends on several factors except pressure gradient. List them and give an example when these factors can change.*

- _____
- _____
- _____

Task 2.7. *List the layers of respiratory membrane:*

- _____
- _____
- _____
- _____
- _____
- _____
- _____

Task 2.8. *Give the definition of ventilation-perfusion ratio.*

_____

_____

Task 2.9. *Non-uniform ventilation-perfusion relationship in different areas of lungs can be explained by the following factors:*

- _____
- _____
- _____
- _____

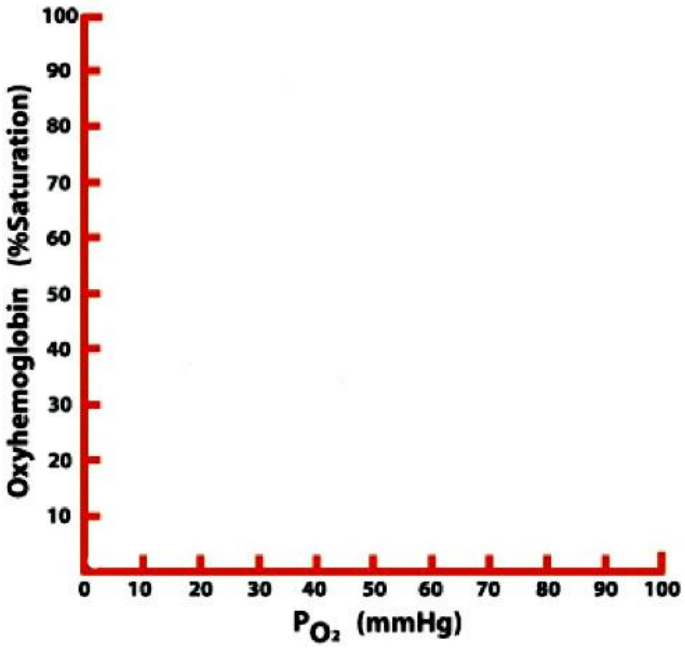
Task 2.10. *List the forms of oxygen transport:*

- _____
- _____

Task 2.11. *Draw the diagram "Oxyhemoglobin dissociation curve". Mark the percent of oxygen saturation when partial pressure of oxygen is:*

- ***Po_2 = 40 mm hg***
- ***Po_2 = 60 mm hg***
- ***Po_2 = 100 mm hg***

Draw the shifts of oxyhemoglobin dissociation curve to the left and to the right and list the conditions when these shifts occur.



Left shift
(_____ affinity)

- _____
- _____
- _____
- _____

Right shift
(_____ affinity)

- _____
- _____
- _____
- _____

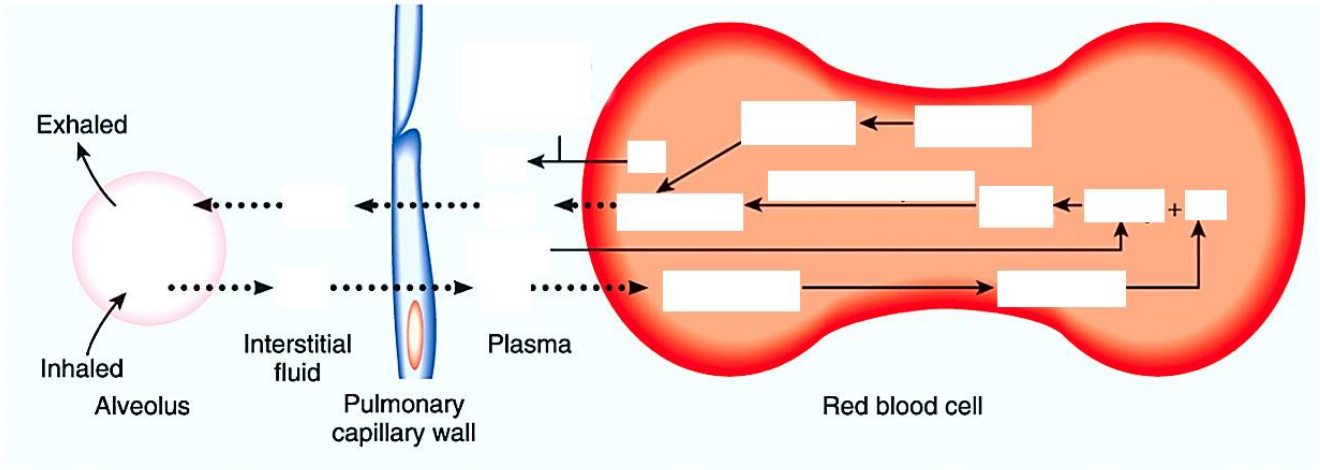
Task 2.12. *Define the factors that provide HbO_2 dissociation:*

- _____
- _____
- _____
- _____
- _____

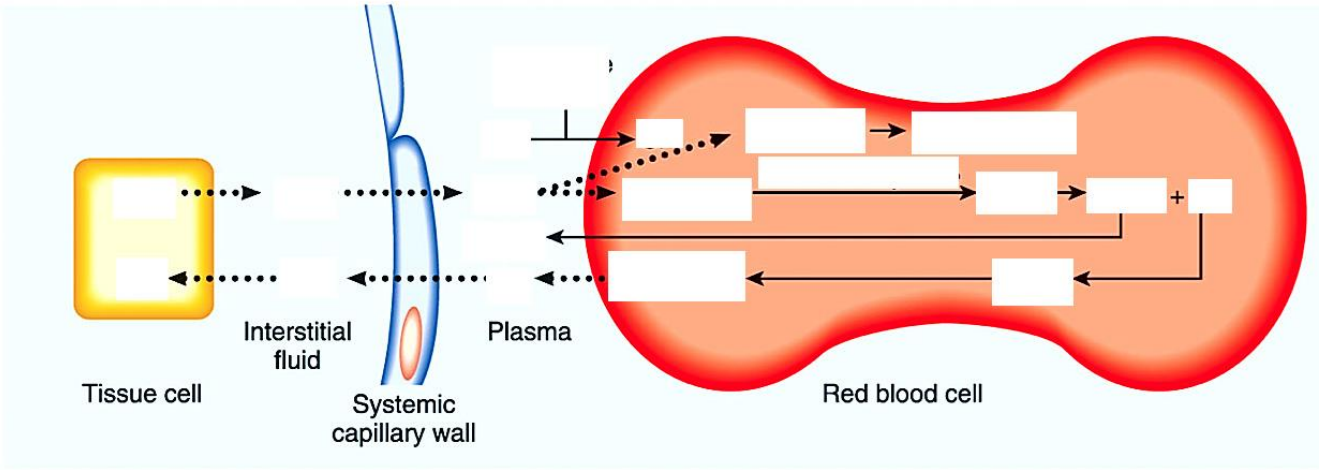
Task 2.13. *List the forms of CO_2 transport:*

- _____
- _____
- _____

Task 2.14. *Fill the following illustrations.*



(a) Exchange of O_2 and CO_2 in pulmonary capillaries (external respiration)



(b) Exchange of O_2 and CO_2 in systemic capillaries (internal respiration)

Task 2.15. *Give the definitions of the following.*

Oxygen utilization coefficient *is* _____

_____

It can be calculated using following formula:

$$\frac{\qquad\qquad}{\qquad\qquad} \times 100\%$$

Oxygen capacity of blood *is* _____

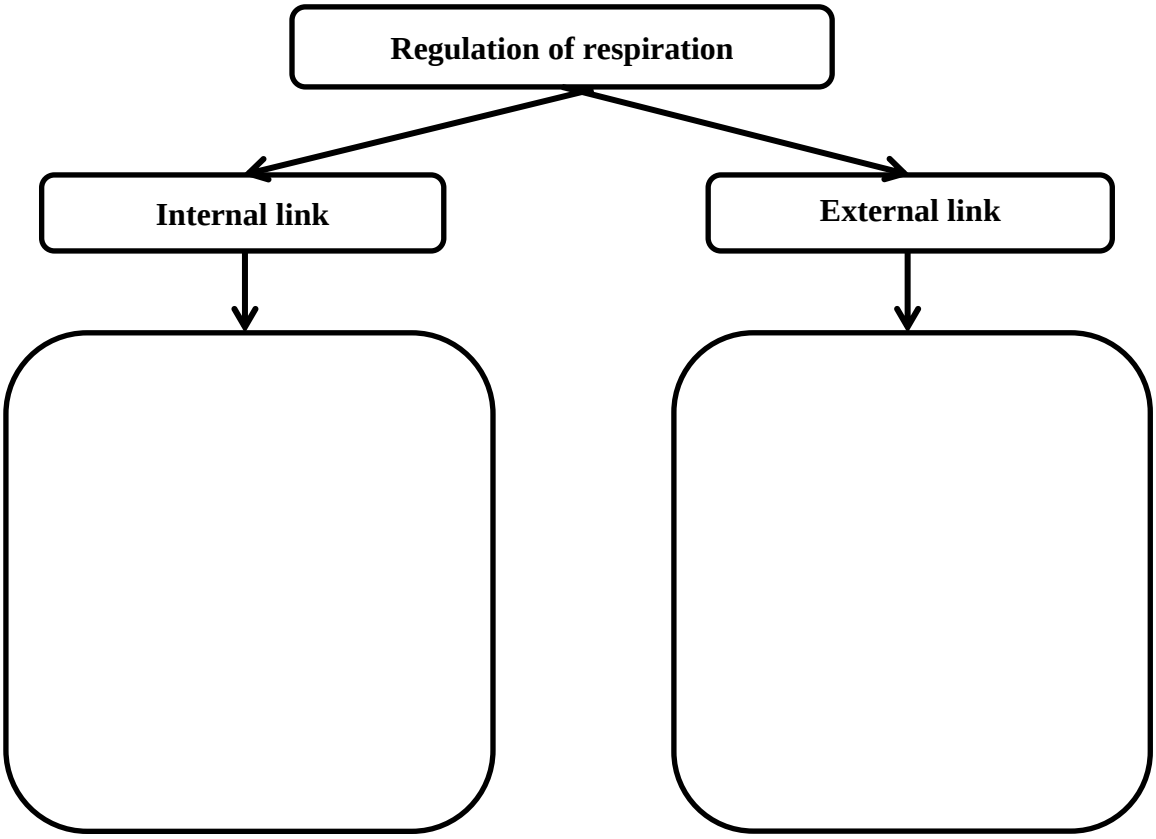
_____

It can be calculated using following formula:

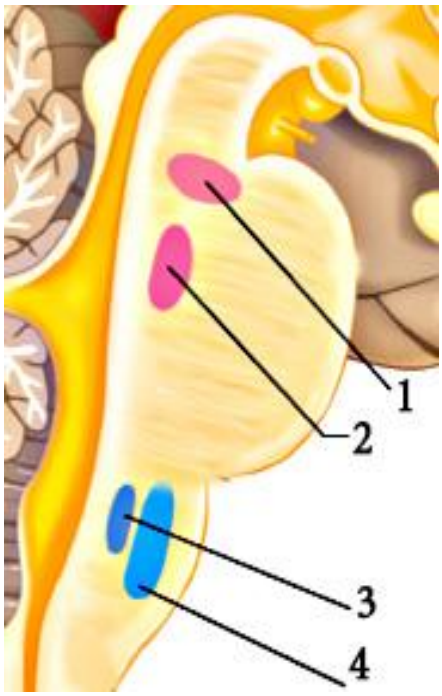
$$\frac{\qquad\qquad}{\qquad\qquad} \times 100\%$$

3. REGULATION OF RESPIRATION

Task 3.1. *Complete the table "Links of respiration regulation"*



Task 3.2. *Fill the scheme "Control respiratory centers of brainstem and their functions"*



Name of center	Its function
1.	
2.	
3.	
4.	

Task 3.3. *List the main afferent connections of brainstem respiratory centers.*

1. Inputs from higher nervous centers:
   - _____
   - _____
   - _____
2. Inputs from receptors:
   - _____
   - _____
   - _____

Task 3.4. *Complete the table "Role of peripheral chemoreceptors in regulation of respiration"*

Stimulation	Receptors	Afferent nerve	Center and effect	Efferent nerve	Organs-effectors	Response

Task 3.5. *Complete the table "Hering-Breuer inflation reflex in regulation of respiration"*

Stimulation	Receptors	Afferent nerve	Center and effect	Efferent nerve	Organs-effectors	Response

Task 3.6. *Explain the changes of respiration during exercise.*

_____
_____
_____
_____

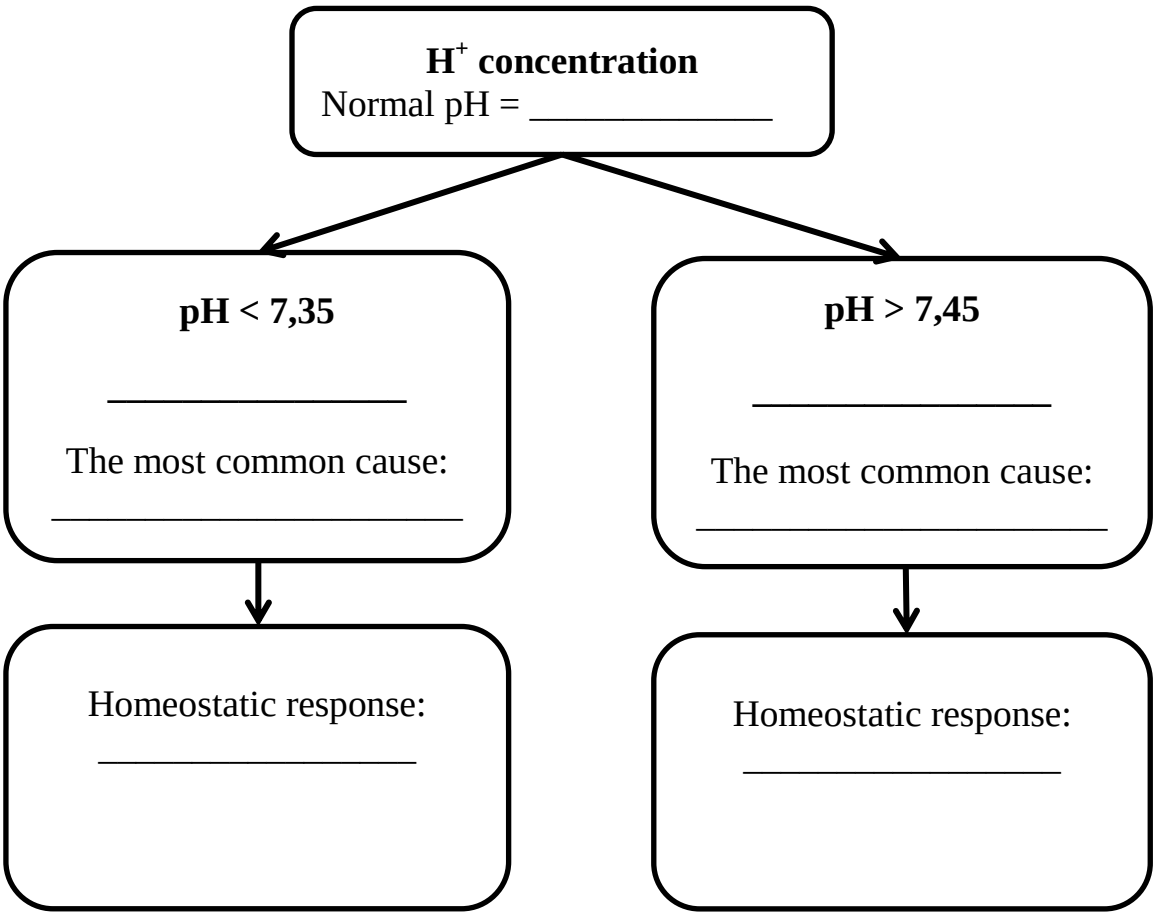
Task 3.7. *Complete the table "Role of other receptors in regulation of respiration"*

Receptors	Effect on respiration

Task 3.8. *List the main humoral factors that influence respiration.*

- _____
- _____
- _____
- _____
- _____

Task 3.9. *Fill the scheme "Influence of hydrogen ions on respiration"*



Task 3.10. *Explain Kussmaul respiration.*

_____

_____

_____

_____

Task 3.11. *Explain the influence of carbon dioxide on respiration.*

1. **Indirect influence:** _____

_____

_____

_____

2. **Direct influence:** _____

_____

_____

_____

Task 3.12. *Explain the effect of oxygen concentration of respiration.*

_____

_____

_____

_____

_____

_____

Task 3.13. *Explain the role of cerebral cortex in regulation of respiration.*

_____

_____

_____

_____

_____

_____

Task 3.14. *Complete the table "Respiratory muscles and their innervation"*

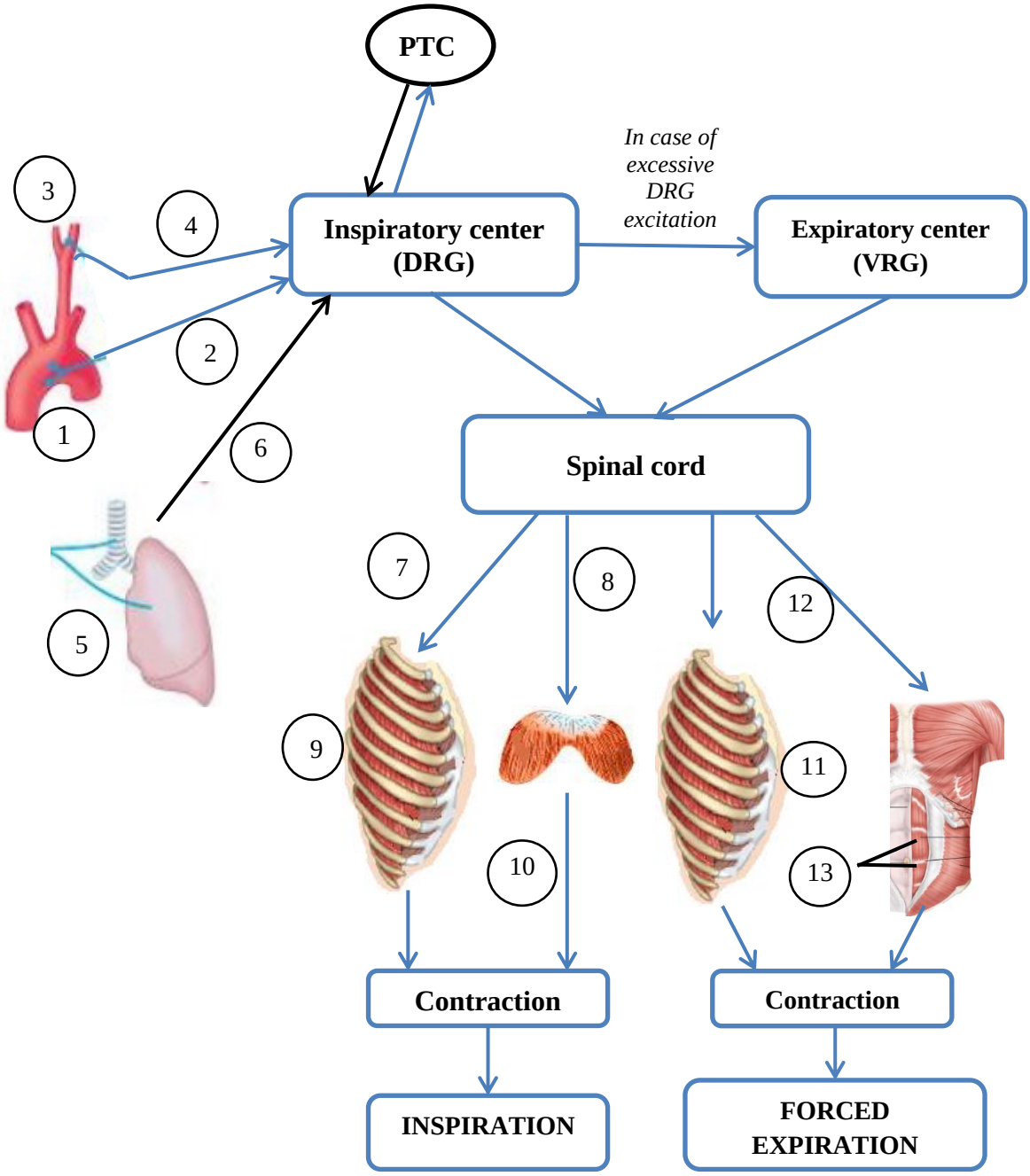
Phase of respiration	Involved respiratory muscles	Innervation of involved respiratory muscles
1. Quiet inspiration		
2. Quiet expiration		

3. Forced inspiration		
4. Forced expiration		

Task 3.15. *Complete the table "Changes of respiration in case of brainstem, spinal cord and peripheral nerves transections on different levels"*

Level of transection	Changes of breathing
Above pons	
Below medulla	
Between pons and medulla	
Above C_3 of spinal cord	
Below Th_6 of spinal cord	
Between C_5 and Th_1 of spinal cord	
Transection of n. vagus	

Task 3.16. *Label the picture "General scheme of respiration" (put "+" for excitatory effect, "-" for inhibitory effect).*



1 –	**8 –**
2 –	**9 –**
3 –	**10 –**
4 –	**11 –**
5 –	**12 –**
6 –	**13 –**
7 –	

Task 3.17. *Explain the respiratory components of following visceral reflexes.*

Hiccup _____

_____

_____

_____

_____

Yawning _____

_____

_____

_____

_____

Task 3.18. *Explain the effects of low barometric pressure on respiration.*

_____

_____

_____

_____

_____

_____

Task 3.18. *List the principal means of acclimatization to low PO_2.*

- _____
- _____
- _____
- _____
- _____

Task 3.19. *Explain the effects of high barometric pressure on respiration.*

_____

_____

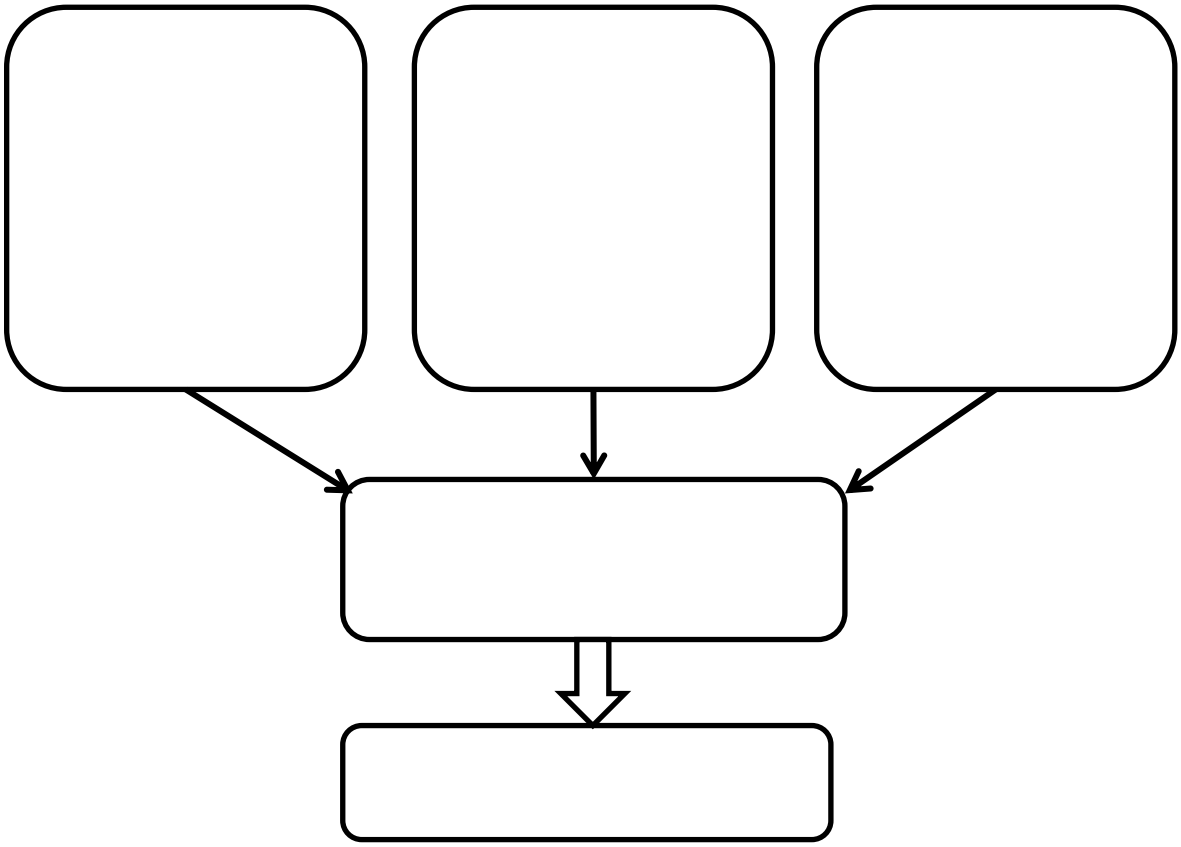
_____

_____

_____

_____

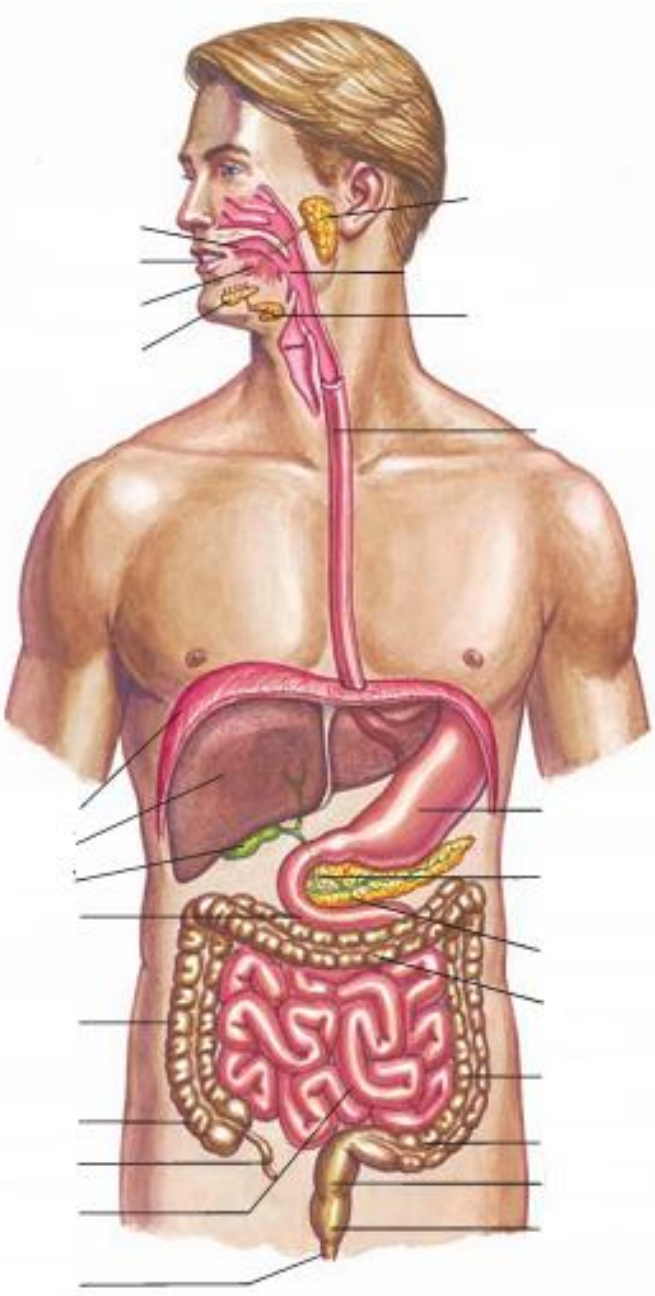
Task 3.20. *Fill the table "Mechanism of first breath in newborn"*



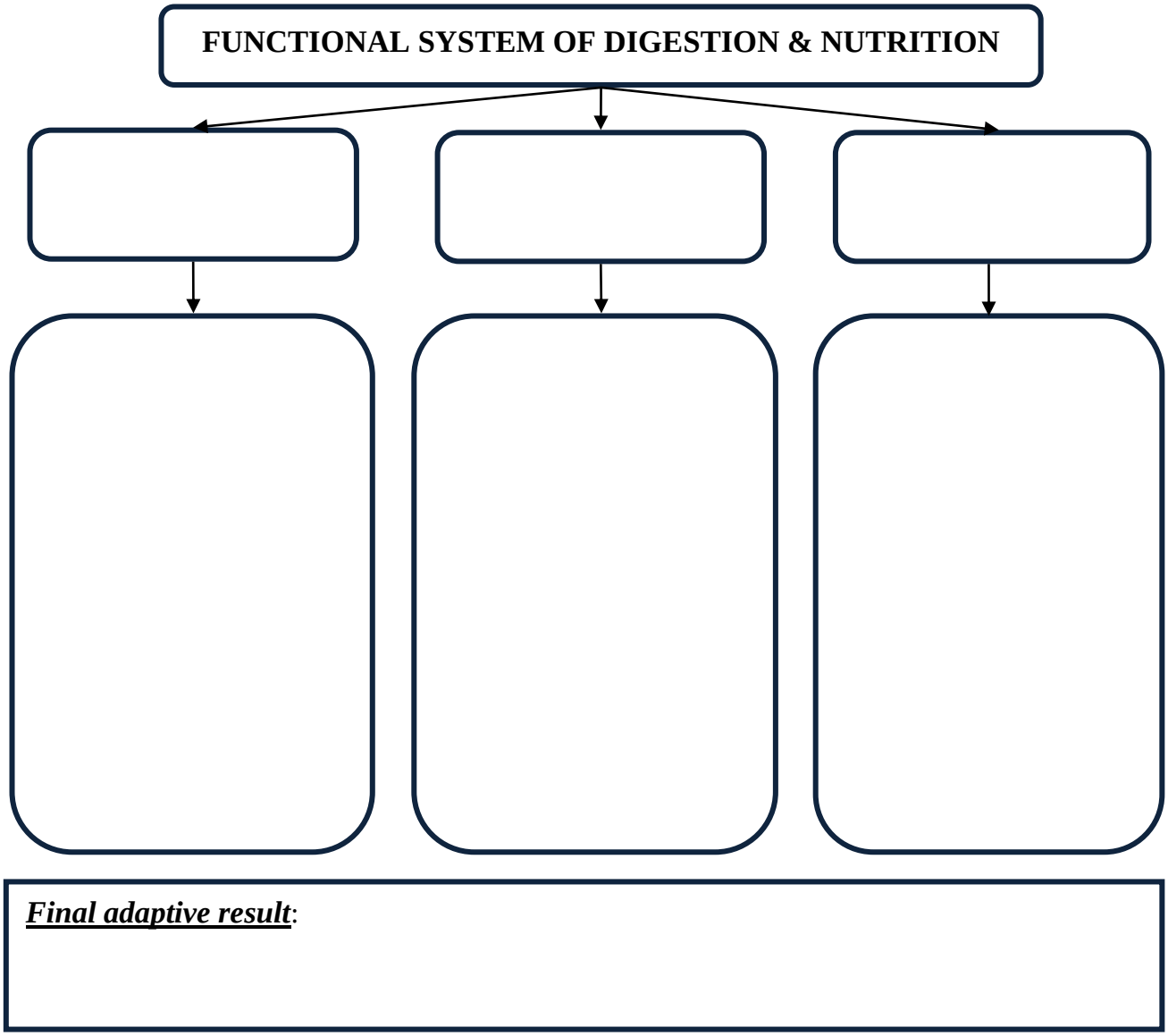
PHYSIOLOGY OF DIGESTION AND NUTRITION FUNCTIONAL SYSTEM

4. GENERAL CHARACTERISTIC OF DIGESTIVE SYSTEM

Task 4.1. *Use your knowledge from anatomy course to label organs of digestion system*



Task 4.2. Digestive functional system consists of three principle components. *Complete the scheme* ***"Digestive functional system"***



Task 4.3. *Give definition of digestion and explain the processes of food digestion*

_____
_____
_____
_____
_____

Task 4.4. *Name the functions of GIT*

1._____
_____
_____

2._____
_____
_____

3._____
_____

4._____
_____
_____
5._____
_____
_____
_____
6._____
_____

Task 4.5. There are two types of digestion according to localization of digestive process. *Please, list these types and define them*

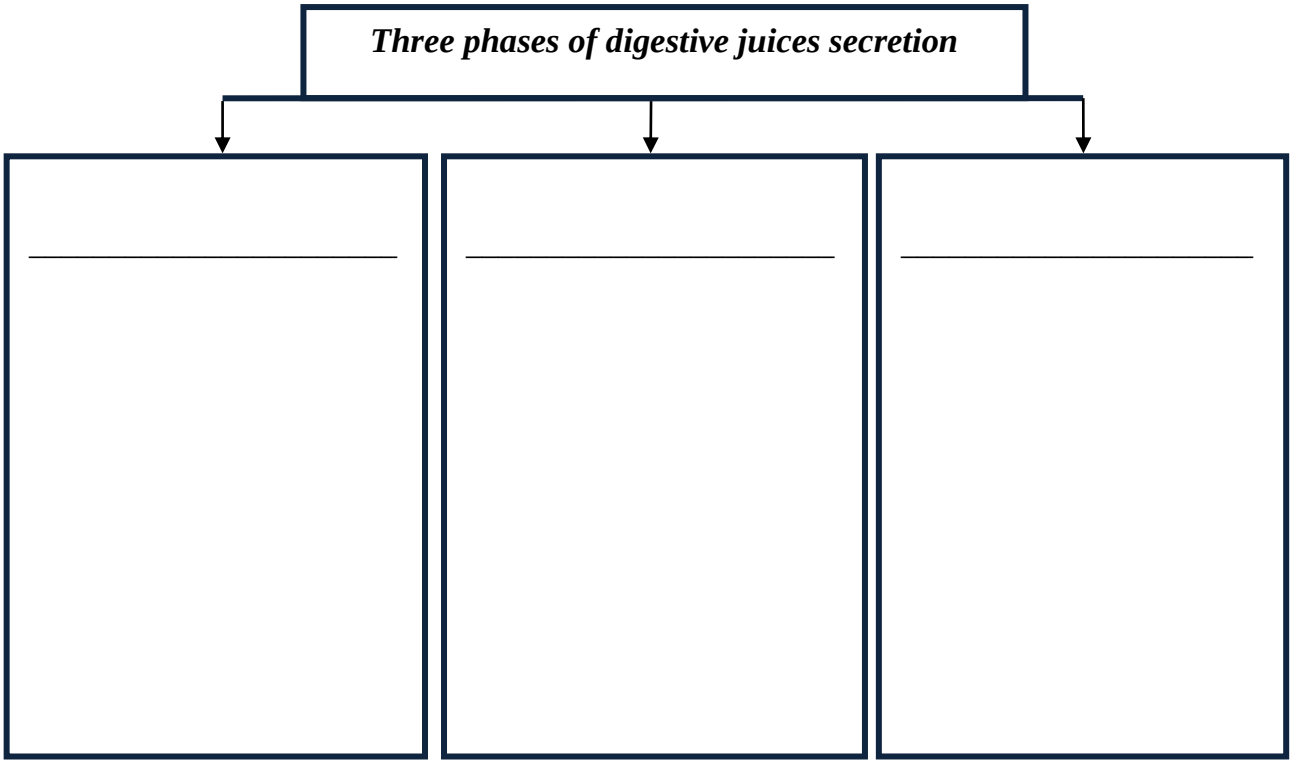
1._____
_____
2_____

- ✓ _____
  _____
- ✓ _____
  _____

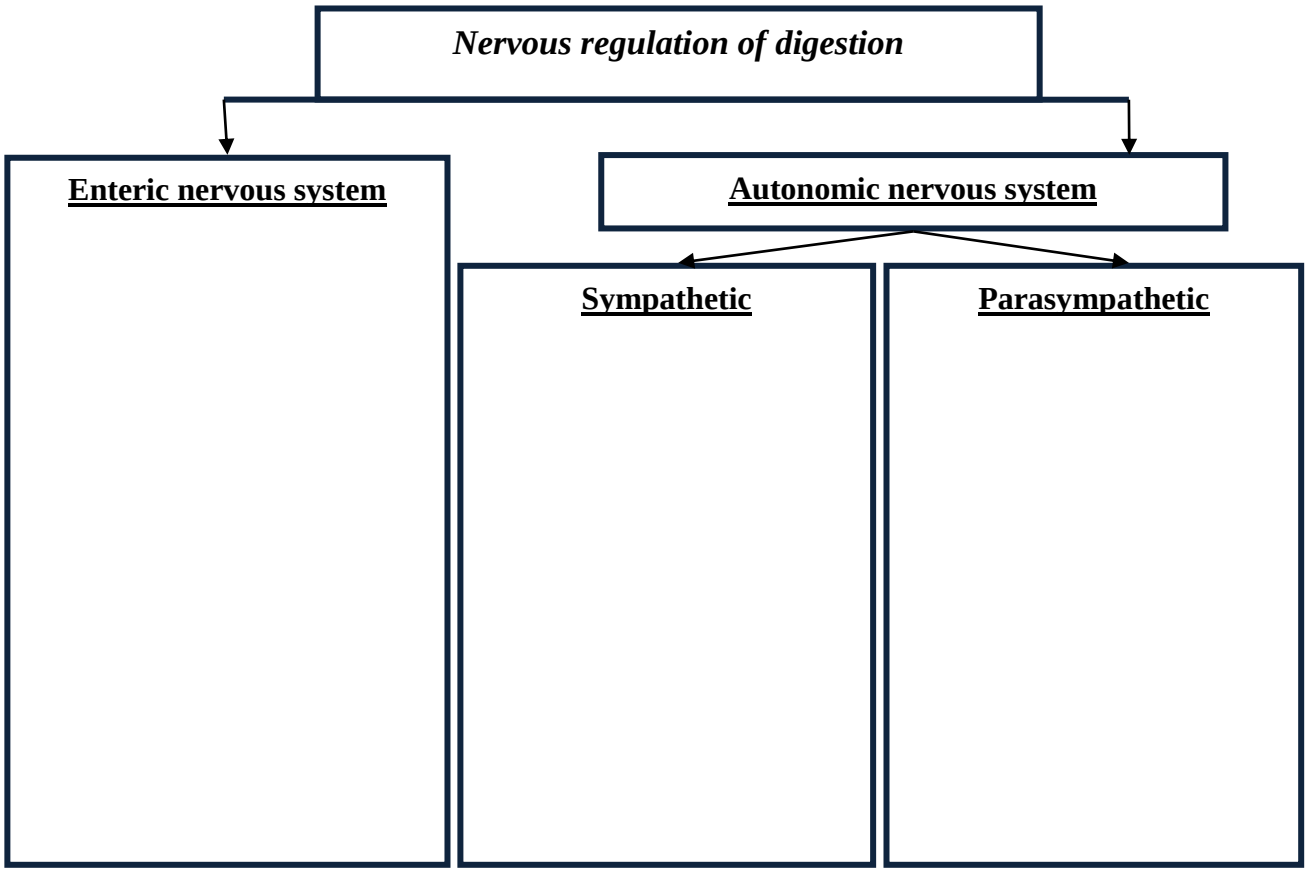
Task 4.6. *List main gastro-intestinal hormones and define their functions*

1._____
_____
_____
2._____
_____
_____
3._____
_____
_____
4._____
_____
_____
5._____
_____
_____

Task 4.7. Secretion of digestive juices occurs in three phases. *Please, define these phases and their significance*



Task 4.8. *Define the main principles of neuronal regulation of digestion*



5. DIGESTION IN THE MOUTH

Task 5.1. *Define the significance of digestion in the mouth*

_____
_____
_____
_____
_____

Digestion in the mouth lasts _____ and depends on _____
_____

Task 5.2. Mechanical digestion in the mouth includes two processes – chewing and swallowing. *Please, define the importance of chewing*

_____
_____
_____

Task 5.3. *Draw the scheme of chewing reflex according the principle scheme of reflex arch: receptors → afferent nerve → center → efferent nerve → target organ*

Study illustration and use this information to answer the following tasks

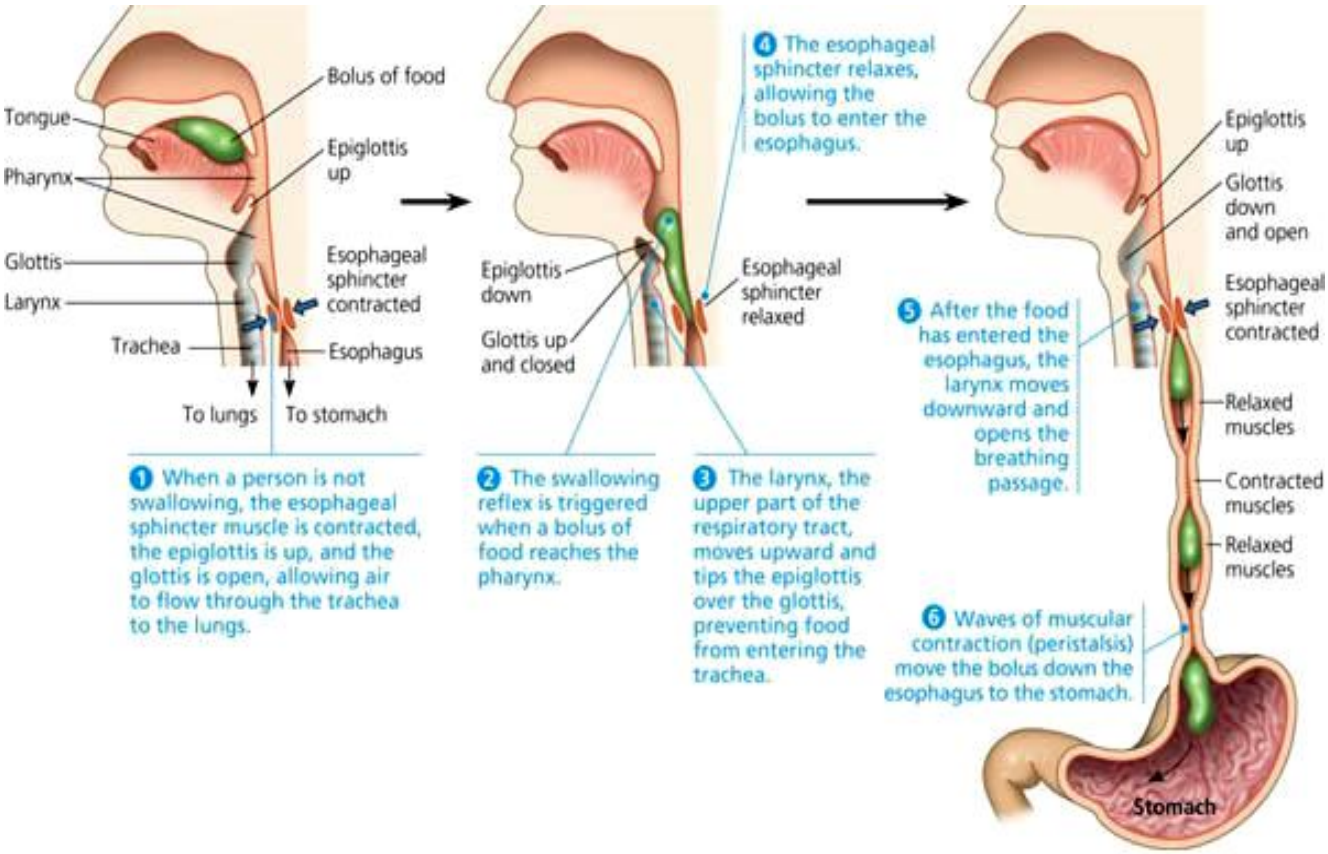


Figure 5.1. Stages of swallowing

Task 5.4. *List the stages of swallowing*

1) _____

_____

_____

_____

2) _____

_____

_____

_____

3) _____

_____

_____

_____

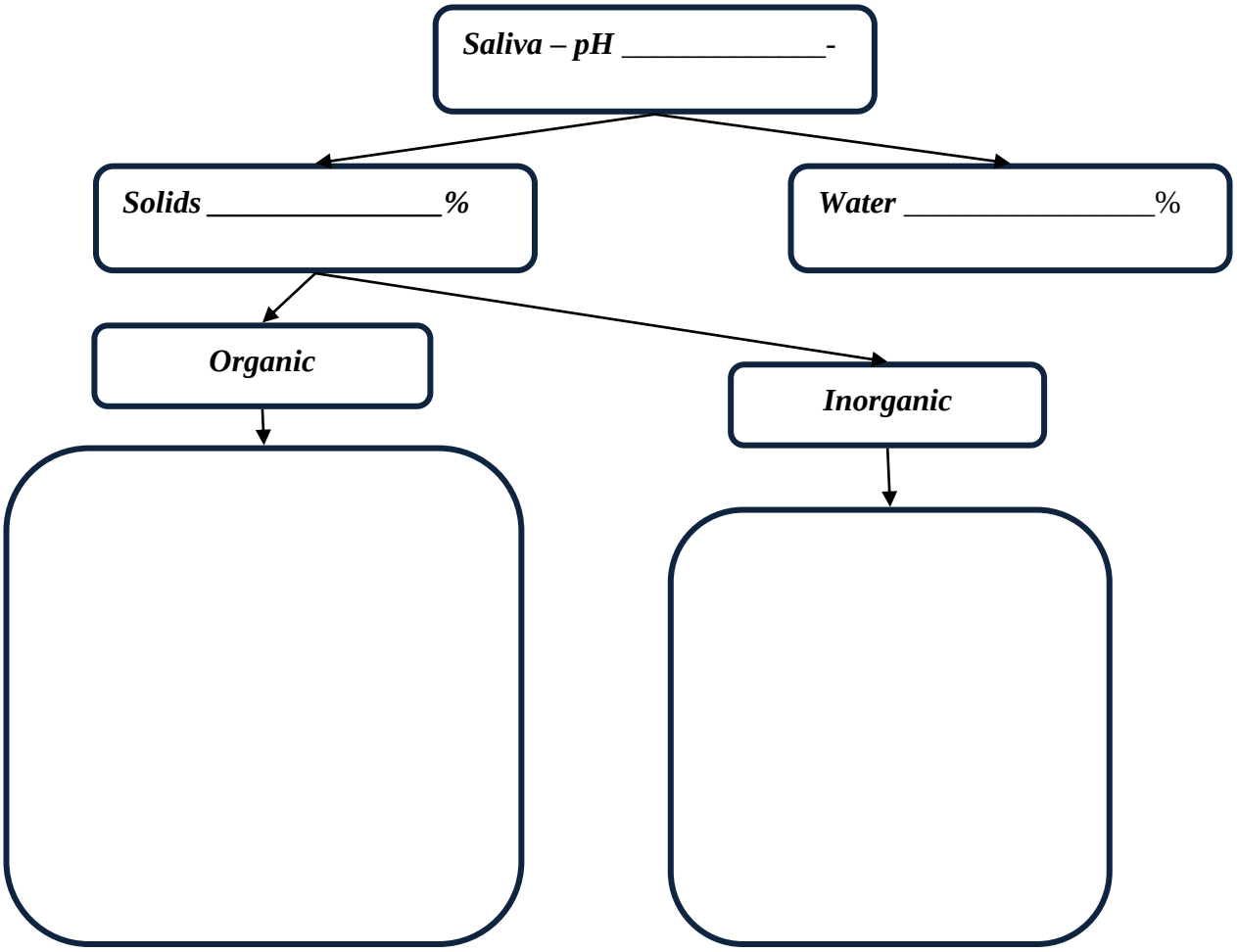
Task 5.5. Chemical digestion in the mouth is provided by secretion of salivary glands. *Please, list the principle salivary glands*

1)_____

2)_____

3)_____

Task 5.6. *Define the composition and pH of saliva*



Task 5.7. *Define the significance of salivary α-amylase*

_____

_____

_____

_____

_____

_____

Task 5.8. Mechanism of saliva formation includes two processes: 1) synthesis of enzymes and mucus in acini and 2) electrolytes and water exchange in salivary ducts. *Please, describe these processes*

1) **Synthesis of enzymes and mucus in acini** _____

2) **Electrolytes and water exchange in salivary ducts** _____

Task 5.9. *List the phases of saliva secretion*

1)_____

2)_____

3)_____

4)_____

Task 5.10. Salivary secretion is controlled by neuronal (autonomic) mechanism of regulation. *Please, complete the schemes of parasympathetic and sympathetic unconditional regulation of salivary secretion*

A) Parasympathetic regulation of salivation

Stimulus and receptors	**Afferent nerves**	**Center of reflex**	**Efferent nerves (preganglionic, ganglion, postganglionic**	**Target organ**	**Response, pH of saliva**

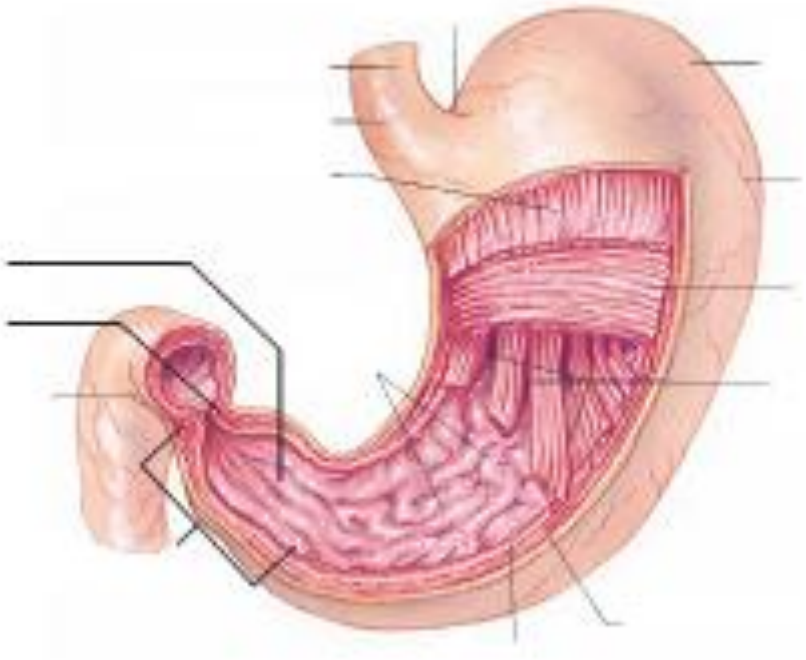
B) Sympathetic regulation of salivation

Stimulus and receptors	**Afferent nerves**	**Center of reflex**	**Efferent nerves (preganglionic, ganglion, postganglionic**	**Target organ**	**Response, pH of saliva**

Task 5.11. *Draw the scheme of conditioned regulation of salivation (sympathetic and parasympathetic), and list all brain departments which take part in this conditioned reflex*

6. DIGESTION IN THE STOMACH

Task 6.1. *Label anatomical structure of stomach*



Task 6.2. *Define the peculiarities of digestion in the stomach*

1)_____

2)_____

3)_____

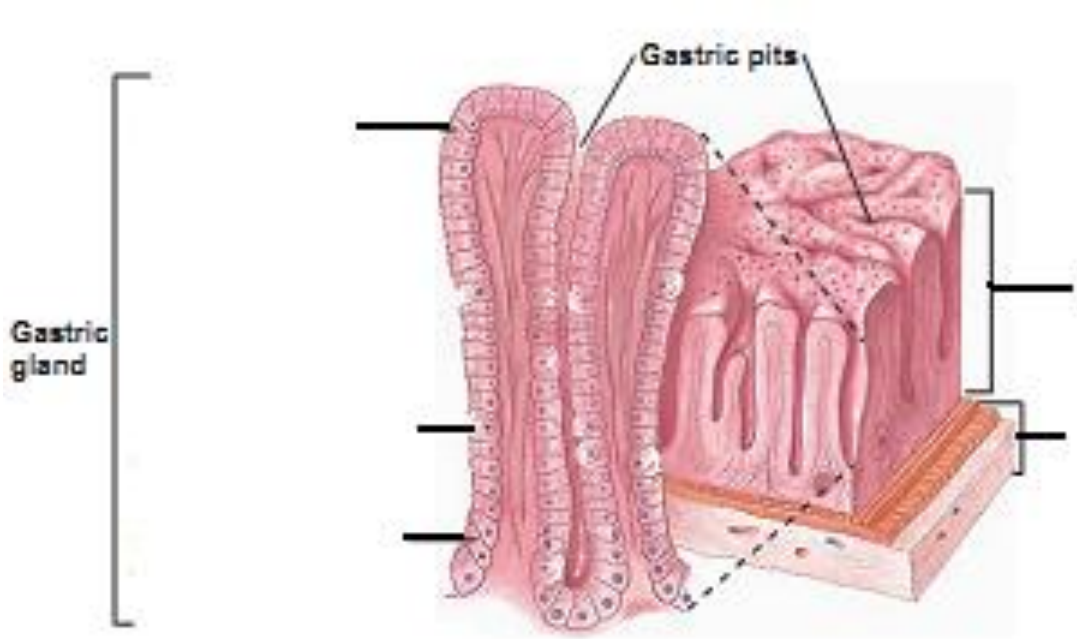
Task 1.3.3. *List and describe the functions of the stomach*

1)_____

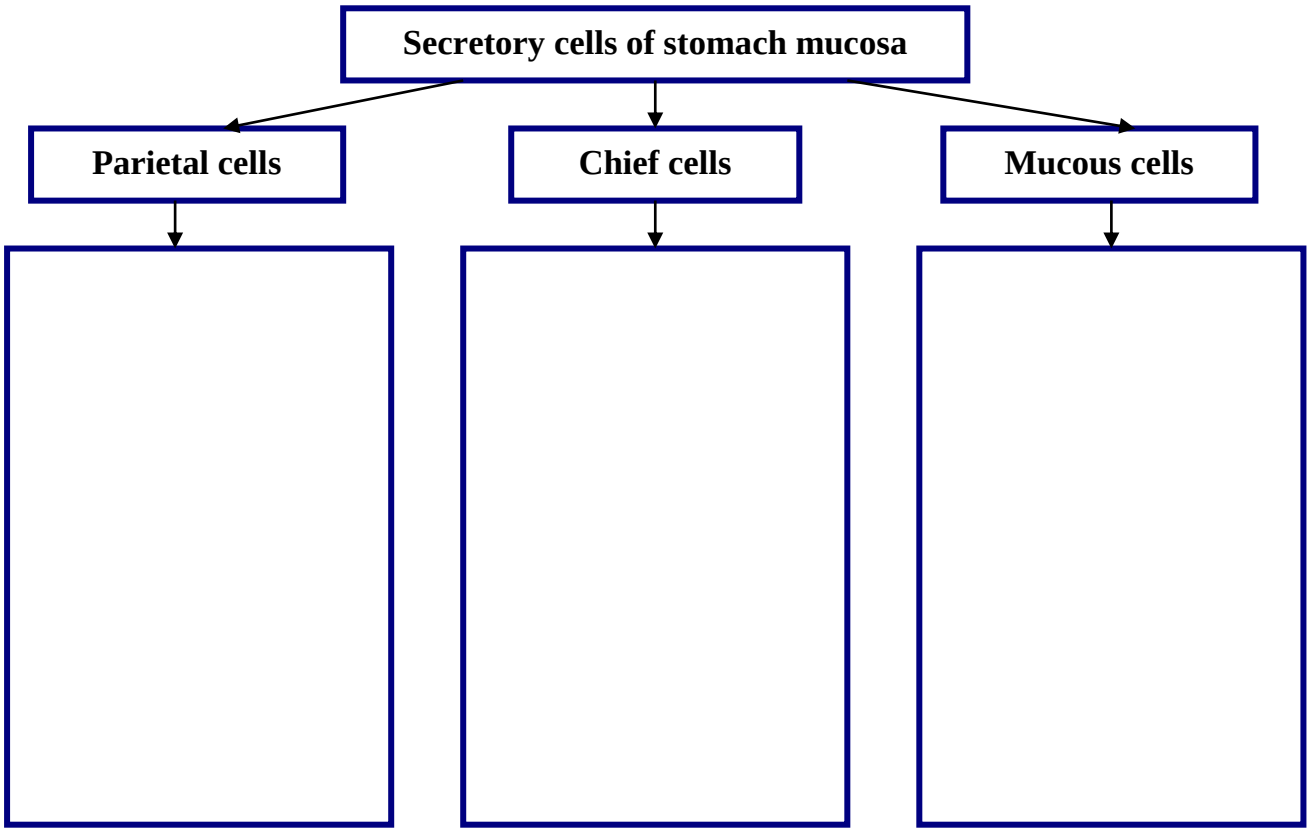
2)_____

3)_____

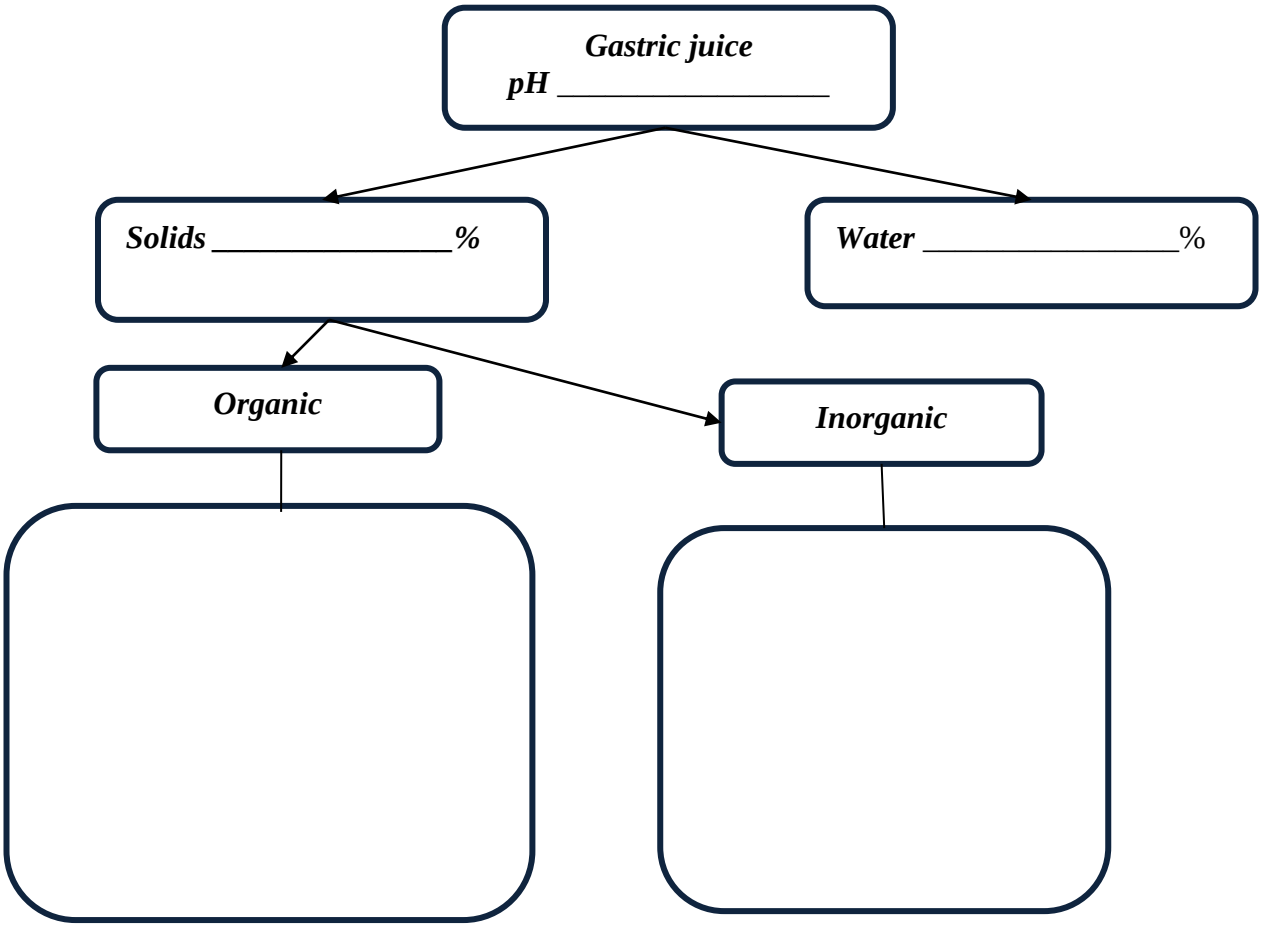
Task 6.4. *Label the structure of stomach mucosa and its main secretory cells*



Task 6.5. Secretory function of the stomach is provided by activity of its exocrine cells. *Please, complete the following scheme*



Task 6.6. *Complete the scheme* ***"Composition of gastric juice"***



Task 6.7. *List the physiological significance of hydrochloric acid of gastric juice*

1)_____

_____

_____

2)_____

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3)_____

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4)_____

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5)_____

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6)_____

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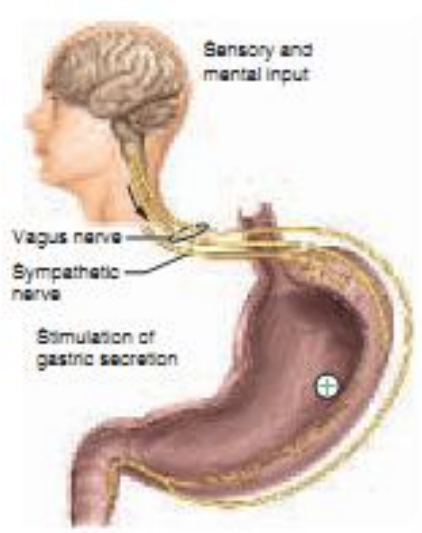
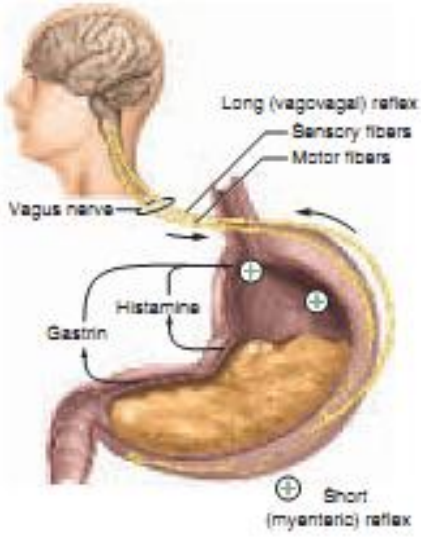
Task 6.8. Regulation of gastric secretion occurs in three stages: *cephalic*, *gastric* and *intestinal*. *Please, define functions of each phase*

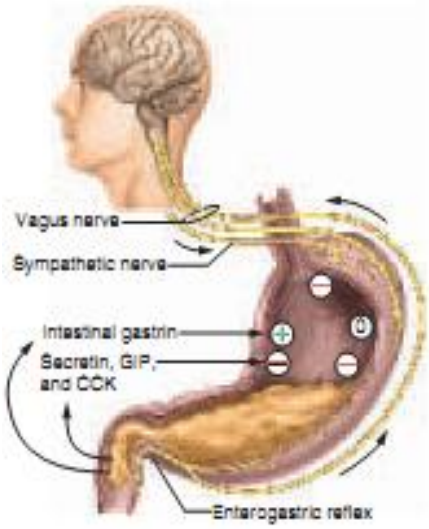
A. Cephalic phase



B. Gastric phase



C. Intestinal phase



Functions:

Functions:

Functions:

Task 6.9. *Define the role of pepsin in gastric juice*

_____

_____

_____

_____

Task 6.10. *Name the types of pepsin and define the optimum of their pH*

_____

_____

_____

_____

Task 6.11. *List the non-proteolytic enzymes of gastric juice and define their functions*

1)_____

2)_____

3)_____

Task 6.12. *List the functions of mucus*

1)_____

_____

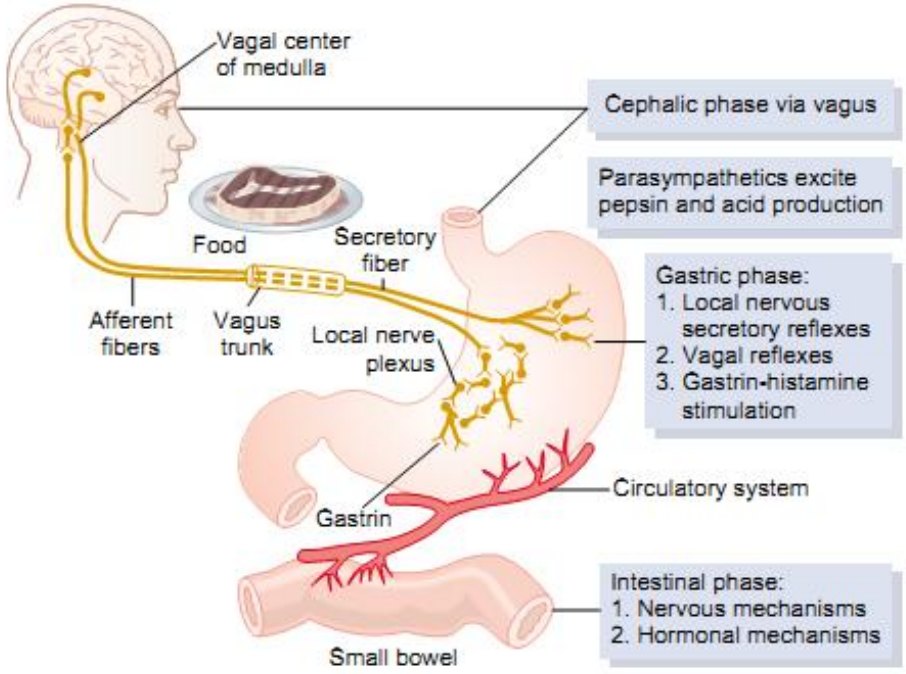
_____

2)_____

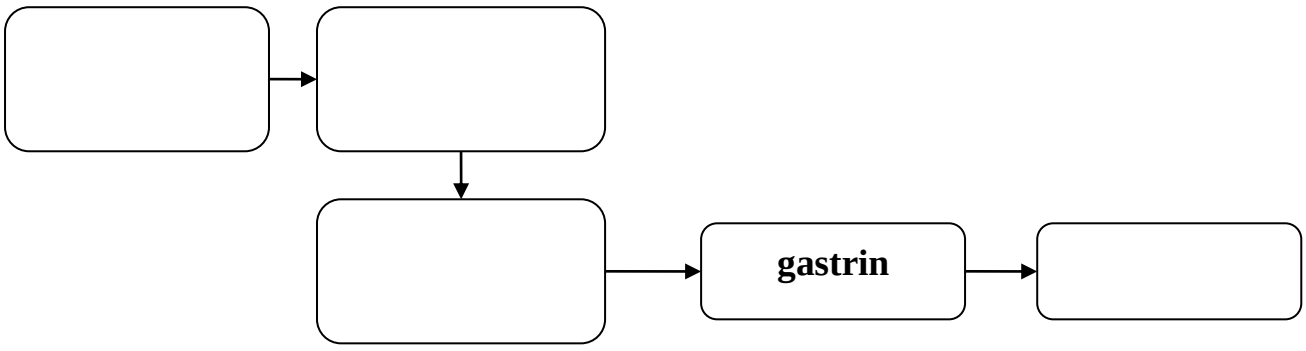
_____

_____

Task 6.13. *On the figure show with arrow the feed-back (inhibition) of gastric secretion by post-stomach digestive factors*

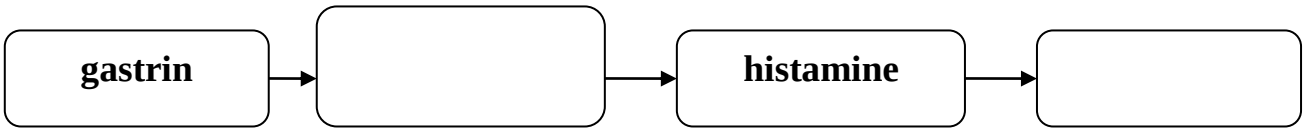


Task 6.14. *Complete the scheme to show the way of gastrin production*

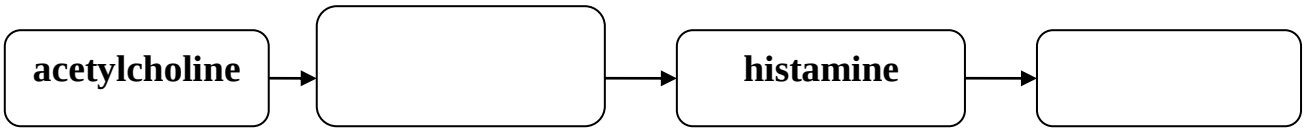


Task 6.15. *Complete the schemes to show the ways of histamine production*

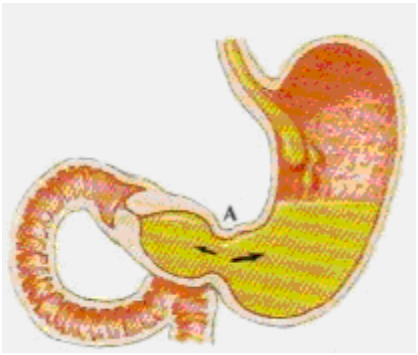
1)



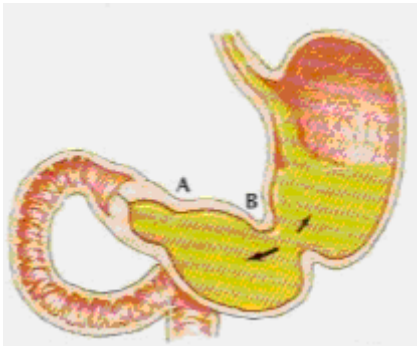
2)



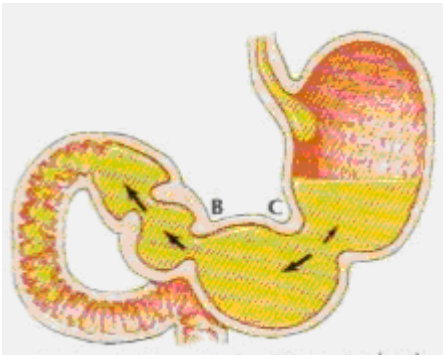
Study with attention the stages of gastric motility and answer the questions below the scheme



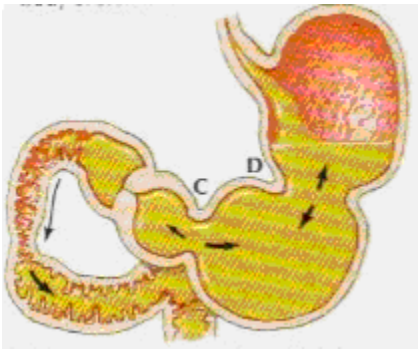
Stage 1. Stomach is filling. A mild peristalsis wave (A) has started in antrum and is passing toward pylorus. Gastric contents are churned and largely pushed back into body of stomach



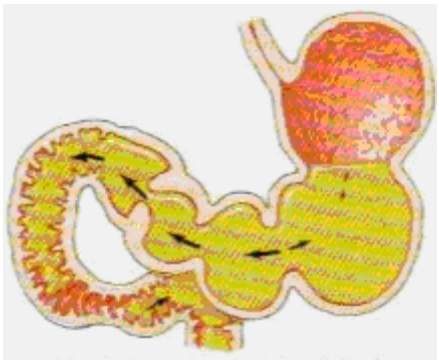
Stage 2. Wave (A) fading out as pylorus fail to open. A stronger wave (B) is originating at incisure and is again squeezing gastric contents in both directions



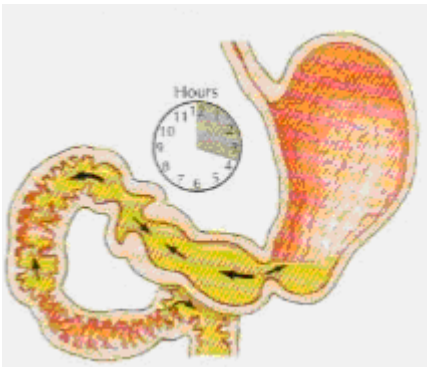
Stage 3. Pilorus opens as wave (B) approaches it. Duodenal bulb is filled, and contents pass into second portion of duodenum. Wave (C) starting just above incisure



Stage 4. Pilorus again closed. Wave (C) fails to evacuate contents. Wave (D) starts higher on body of stomach. Duodenal bulb may contract or may remain filled as peristalsis wave originating just beyond it empties second portion



Stage 5. Peristalsis waves are now originating higher on body of stomach. Gastric contents are evacuated intermittently. Contents of duodenal bulb area pushed passively into second portion as more gastric contents emerge



Stage 6. 3 to 4 hours later, stomach is almost empty. Small peristaltic wave empties duodenal bulb with some reflux into stomach. Reverse and antegrade peristalsis present in duodenum

Task 6.16. *Name the significance of stomach motor functions*

Motor functions of stomach

1.

Significance:

2.

Significance:

3.

Significance:

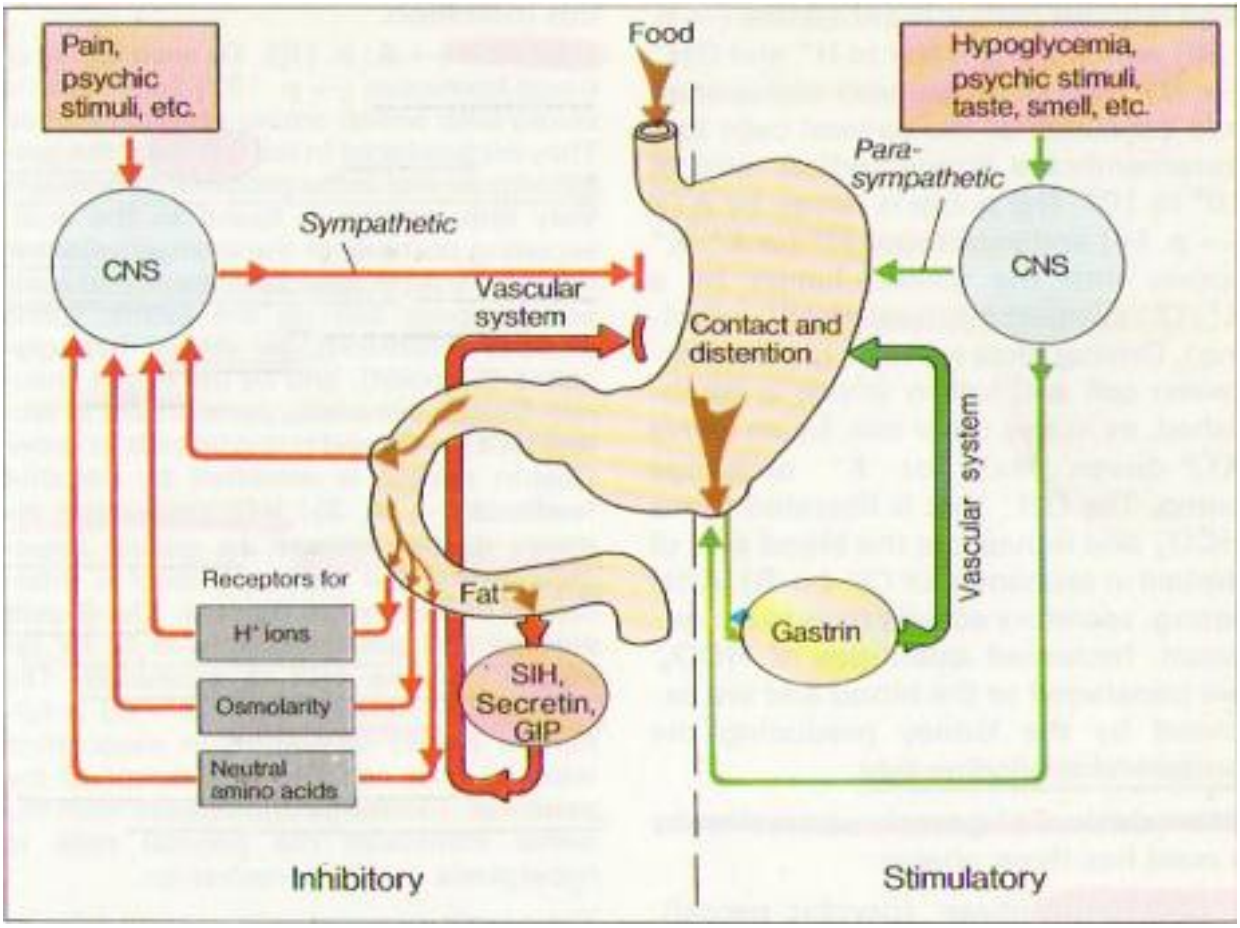


Figure 6.1. Factors that have an influence upon gastric motility

Task 6.17. *Complete the scheme "Sympathetic and parasympathetic regulation of gastric motility"*

1) Sympathetic regulation of gastric motility

Stimulus and receptors	Afferent nerves	Center of reflex	Efferent nerves (preganglionic, ganglion, postganglionic	Target organ	Response

2) Parasympathetic regulation of gastric motility

Stimulus and receptors	Afferent nerves	Center of reflex	Efferent nerves (preganglionic, ganglion, postganglionic	Target organ	Response

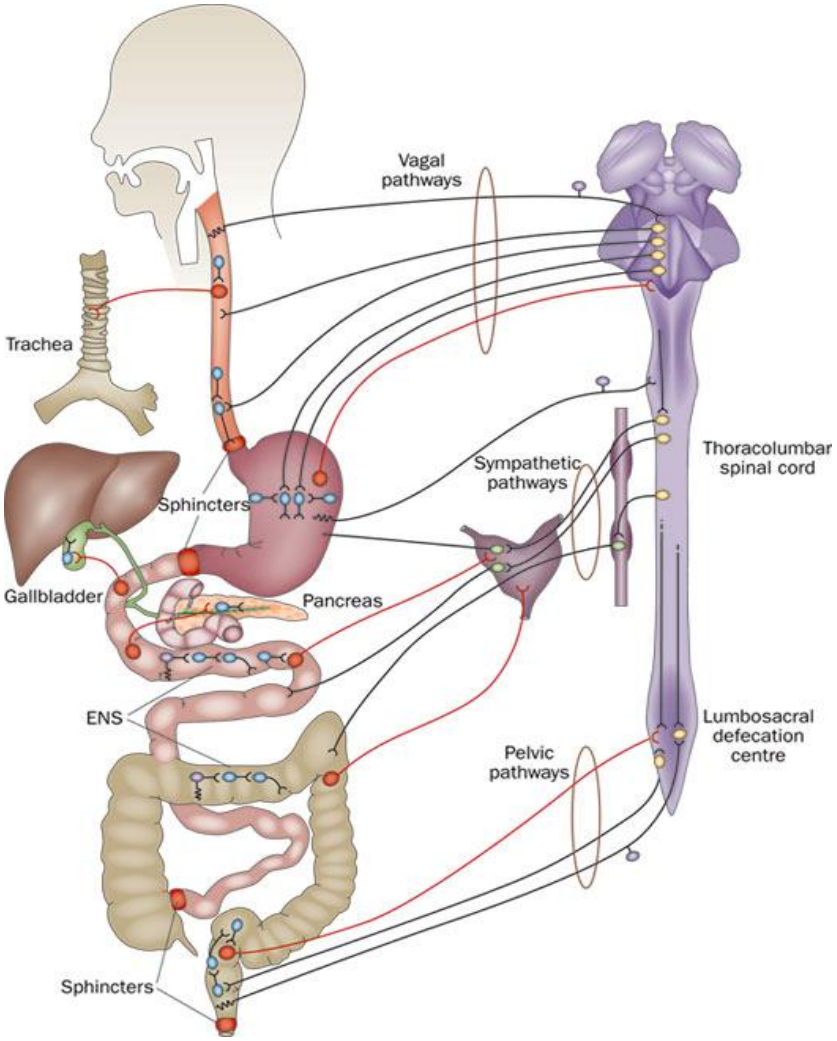
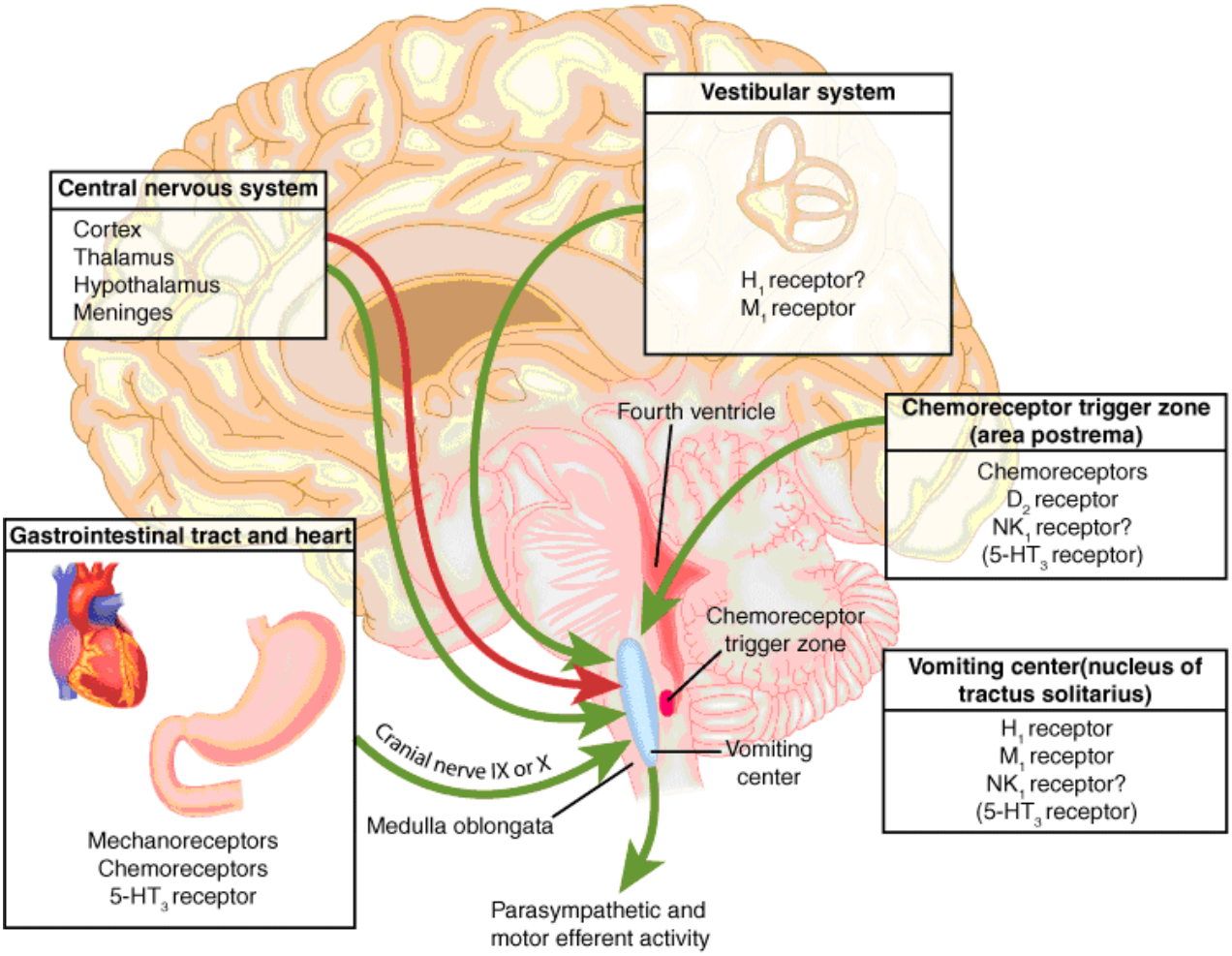


Figure 6.2. Sympathetic and parasympathetic pathways of GIT regulation

Summarize your knowledge about composition of gastric juice

Secretory Cells	Secretion	Function
Mucus neck cells	Mucus	Protects mucosa from HCl and enzymes
Parietal cells	Hydrochloric acid	Activates pepsin and lingual lipase; helps liquefy food; reduces dietary iron to usable form (Fe^{2+}); destroys ingested pathogens
	Intrinsic factor	Enables small intestine to absorb vitamin B_{12}
Chief cells	Pepsinogen	Converted to pepsin, which digests protein
	Chymosin	Coagulates milk proteins in infant stomach; not secreted in adults
	Gastric lipase	Digests fats in infant stomach; not secreted in adults
Enteroendocrine cells	Gastrin	Stimulates gastric glands to secrete HCl and enzymes; stimulates intestinal motility; relaxes ileocecal valve
	Serotonin	Stimulates gastric motility
	Histamine	Stimulates HCl secretion
	Somatostatin	Inhibits gastric secretion and motility; delays emptying of stomach; inhibits secretion by pancreas; inhibits gallbladder contraction and bile secretion; reduces blood circulation and nutrients absorption in small intestine

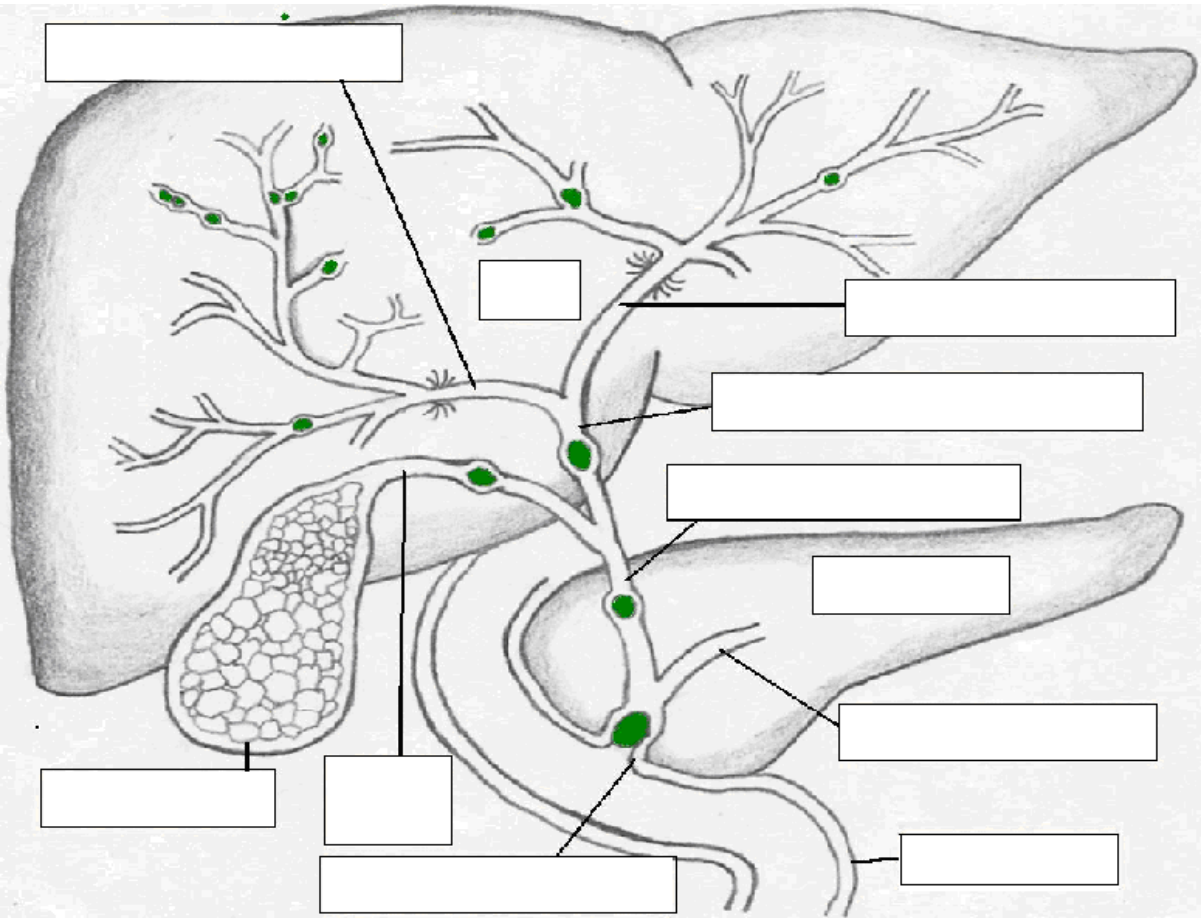
Task 6.18. *Study the picture and define significance of protective vomiting reflex*



Task 6.19. *Describe gastric secretion during the interdigestive period*

7. DIGESTION IN DUODENUM.
ROLE OF PANCREATIC JUICE AND BILE IN DIGESTION

Task 7.1. *Revise your knowledge from anatomy course and label the picture*



Task 7.2. *Define peculiarities of digestion in the duodenum*

1) _____

_____

_____

2) _____

_____

_____

3) _____

_____

_____

Task 7.3. *Name the functions of pancreas*

1) _____

_____

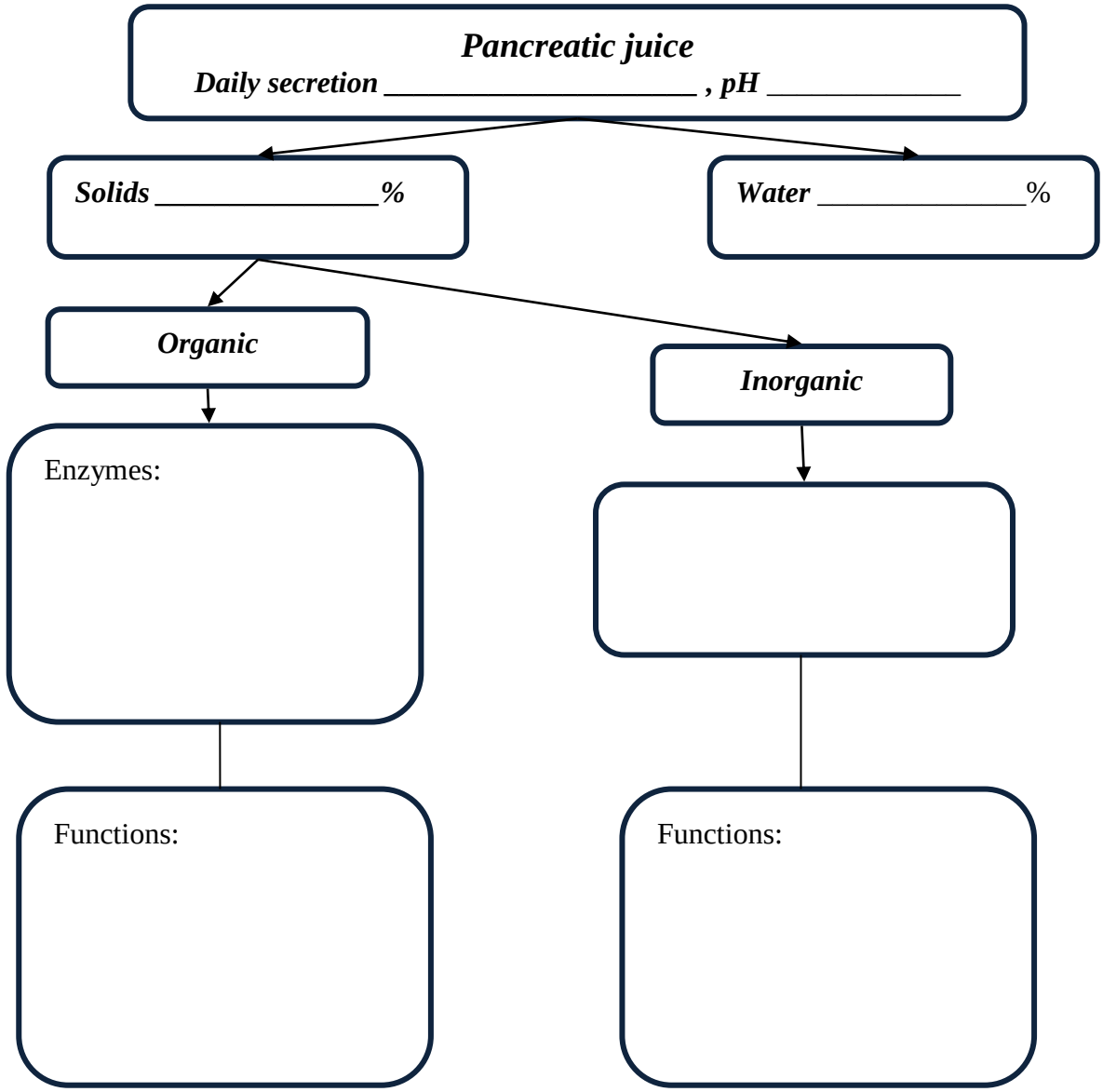
_____

2) _____

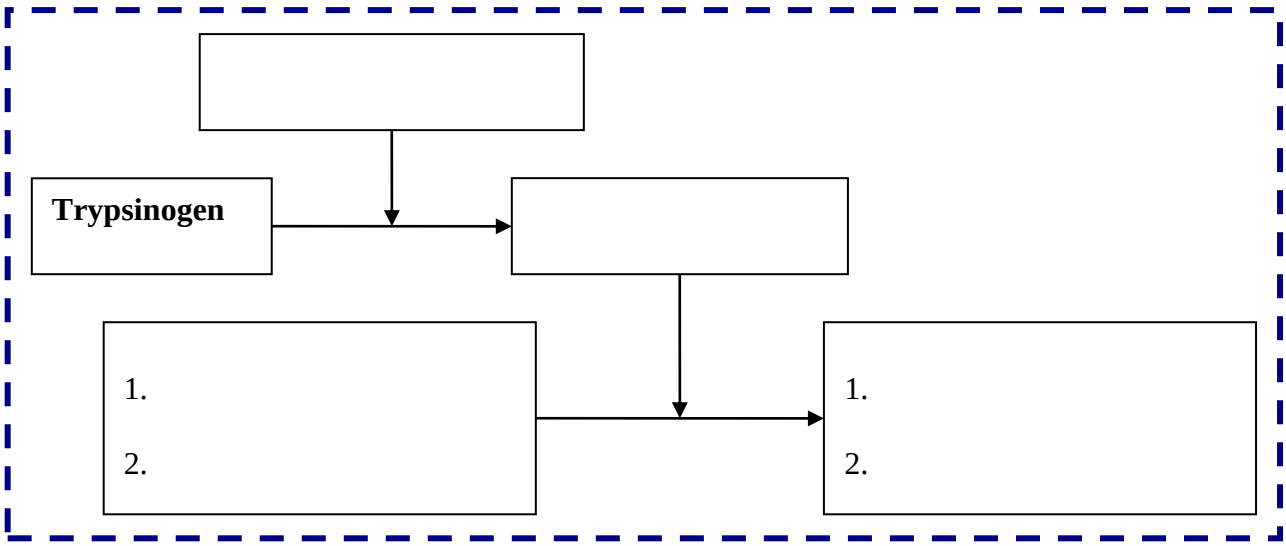
_____

_____

Task 7.4. *Define the composition of pancreatic juice*



Task 7.5. *Draw the scheme of pancreatic proteolytic enzymes activation*



Task 7.6. *Define the role of proteolytic enzymes of pancreas in proteins hydrolysis*

Trypsin and chymotrypsin _____

_____

Carboxypeptidase _____

_____

Task 7.7. *List pancreatic enzymes for carbohydrates digestion and define their role*

_____

_____

_____

_____

Task 7.8. *Name pancreatic enzymes for fats digestion and define their role*

1)_____

_____

_____

2)_____

_____

_____

3)_____

_____

_____

Task 7.9. *Define factors which prevent digestion of pancreas itself*

_____

_____

_____

_____

Task 7.10. *Define the role of bicarbonate ions*

_____

_____

_____

_____

Task 7.11. *Name the phases of pancreatic secretion*

1)_____

_____

_____

2)_____

_____

_____

3)_____

_____

_____

Task 7.12. *Complete the scheme* ***"Unconditional parasympathetic regulation of pancreatic secretion"*** *(its gastric and cephalic phases)*

Stimulus and receptors	**Afferent nerves**	**Nervous center of reflex**	**Efferent nerves (preganglionic, ganglion, postganglionic**	**Target organ Response**

Task 7.13. *Define the role of hormones in regulation of pancreatic secretion. Use the illustration below to give complete answer.*

	Secretin	***Cholecystokinin***
Stimulus		
Cells producing hormone		
Target cells		
Effect		

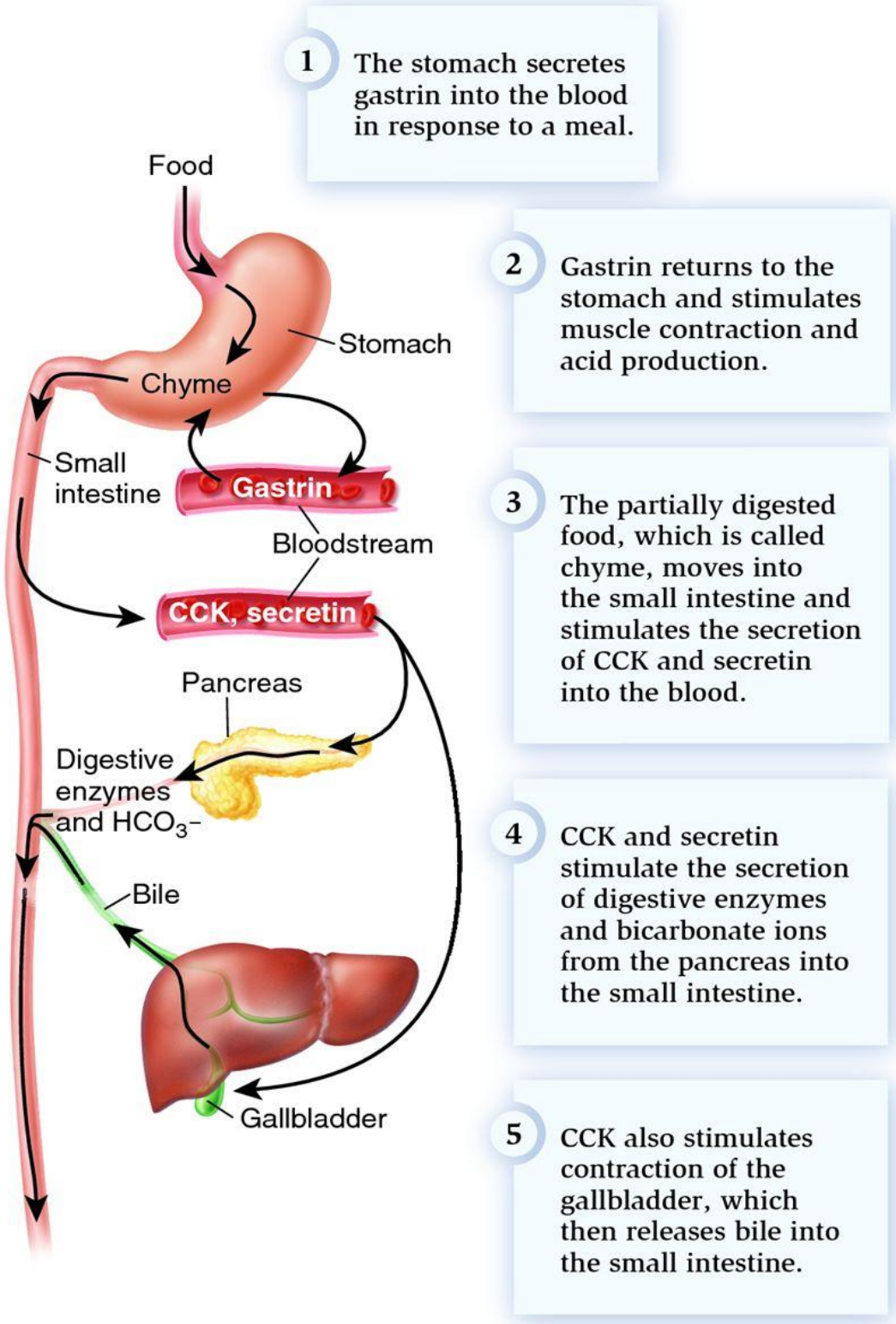


Figure 7.1. Cascade of gastrointestinal hormones

Task 7.14. *Complete the table* ***"Functions of liver"***

Function	*Description*
Digestive	
Carbohydrates metabolism	
Proteins metabolism	
Lipids metabolism	
Hormones	
Blood	
Detoxification	
Storage	

Task 7.15. *Describe the stages of bile secretion by liver*

1)_____

_____

2)_____

_____

Task 7.16. *Define the functions of bile*

1)_____

2)_____

3)_____

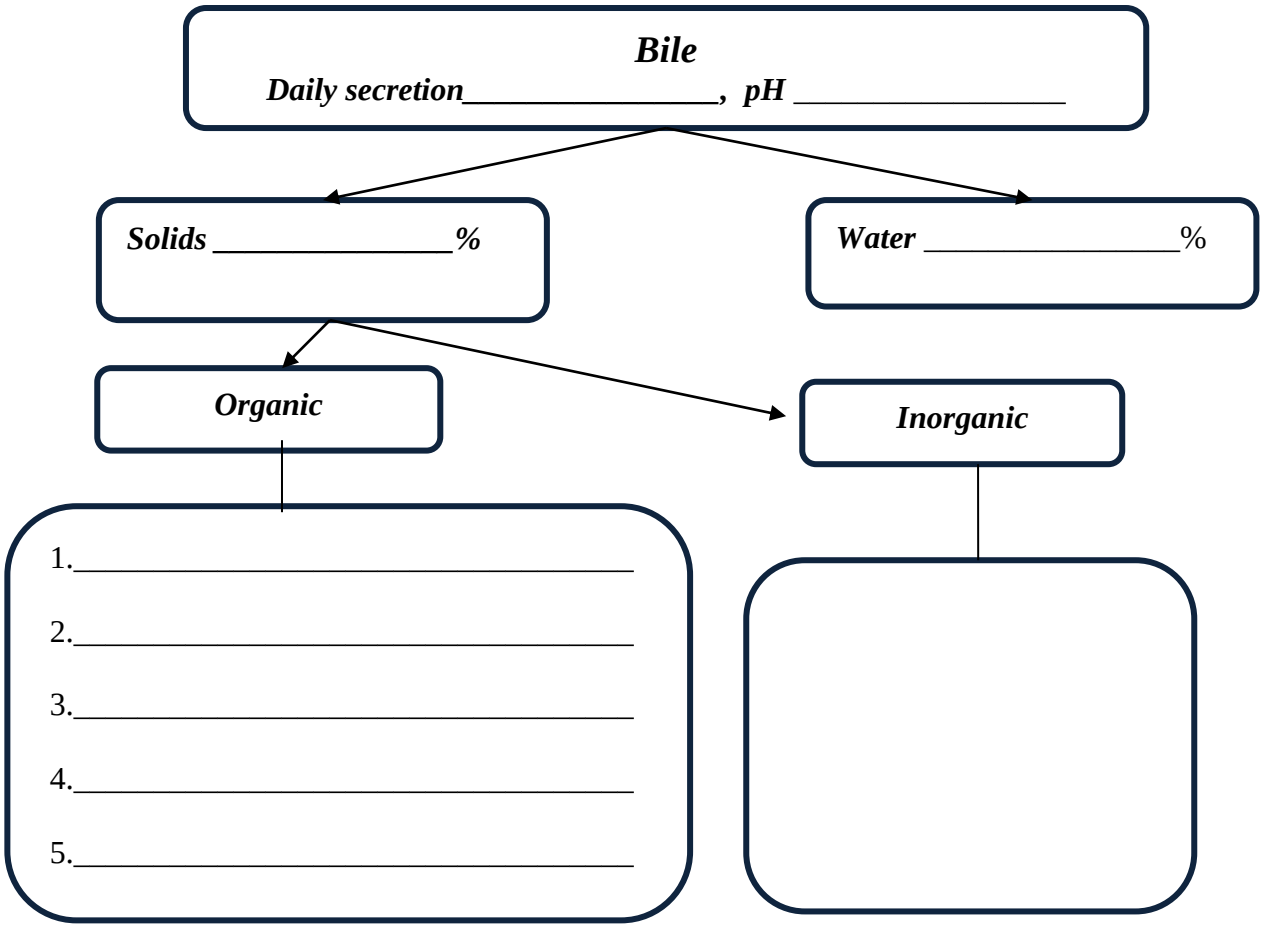
4)_____

5)_____

6)_____

7)_____

Task 7.16. *Complete the table* ***"Bile composition"***



Task 7.17. *Explain differences between cystic and hepatic bile. Give their characteristics*

_____

_____

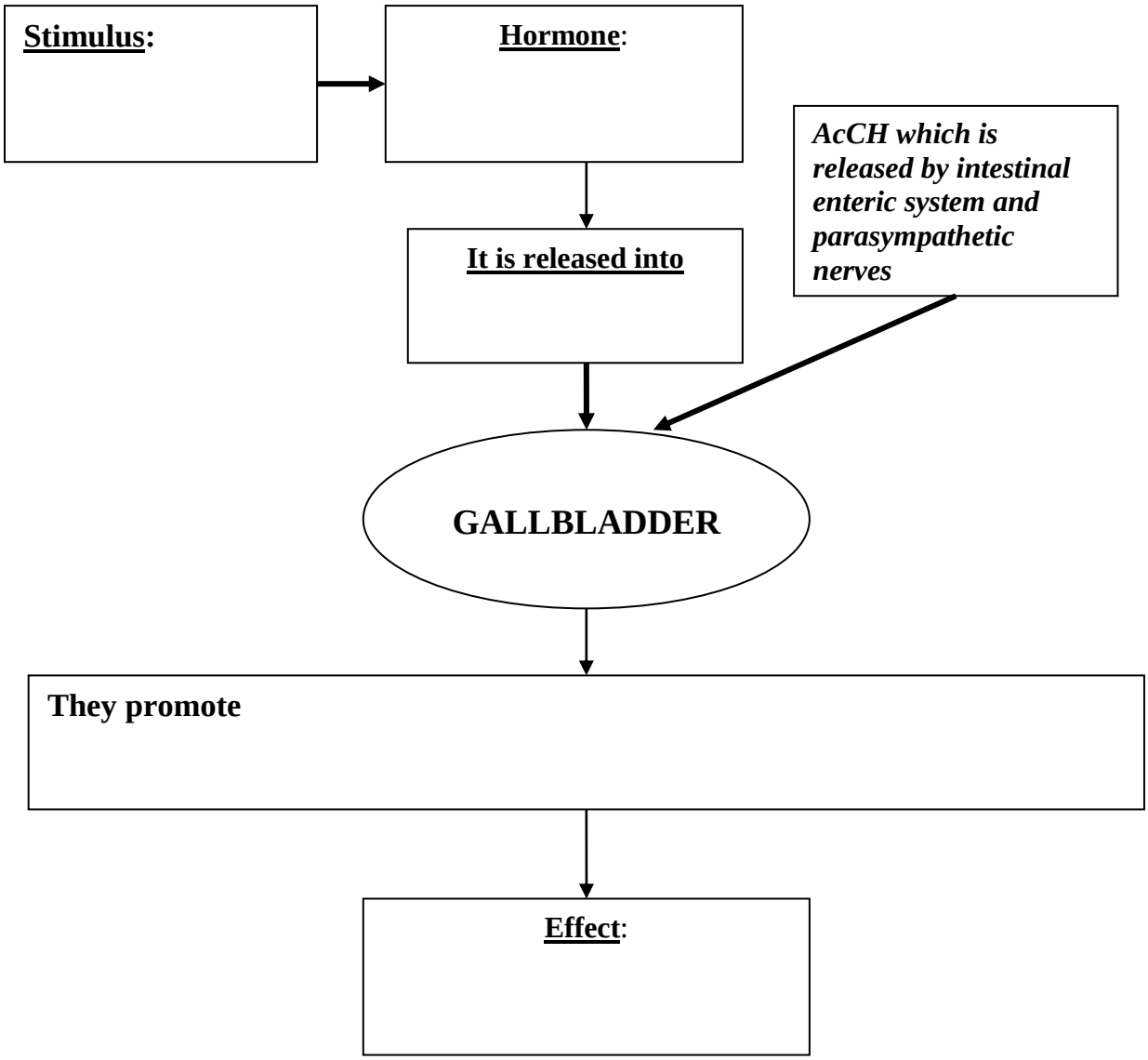
_____

_____

Hepatic bile*_____*, pH*_____*.

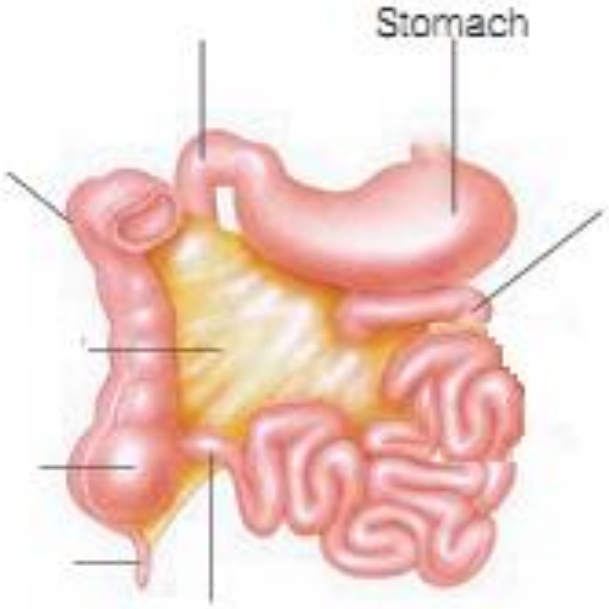
Cystic bile*_____*, pH*_____*.

Task 7.16. *Complete the scheme* ***"Regulation of bile secretion"***



8. DIGESTION IN SMALL AND LARGE INTESTINE

Task 8.1. *Label departments of small and large intestine*



Task 8.2. *Complete the table* ***"Composition of intestinal juice"***

Intestinal juice – pH _____

Solids _____***%***

Water _____%

Organic

Inorganic

Enzymes:

1.

2.

3.

Ions:

Study and memorize major digestive enzymes and their functions

Table 8.1. Characteristics of major digestive enzymes

Enzyme	*Site of action*	*Source*	*Substrate*	*Optimum pH*	*Products*
Salivary amylase	Mouth	Saliva	Starch	6.7	Maltose
Pepsin	Stomach	Gastric glands	Protein	1.6-2.4	Shorter polypeptides
Pancreatic amylase	Duodenum	Pancreatic juice	Starch	6.7-7.0	Maltose, maltriose, oligosaccharides
Trypsin, chymotrypsin, carboxypeptidase	Small intestine	Pancreatic juice	Polypeptides	8.0	Amino acids, dipeptides, and tripeptides
Pancreatic lipase	Small intestine	Pancreatic juice	Triglycerides	8.0	Fatty acids and monoglycerides
Maltase	Small intestine	Brush-border of epithelial cells	Maltose	5.0-7.0	Glucose
Sucrase	Small intestine	Brush-border of epithelial cells	Sucrose	5.0-7.0	Glucose+fructose
Lactase	Small intestine	Brush-border of epithelial cells	Lactose	5.8-6.2	Glucose+galactose
Aminopeptidase	Small intestine	Brush-border of epithelial cells	Polypeptides	8.0	Amino acids, dipeptides, and tripeptides

Table 8.2. Brush-border enzymes attached to the cell membrane of microvilli in the small intestine

Category	*Enzyme*	*Functions*
Disaccharidase	Sucrase	Digests sucrose to glucose and fructose; deficiency produces gastrointestinal disturbances
	Maltase	Digests maltose to glucose
	Lactase	Digests lactose to glucose and galactose; deficiency produces gastrointestinal disturbances (lactose intolerance)
Peptidase	Aminopeptidase	Produces free amino acids, dipeptides, and tripeptides
	Enterokinase	Activates trypsin (and indirectly other pancreatic juice enzymes); deficiency results in protein Malnutrition
Phosphatase	Ca2+, Mg2+-ATPase	Needed for absorption of dietary calcium; enzyme activity regulated by vitamin D
	Alkaline phosphatase	Removes phosphate groups from organic molecules; enzyme activity may be regulated by vitamin D

Task 8.3. *Define types of digestion in small intestine*

1)_____
2)_____

Task 8.4. *Define peculiarities of digestion in the small intestine*

_____
_____
_____
_____

Task 8.5. *Characterize cavitary digestion in the small intestine*

1)_____
_____
2)_____
_____
3)_____
_____

Task 8.6. *List the significant features of membrane digestion*

1)_____
_____
2)_____
_____
3)_____
_____
4)_____
_____
5)_____
_____

Task 8.7. *Define peculiarities of regulation of intestinal secretion*

1)_____
_____
2)_____
_____
3)_____
_____
4)_____
_____
_____

Task 8.8. *Use the illustrations below to draw the following schemes*

1) Digestion of Carbohydrates

2) Digestion of proteins

3) Digestion of fats

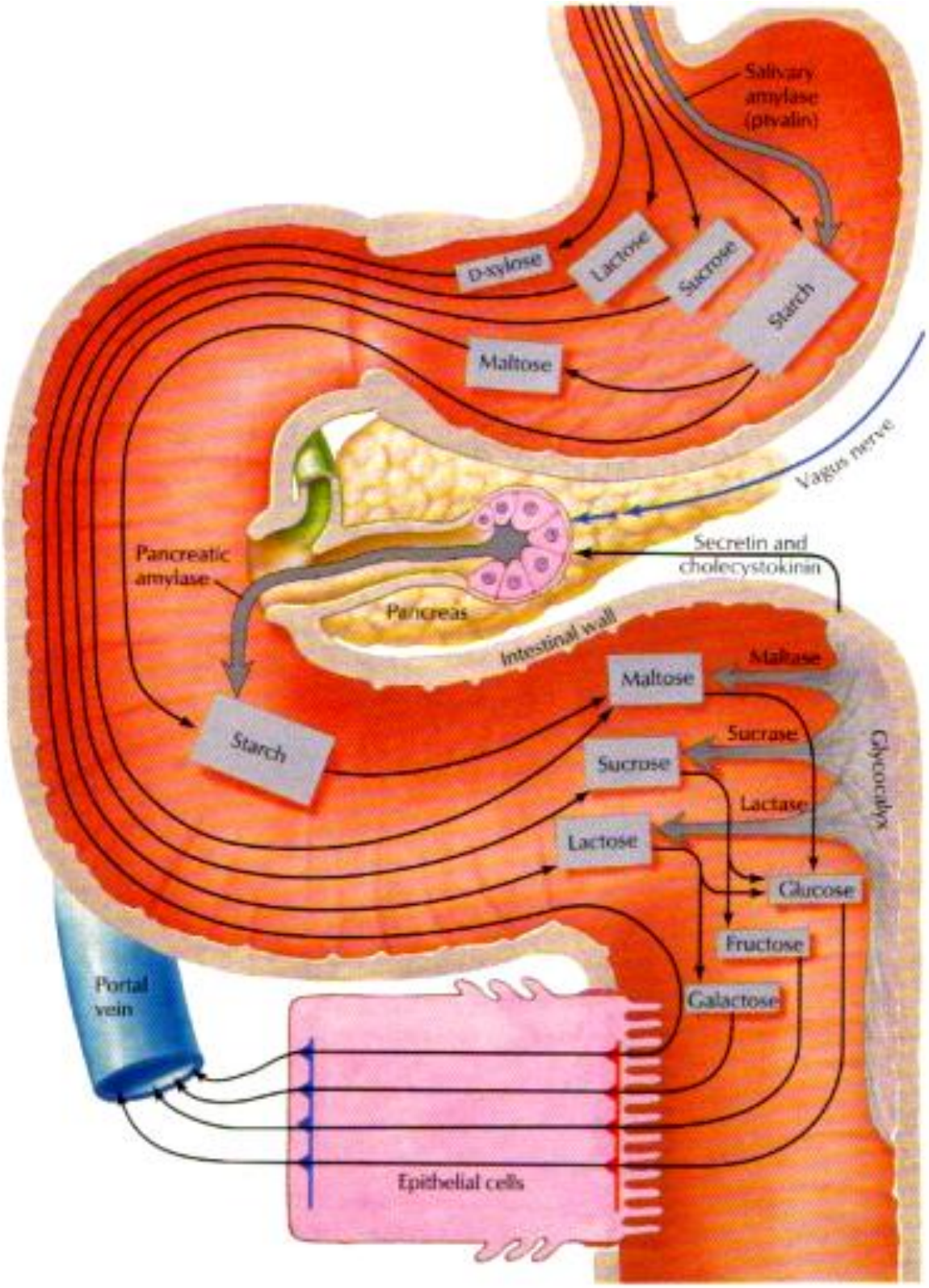


Figure 8.1. Digestion of Carbohydrates

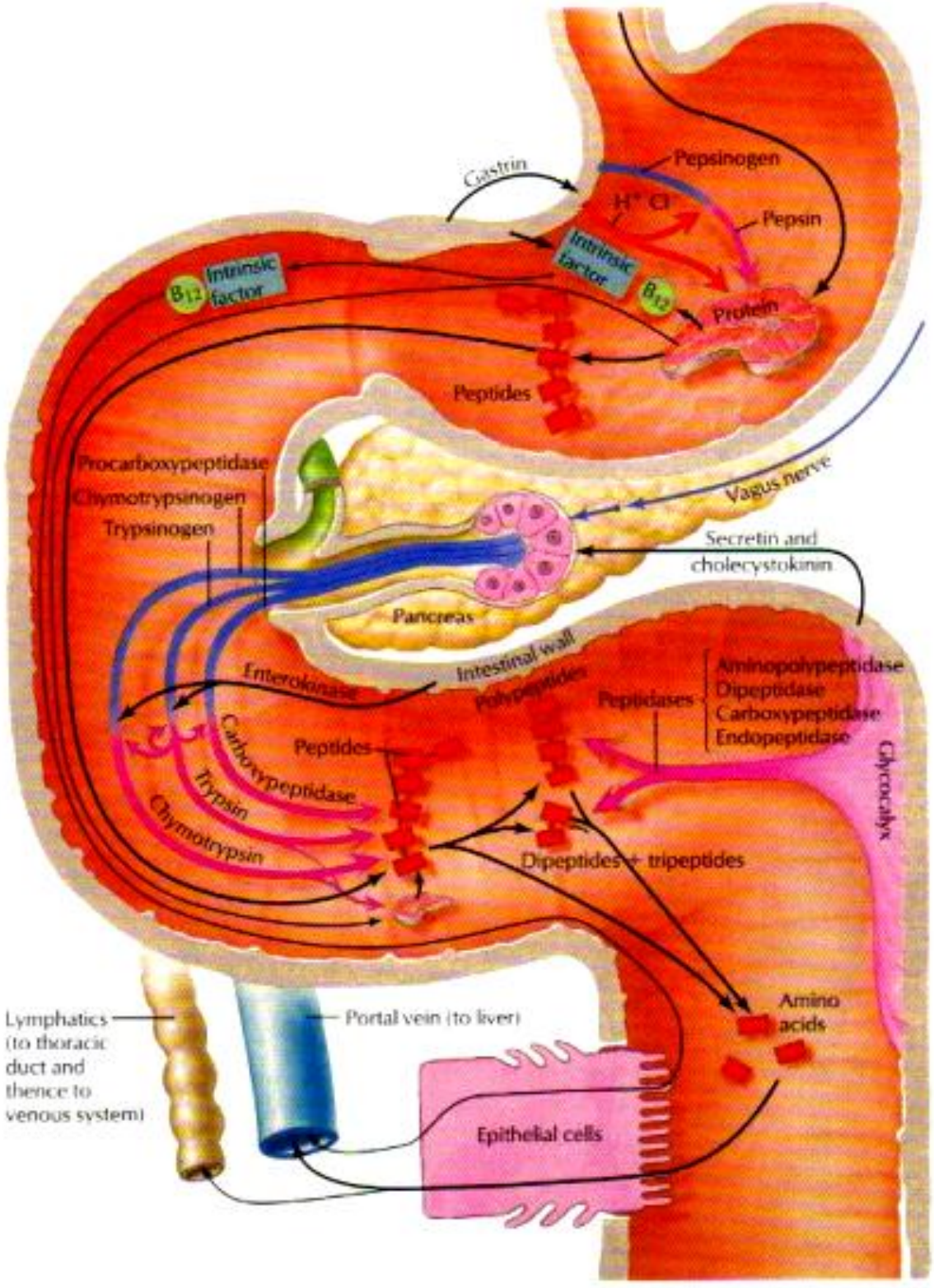


Figure 8.2. Digestion of Proteins

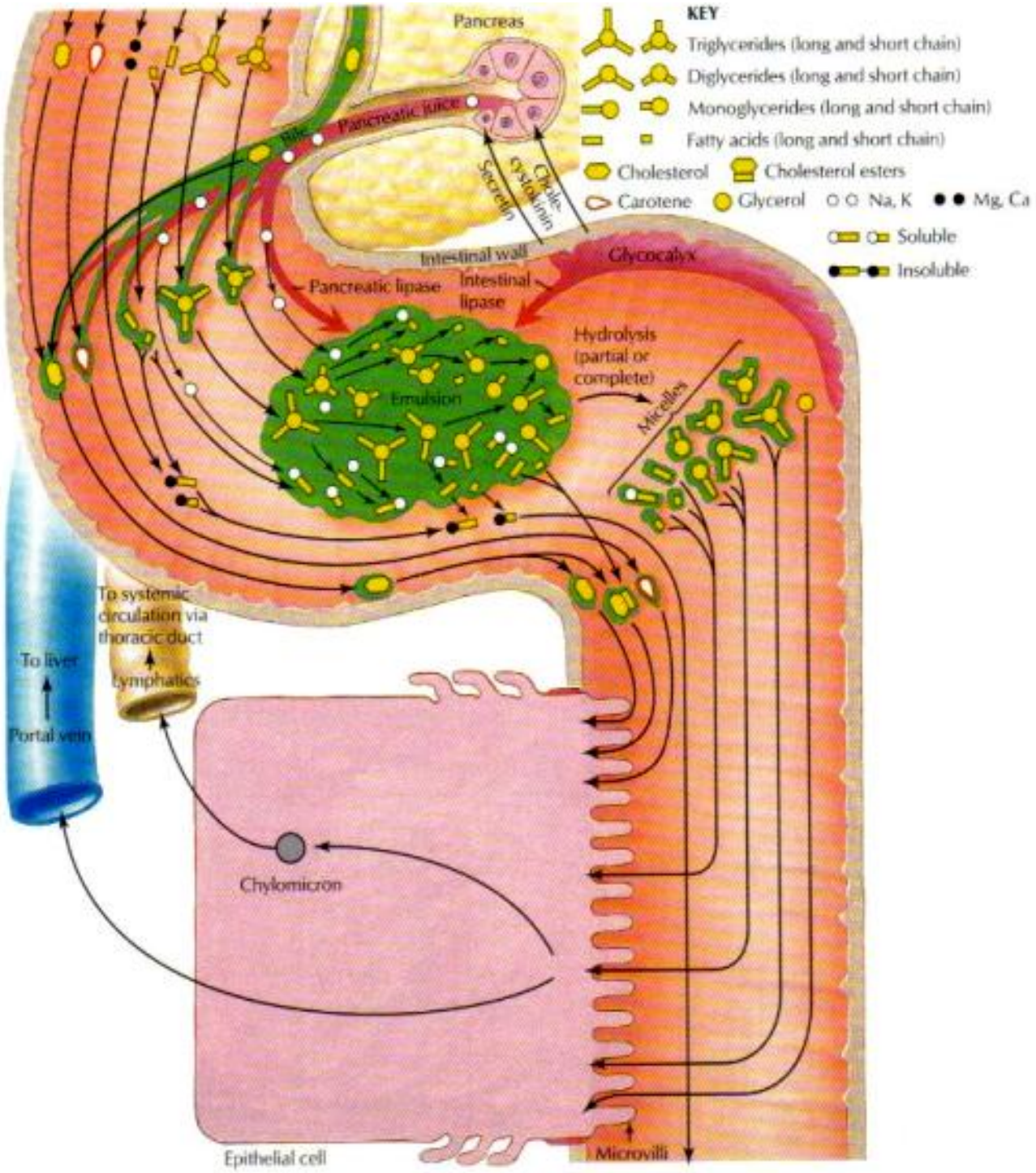
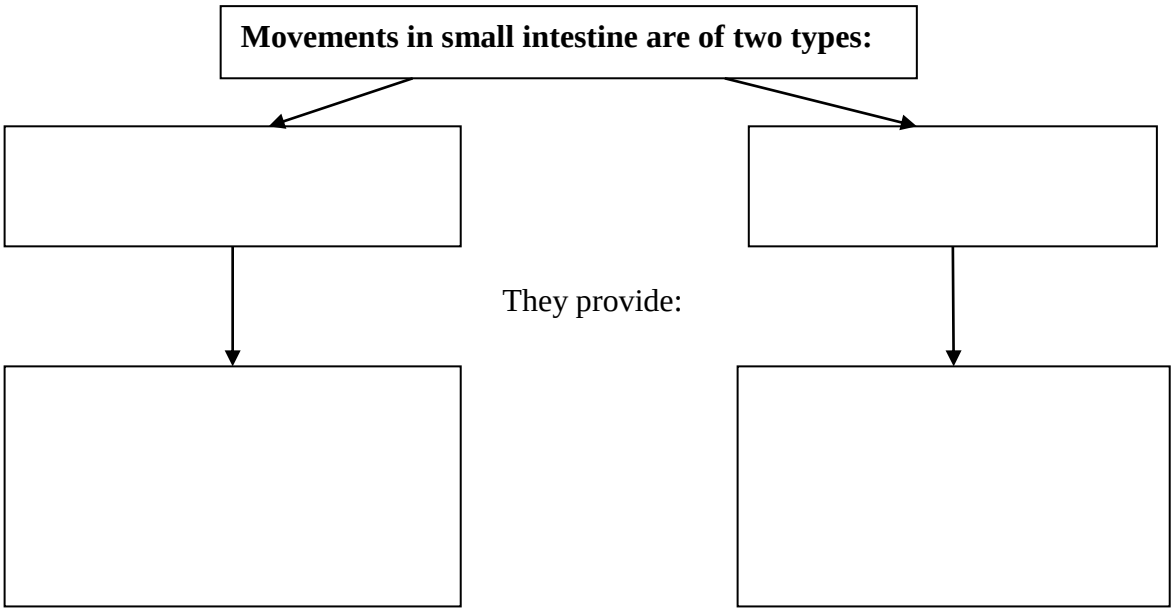


Figure 8.3. Digestion of Fats

Task 8.9. *Complete the following scheme*



Task 8.10. *Define peculiarities of regulation of small intestinal motor activity*

1) Regulation of motor activity starts _____

2) It is caused by _____ ***reflex*** _

that is initiated by _____

_____

Task 8.11. *List hormones which take part in regulation of small intestine motor function according their effects*

Stimulation	***Inhibition***

Task 8.12. *Draw schemes of following motor reflexes of small intestine*

1) esophago-intestinal reflex

2) gastro-enteric reflex

3) entero-enteric reflex

Task 8.13. *Draw schemes of inhibitory reflexes of small intestine*

1) entero-enteric reflex

2) recto-enteric reflex

Task 8.14. *Fill on the table **"Absorption in GIT"**. Please, name substances which are absorbed and mechanisms of their absorption.*

Department of GIT	***Substances and mechanisms of their absorption***
Mouth	
Stomach	
Duodenum	
Jejunum, ileum	
Large intestine	

Task 8.15. *Define mechanisms of substances absorption.*

Substance	***Mechanisms of absorption***
Water	
Ions	
Carbohydrates	
Proteins	
Fats	

Task 8.16. *Complete the table* ***"Digestion of proteins"***

Department of GIT	***Chemical processing (name secretory cells and enzymes)***	***Mechanical processing***
Mouth		
Stomach		
Duodenum		
Jejunum, ileum		
Absorption		

Task 8.17. *Complete the table* ***"Digestion of carbohydrates"***

Department of GIT	***Chemical processing (name secretory cells and enzymes)***	***Mechanical processing***
Mouth		
Stomach		
Duodenum		
Jejunum, ileum		
Absorption		

Task 8.18. *Complete the table* ***"Digestion of lipids"***

Department of GIT	***Chemical processing (name secretory cells and enzymes)***	***Mechanical processing***
Mouth		
Stomach		
Duodenum		
Jejunum, ileum		
Absorbtion		

Task 8.19. *Define peculiarities of digestion in large intestine.*

1)_____
2)_____
3)_____
4)_____
5)_____
6)_____
7)_____

Task 8.20. *Define the significance of mucus in large intestine.*

1)_____
_____
2)_____
_____
3)_____
_____
4)_____
_____

Task 8.21. *Define the significance of bacteria of large intestine.*

1)_____

2)_____

3)_____

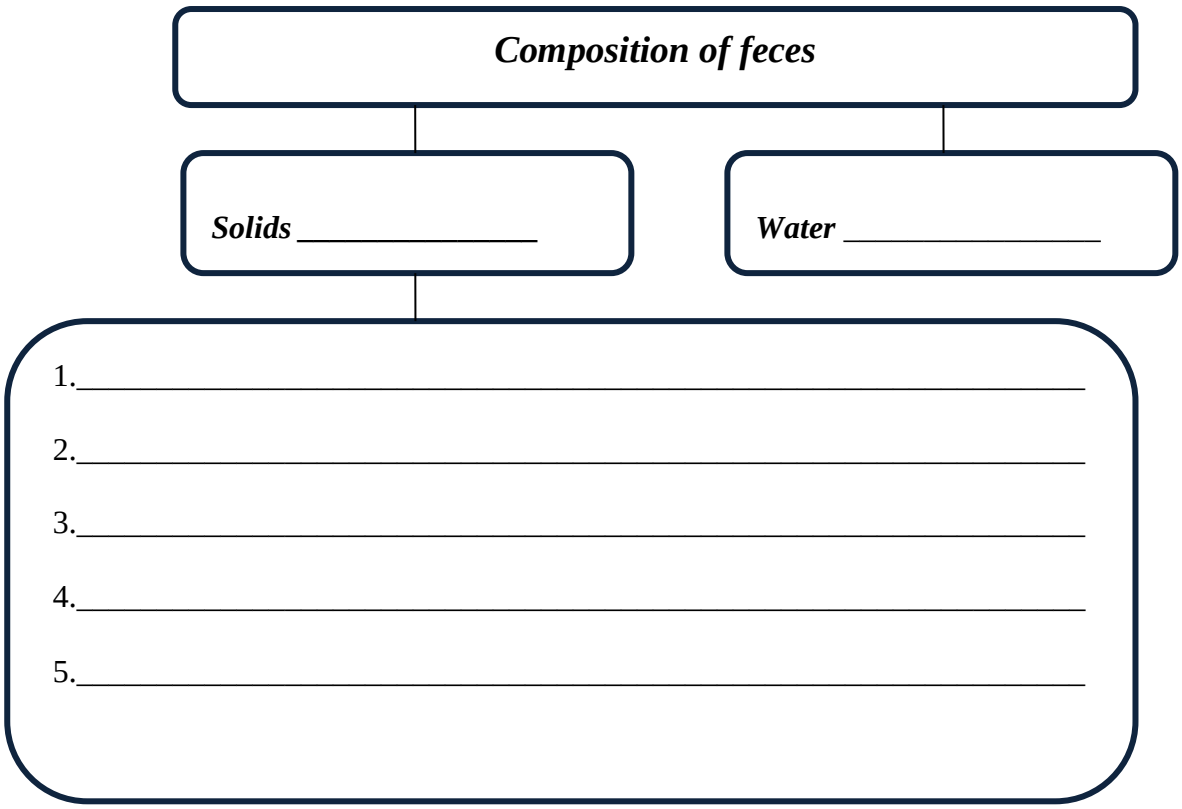
4)_____

5)_____

6)_____

7)_____

Task 8.22. *Complete the scheme* **"*Composition of feces"***



Brown color of feces is caused by _____

_____

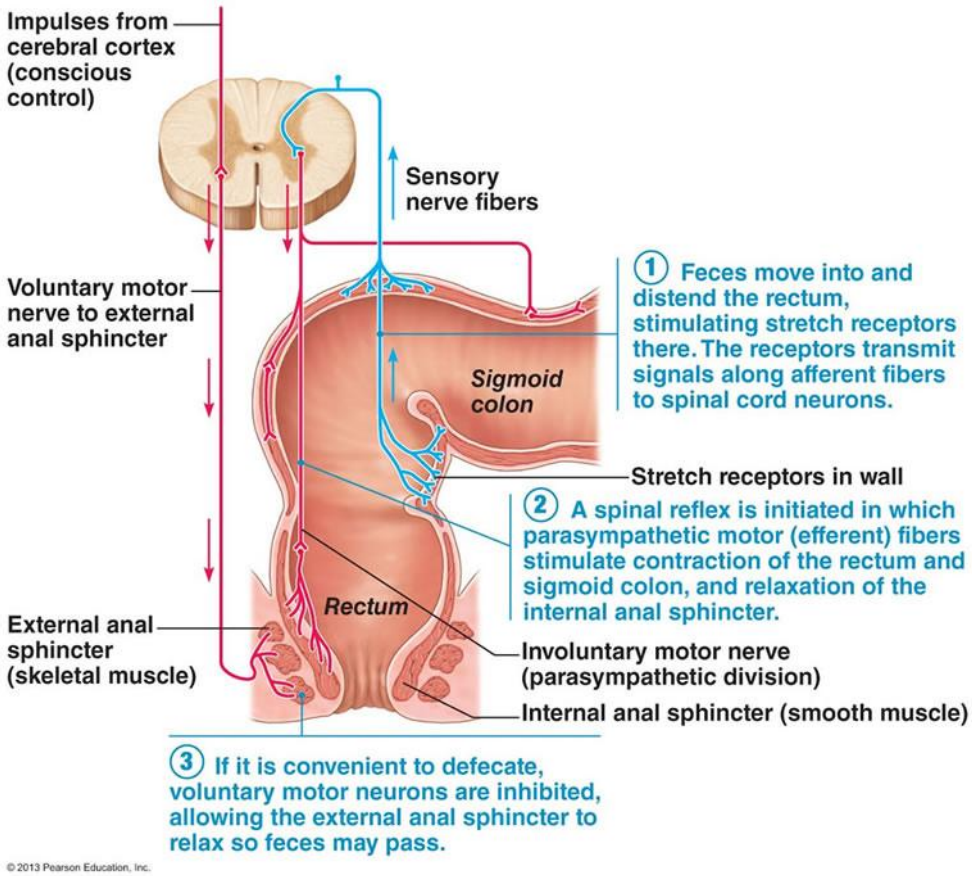
_____

Their odor is caused by _____

_____

_____

Task 8.23. *Study the following illustration and draw the scheme of defecation reflex: stimuli → afferent nerve → center → efferent nerve → target structures*



9. PHYSIOLOGICAL BASIS OF HUNGER AND SATIETY

Task 9.1. *Define stimuli that cause the feeling of hunger*

_____

_____

_____

_____

Task 9.2. *Describe the structure and localization of "feeding" center*

_____

_____

_____

_____

_____

_____

Task 9.3. *Describe receptors of hunger center*

_____

_____

_____

Task 9.4. *What types of satiety are known?*

1) _____

2) _____

Task 9.5. *Describe receptors of hunger center*

_____

_____

_____

Task 9.6. *Define factors that determine the expression of satiety*

1)_____

_____

2)_____

_____

3)_____

_____

4)_____

_____

Task 9.7. *Draw the scheme* ***"Functional system of nutrition"***

ENERGY METABOLISM AND METHODS OF ITS EXAMINATION

10. METABOLISM AND ENERGY EXCHANGE

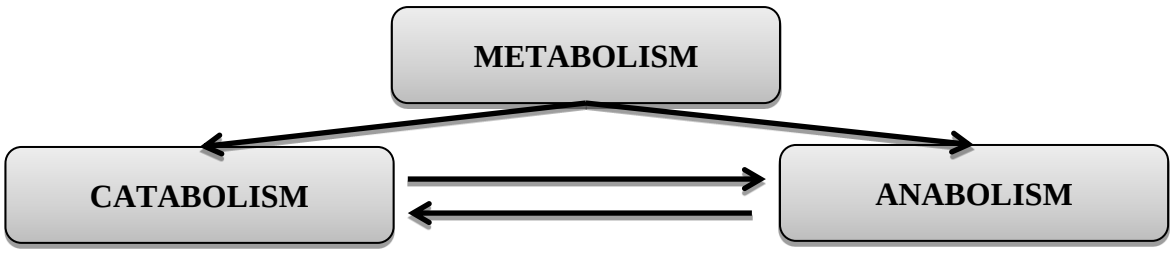
Task 10.1. *Give definition of metabolism and energy exchange.*

_____
_____
_____
_____

Task 10.2. *Define importance of these processes.*

_____
_____
_____
_____

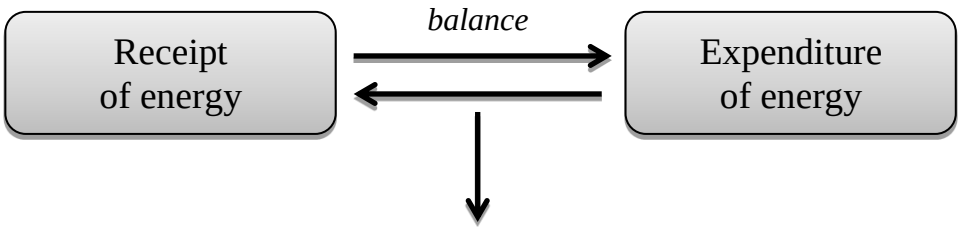
Task 10.3. *Complete the following scheme.*



_____
_____
_____
_____
_____
_____

_____
_____
_____
_____
_____
_____

Task 10.4. *Complete the following scheme.*



They characterize: _____
_____
_____
_____
_____

Task 10.5. *Define the sources of energy in organism.*

_____
_____
_____
_____
_____
_____

Task 10.6. *Define the importance of ATP.*

_____
_____
_____
_____

Task 10.7. *Define how many ATP molecules are used to supply different mechanisms and systems activities.*

Secondary heat production which can be measured by methods of calorimetry

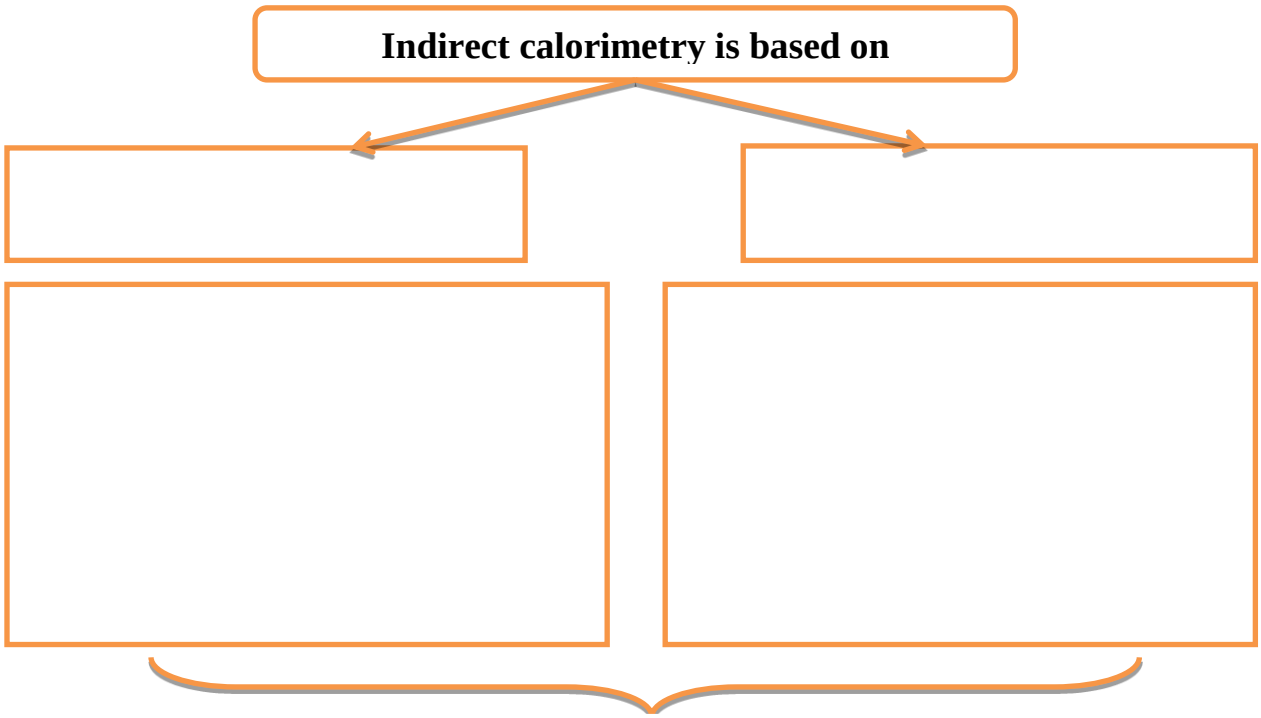
Task 10.8. *Define the methods of energy and total metabolism measurement.*

1. _____
   _____
2. _____
   _____

Task 10.9. *Complete the following statements.*

Direct calorimetry is _____
_____
_____

Task 10.10. *Complete the following statements.*



to analyze intensity of **METABOLIC RATE**

Significance: _____
_____
_____
_____

Task 10.11. Metabolic rate can be calculated from the rate of O_2 utilization, because 95 % of energy expended in the body is derived from reactions of oxidation with different foods. *Complete the following statements.*

- ✓ *If 1 L of O_2 is metabolized with starch, as a result _____ calories of energy are released*
- ✓ *If 1 L of O_2 is metabolized with fat, as a result _____ calories of energy are released*
- ✓ *If 1 L of O_2 is metabolized with proteins, as a result _____ calories of energy are released*

Task 10.12. *Give definition of* ***oxygen calorific equivalent***

_____
_____
_____
_____

Task 10.13. *Give definition of RQ and complete the formula*

_____

_____

$$RQ = \frac{\qquad\qquad}{\qquad\qquad}$$

Task 10.14. *Complete the formulae and calculate the RQ for glucose, fats and proteins*

1) *Oxidation of glucose:*

$$C_6H_{12}O_6 + 6O_2 \rightarrow$$

so $RQ_{glucose}$ = _____ = _____

2) *Oxidation of fats (on example of triglycero-palmitate – glycerol ether of saturated palmitic acid)*

$$2C_3H_5(C_{15}H_{31}COO)_3 + 145O_2 \rightarrow 102CO_2 + 98H_2O$$

so RQ_{fats} = _____ = _____

3) *RQ for proteins can be measured by the same way*

so $RQ_{proteins}$ = _____

Task 10.15. *Energy expenditure is divided on two types: basal metabolism and working metabolism. Complete the following table to characterize both.*

Basal metabolism	***Working metabolism***

Task 10.16. *Define the conditions to determine Basal Metabolic Rate (BMR)*

1. _____
2. _____
3. _____
4. _____

Task 10.17. *Complete the following statements:*

BMR is about _____ cal/hour in man with the weight _____ kg.

BMR depends on:

1. _____
2. _____
3. _____
4. _____
5. _____

Task 10.18. *Complete the table to define the factors regulating the BMR.*

Increasing factors	***Decreasing factors***
1.	*1.*
2.	*2.*
3.	*3.*
4.	*4.*
5.	*5.*

Task 10.19. *Complete the following statements*

The highest BMR is typical for 6 month children; then it gradually decreases and in puberty is about equal to adults. After 40 years old it gradually decreases. BMR in man 70 kg is _____ Cal/day, in woman _____.

Energy expenditure is _____ in mental work than in _____ exertion. Emotional excitement causes acceleration of MR in _____ % from BMR due to involving of muscles contraction. Children's cry increases MR in 3 times.

After food intake MR and energy expenditure increases in 1 hour, reach maximal level in 3 hours, and remain in that level for several hours. So, effect of food intake leading to increase of MR and EC is called _____.

Task 10.20. *Give definition and explain phenomenon of specific dynamic food effect*

_____
_____
_____
_____
_____

Task 10.21. *Define main physiological principles of adequate nutrition*

1)_____

2)_____

3)_____

Task 10.22. *Complete the following statements*

Organic components of food – proteins, carbohydrates and fats – contain chemical energy necessary for synthesis of ATP. Energy intensity of diet has to correspond to the needs of an organism. It depends on:

1._____

(caloric content of diet for men has to be in _____ % higher than for women).

2._____

(for male from _____ to _____ ; students: men _____ , women _____

Task 10.23. *The most important criterion of optimal diet is the body weight (BW); normal BW differs from ideal in 10 % (±10 %)*

1) *Broca's method for calculation of ideal BW:*
   IBM_m=height (cm) – 100 (for men)
   IBM_m=height (cm) – 105-110 (for women)
2) *Index of Ketle =* $\frac{m}{h^2}$

Calculate your ideal BW and compare with the normal one (normal index is 22-30 units)

_____

_____

Task 10.24. *Define the optimal ratio of proteins, fats and carbohydrates in balanced diet*

Proteins	***Fats***	***Carbohydrates***

Proteins minimum is _____gram per day

Proteins optimum is _____gram per day, or _____ to 1 kg/body weight.

Protein optimum id diet for children is _____ gram/kg/day,

for pregnant women – _____ gram/kg/day

Fats can be synthesized from carbohydrates in organism. Daily diet content of fats has to be about _____ %. Carbohydrates may be synthesized from _____ and _____. Daily diet content of carbohydrates has to be minimum _____ g.

Task 10.25.

The adequate daily distribution of food ration is _____ meals with time interval in _____ hours

Complete percentage content of daily food intake (ration)

1st breakfast −	%	Breakfast −	%
2nd breakfast −	%	Dinner −	%
Dinner −	%	Supper −	%
Supper −	%		

11. BODY TEMPERATURE REGULATION

Task 11.1. *Give definitions of "core temperature" and "shell temperature" and describe their peculiarities*

Core temperature is _____.

_____

_____

Shell temperature is _____.

_____

_____

_____

_____

Task 11.2. *Complete following statements*

Comfort temperature in case of humidity _____ % is _____ ºC for easy dressed men and _____ ºC for stripped one.

Task 11.3. *Give definition*

Endogenous thermoregulation is _____

_____

_____

_____

Task 11.4. *Define main ways of heat production*

1)_____

- ✓_____
- ✓_____

_____

2)_____

_____

Task 11.5. *Define the most important factors affecting metabolic rate*

*1)*_____

_____

2)_____

_____

3)_____

_____

4)_____

_____

5)_____

_____

Task 3.6. *Define the importance of brown fat in infants to maintain normal body temperature:*

_____
_____
_____
_____
_____
_____

Task 11.7. *Define each way of heat loss and its importance for thermoregulation:*

Radiation is _____
_____
_____
_____
_____
_____

Conduction is _____
_____
_____
_____
_____
_____

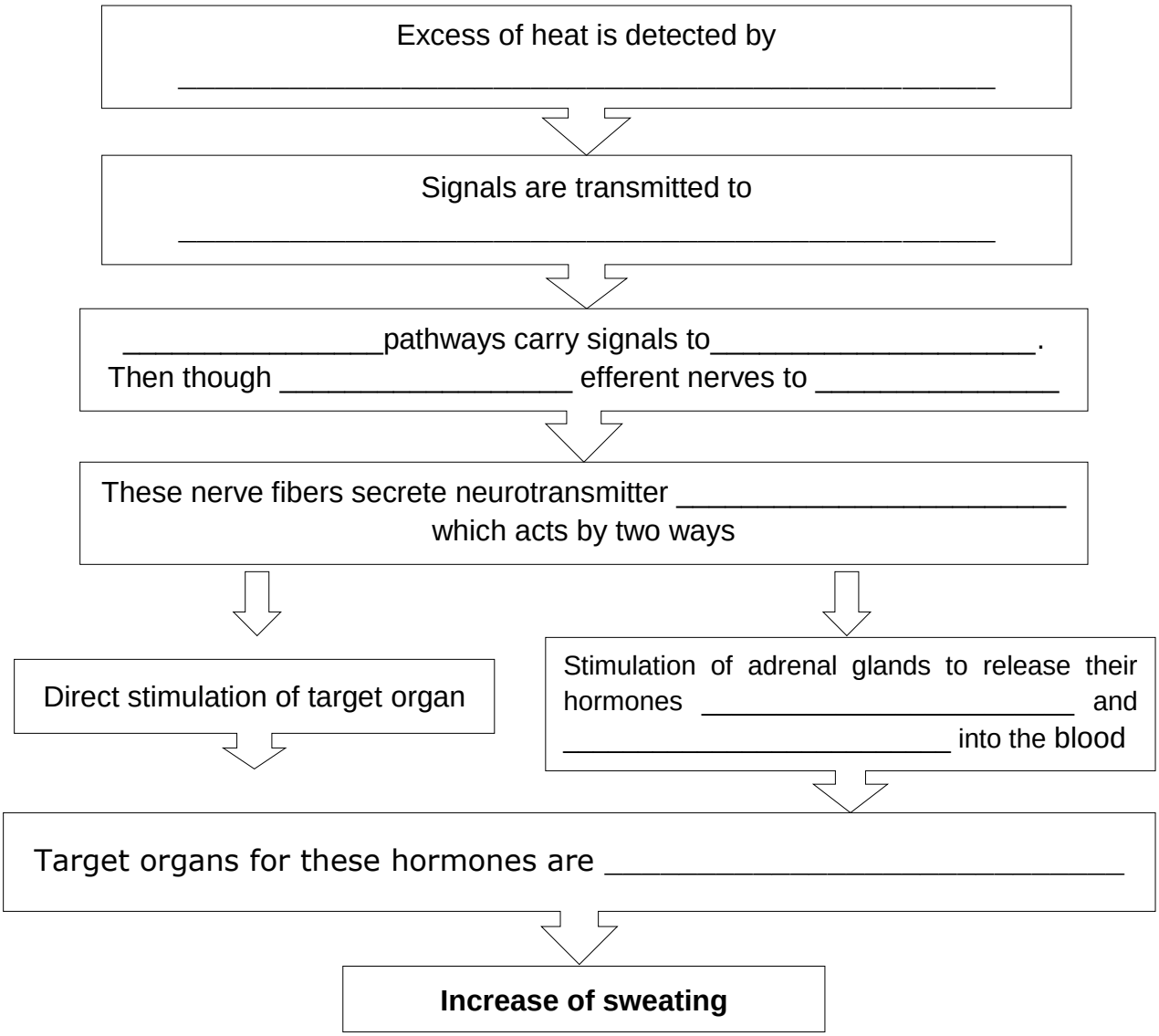
Convection is _____
_____
_____
_____
_____
_____

Evaporation is _____
_____
_____
_____
_____
_____

Task 11.8. Evaporation is the most important mechanism of adaptation to the hot climate. During adaptation the content of electrolytes in sweat decreases. *Explain the mechanism of this phenomenon.*

_____
_____
_____
_____
_____
_____

Task 11.9. *Complete the scheme* ***"Regulation of sweating by Autonomic Nervous System"***



Task 11.10. *Complete the following statements. Define types of thermoreceptors and describe their peculiarities*

Receptors which are adapted to detect temperature are _____ of afferent nerve fibers of _____ and _____ types. Depending on their localization thermoreceptors are of two types:

1)_____

_____

_____

_____

_____

2)_____

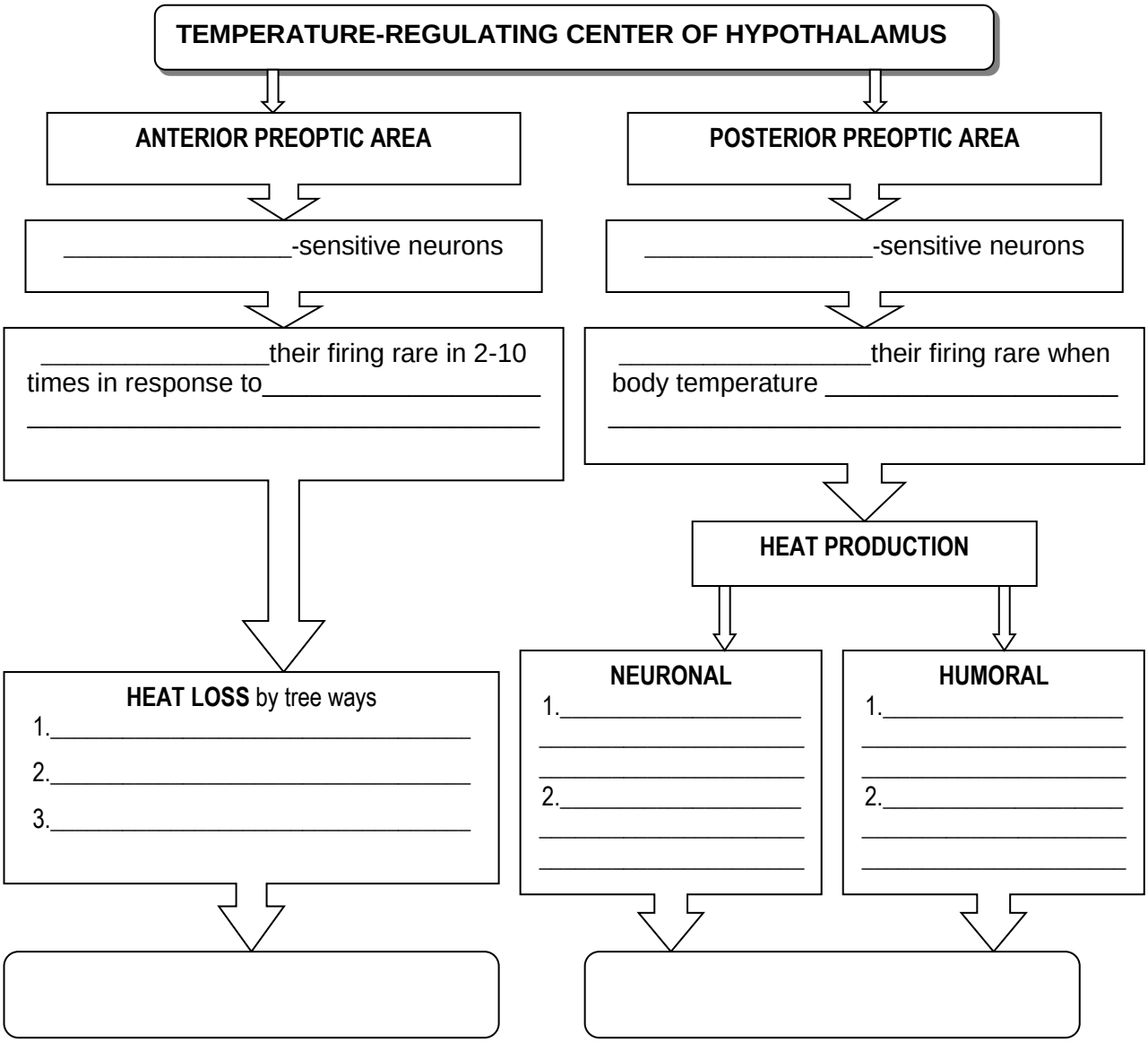
_____

_____

_____

_____

Task 11.11. *Complete the scheme* ***"Role of Hypothalamus in body temperature regulation"***



Task 11.12. *Define the temperature-increasing mechanisms when the body is too cold.*

1._____
2._____
3._____
_____

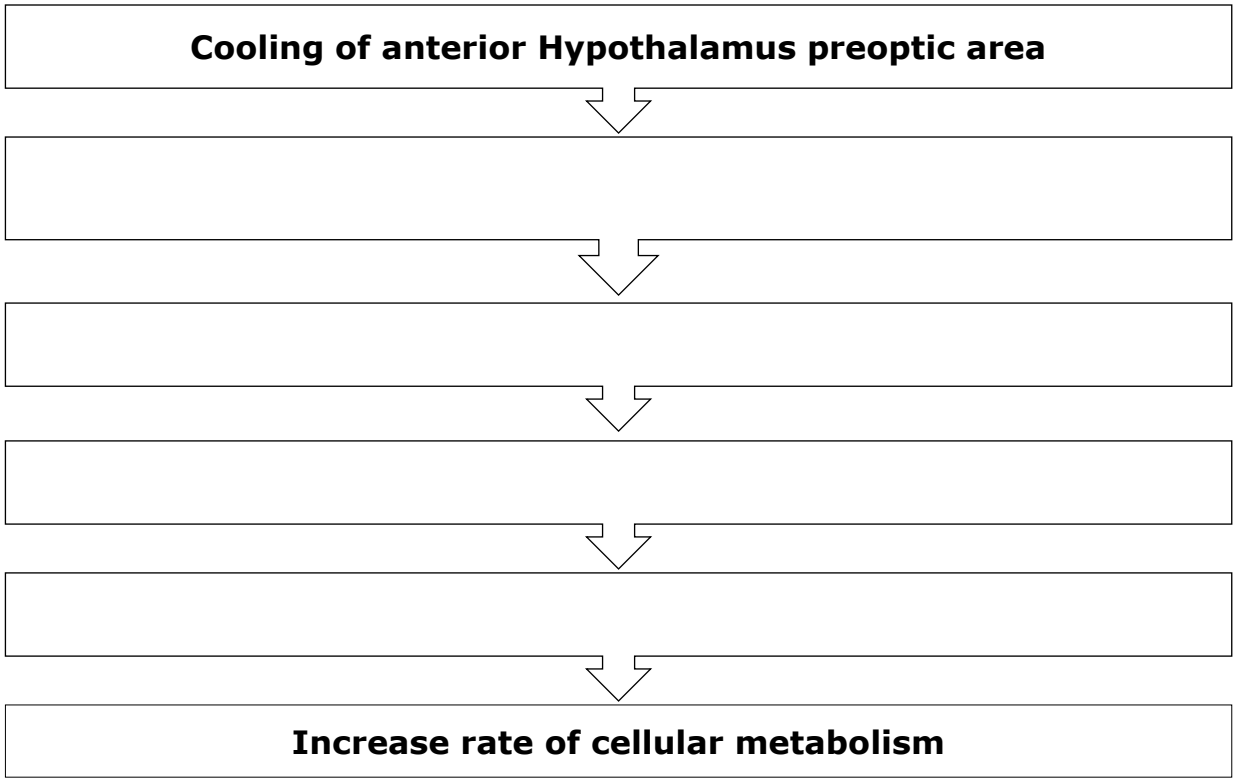
Task 11.13. *Define mechanism of shivering.*

1. _____ signals from _____ and _____ are detected by _____ receptors.
2. They are transmitted to primary motor center of shivering which is located _____.
3. Then impulses are transmitted from _____ to_____.
4. Target organs are _____.
5. Tone of _____.
6. It results in _____.

Task 11.14. *Define temperature-decreasing mechanisms.*

1._____
_____
2._____
_____
3._____
_____

Task 11.15. *Complete the following scheme to define the role of thyroxin in thermoregulation*

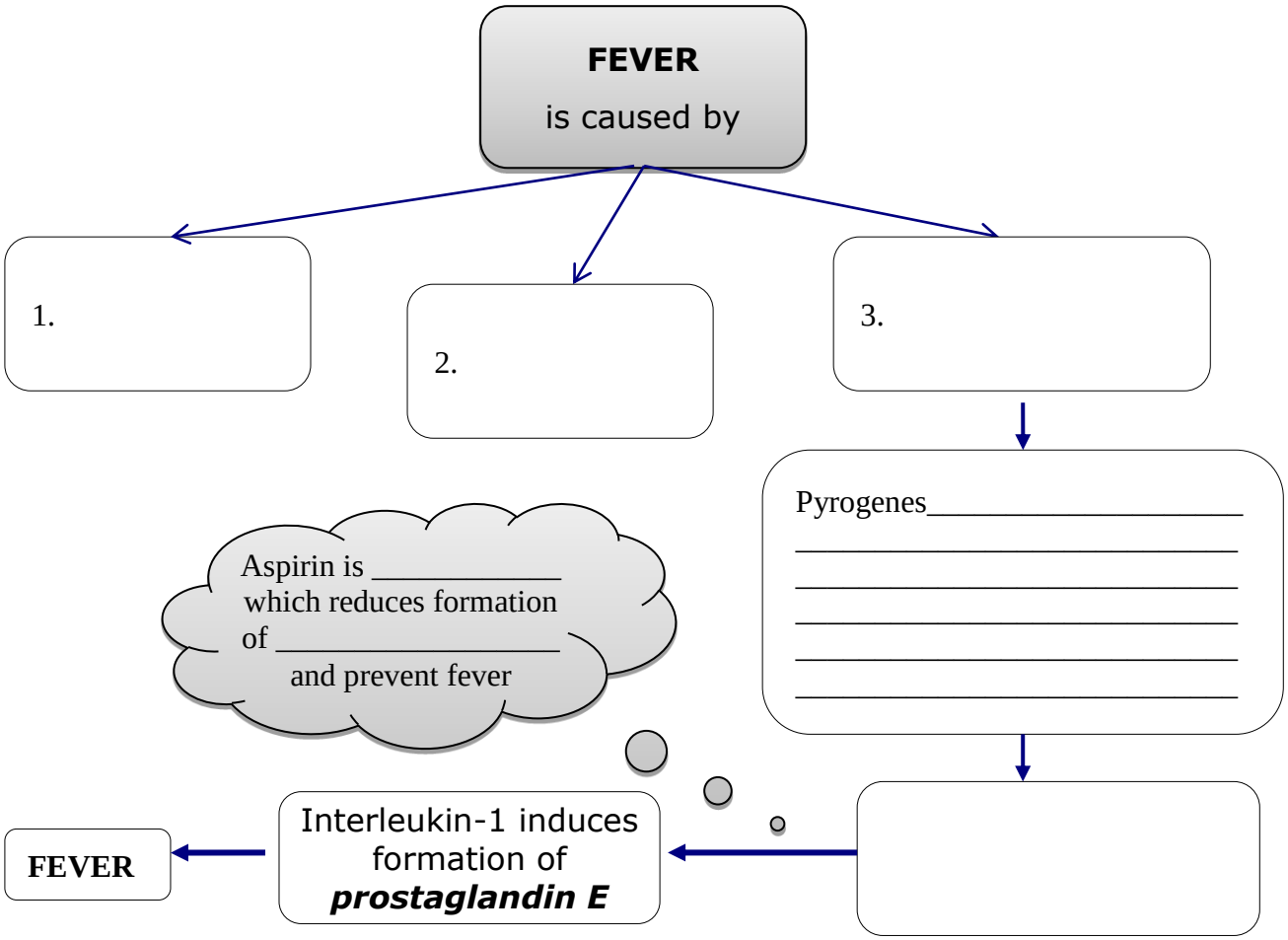


Task 11.16. *Describe mechanisms of behavioral control of thermoregulation*

When temperature is too high _____
_____
_____
_____
_____
_____

When temperature is too low _____
_____
_____
_____
_____
_____

Task 11.17. *Complete the scheme* ***"Mechanisms of hyperthermia"***



PHYSIOLOGY OF EXCRETION

12. MECHANISM OF URINE FORMATION BY KIDNEY

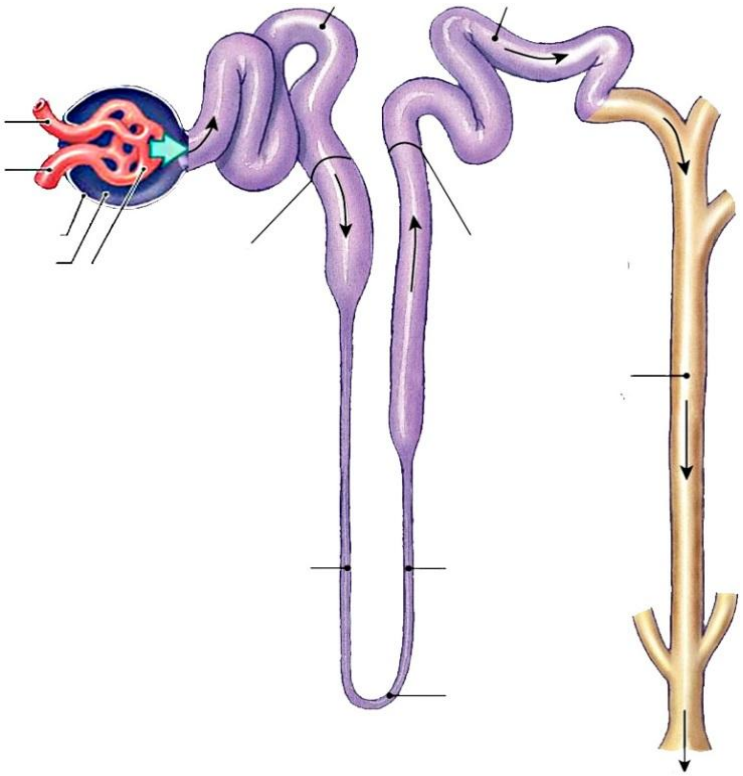
Task 4.1. *Functional system of excretion includes several organs. Define them and their role in excretory function of the organism.*

1. _____
   _____
2. _____
   _____
3. _____
   _____
4. _____
   _____
5. _____
   _____
6. _____

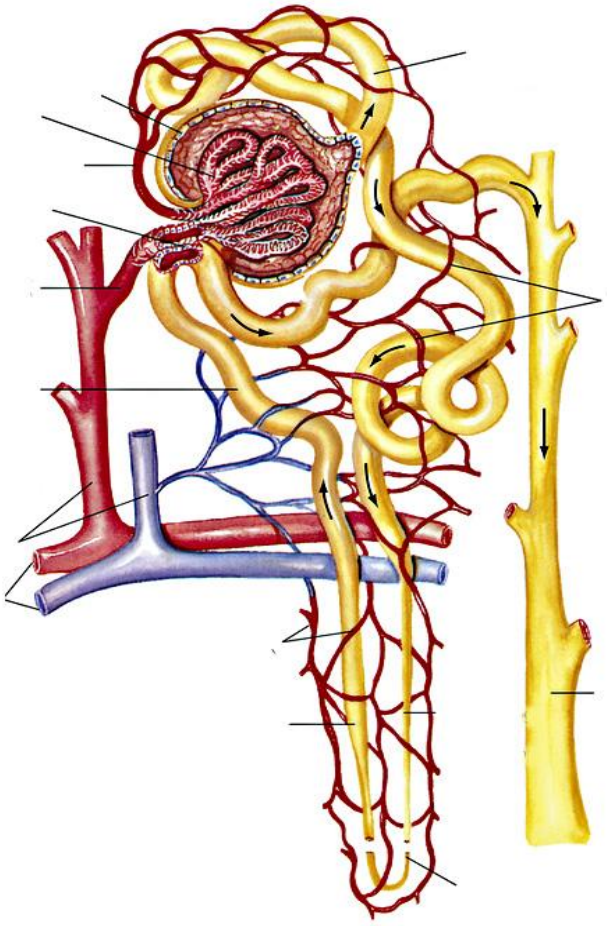
Task 4.2. *Define the role of kidneys in human organism by filling the following table.*

Function	Explanation
1.	
2.	
3.	
4.	
5.	
6.	
7.	

Task 12.3. *Label the illustration* ***"Nephron as a structural and functional unit of kidneys"***



Task 12.4. *Label the picture "Renal blood supply"*



Task 12.5. *Define the peculiarities of renal circulation by filling the following table.*

Peculiarity	Explanation
1.	
2.	
3.	
4.	
5.	
6.	

Task 12.6. *List the processes of urine formation and give the definition of them by filling the following table.*

Process	Type of transport	Definition
1.		
2.		
3.		

Task 12.7. *List the layers of renal filter and define peculiarities of each of them.*

Layer	Peculiarities

Task 12.8. *Define GFR and write its formula.*

GFR is _____
_____
_____

GFR = _____ x _____

Task 12.9. *List the factors influencing NFP.*

Factor	Value	Explanation
1.		
2.		
3.		
4.		

Task 12.10. *Define the factors that influence K_f (filtration coefficient).*

Factor	Conditions that lead to its change
1.	
2.	

Task 12.11. *Define the factors that regulate the tone of afferent and efferent arterioles.*

Factor	Response
Afferent arteriole	
1.	
2.	
3.	
4.	
Efferent arteriole	

Task 12.12. *Draw the scheme of RAAS activity and list its effects.*

Effects of RAAS:

- _____
- _____
- _____
- _____
- _____

Task 12.13. *Complete the following table "Influence of afferent and efferent arterioles resistance on GFR".*

Mechanism	Hydrostatic pressure in capsule	GFR
Afferent arteriole dilation		
Afferent arteriole constriction		
Efferent arteriole dilation		
Moderate constriction of efferent arteriole		
Severe constriction of efferent arteriole		

Task 12.14. *Fill the table "Reabsorption in nephron"*

Part of nephron	Type of reabsorption	Mechanism of reabsorption	Substances which are reabsorbed	Hormones that regulate reabsorption
Proximal tubule				
Descending limb of Henle's loop				
Ascending limb of Henle's loop				
Distal tubule				
Collecting duct				

Task 12.15. *List the steps of countercurrent multiplier.*

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____

Task 12.16. *Define the role of vasa recta in maintenance of osmolarity of renal medulla.*

_____
_____
_____
_____

Task 12.17. *Describe the process of secretion and define the substances that are excreted by urea by this way.*

_____
_____
_____
_____
_____

Task 12.18. *Explain the significance of tubuloglomerular feedback.*

_____

_____

_____

_____

_____

_____

Task 12.19. *Fill the table "Reflex of urination"*

Stimulus	Receptors	Afferent nerve	Nerve center	Efferent nerve	Target organ	Response

Task 12.20. *Complete the table "Role of kidneys in homeostasis maintenance"*

Regulation of water-ion balance		
Aldosterone	***ADH***	***ANP***
Regulation of blood pressure		
Regulation of acid-base balance		

SUPPLEMENT

You should collect values of important physiological parameters in the table below

NORMAAL VALUES OF HOMEOSTATIC PARAMETERS

Parameter	***Units of measure***

For your notes

For your notes

For your notes

For your notes