

Colon physiology

Objectives:

- ❖ Physiological Functions of Different Colon Regions
 - ❖ Secretion in the Colon
 - ❖ Nutrient Digestion & Absorption in the Colon
 - ❖ Gut Flora (Gastrointestinal Microbiota)
 - ❖ Motility in the Colon
 - ❖ Defecation Reflex
-

Color index:

- ❖ Important.
- ❖ Girls slide only.
- ❖ Boys slide only.
- ❖ Dr's note.
- ❖ Extra information.



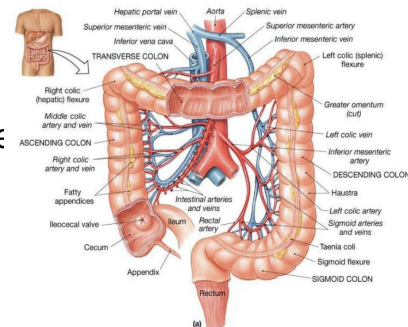
Editing File

The Large Intestines

- ❖ This is the final digestive structure.
- ❖ By the time the digested food (chyme) reaches the large intestine, most of the nutrients have been absorbed.
- ❖ The primary role of the large intestine is to convert chyme into feces for excretion.
- ❖ **at this stage the material is mostly waste but we still need to extract some nutrients like vitamins, electrolytes, and water**

Anatomy

- The colon has a length of about 1.5 meters (1/5 of the whole length of GI_T).
- The transit of radiolabeled chyme through the large intestine occurs in 36-48 hrs.



It consists of:

1 Cecum

2 Ascending colon

3 Transverse colon

4 descending colon

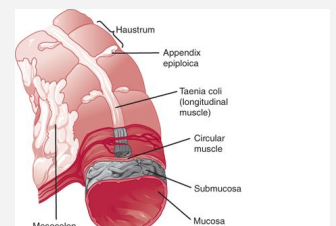
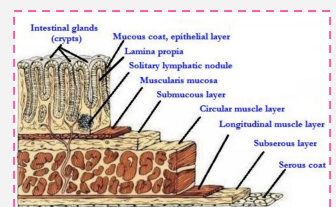
5 sigmoid colon

6 rectum

7 anal canal

The Mucous Membrane of the Colon

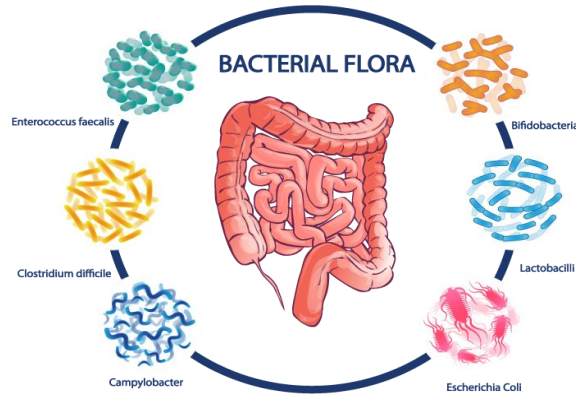
1. **Lacks villi¹** and **has many crypts of Lieberkühn.**
2. The crypts consist of simple short glands lined by mucous-secreting goblet cells (**provides an adherent medium for holding fecal matter together**).
3. The outer longitudinal muscle layer is modified to form three **longitudinal bands** called tenia coli visible on the outer surface.
4. Since the **muscle bands are shorter** than the length of the colon, the colonic wall is sacculated and **forms haustra**.



1) Absence of villi is because we don't need the extra surface area

Gut Flora (Gastro-Intestinal Microbiota)

- It is the complex community of microorganisms that live in the digestive tracts.
- It is established at one to two years after birth.
- chronic disruption of the normal flora in the large intestine leads to bruising and excessive bleeding.
- Bacterial flora is living in symbiosis with human and its effects are beneficial to the body as follows:



Deconjugation and decarboxylation of bile salts: Break down of bile pigments to produce stercobilinogen (responsible for brown color of feces).

Decarboxylation of some AA to produce amine and histamine. The amines are excreted in feces and are responsible for its smell.

Fermentation of undigested oligo-saccharides producing gases.

Synthesis of vitamin K and some B group vitamins as folic acid, biotin, thiamine and B12. The bacteria-formed vitamin K is especially important because the amount of this vitamin in the daily ingested foods is normally insufficient to maintain adequate blood coagulation. **Imp**

Digestion of small amounts of cellulose (fibers) producing gases and organic acids.

Breakdown of urea by bacterial urease to ammonia. Most ammonia is absorbed and reconverted into urea by liver.



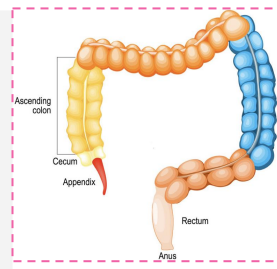
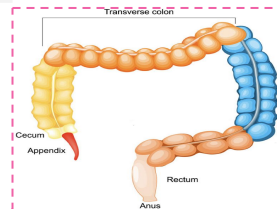
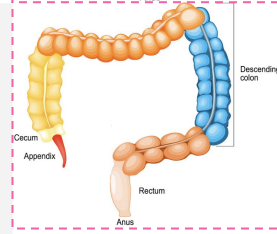
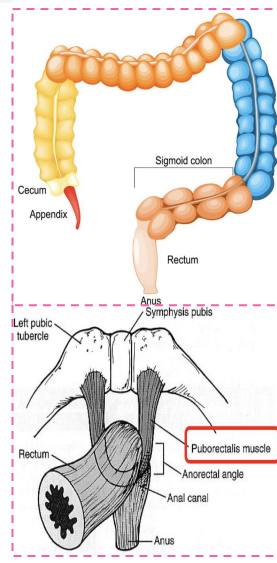
- The large intestine houses over 700 species of bacteria that perform a wide variety of functions.
- any reduction of vit k will cause bleeding because of deficiency of synthesis clotting factor (2/7/9/10), it may reduce by bile deficiency and cause lipid malabsorption so reducing absorption of vitamins, also because of infection and prolong use of Antiseptic drugs .antiseptic is a substance that stops or slows down the growth of microorganisms
- Escherichia coli is one of the many species of bacteria present in the human gut.
- Symbiosis interaction between two different organisms living in close physical association, typically to the advantage of both.

The physiological functions of different colon regions

Functions of colon in general :

- 1 **Absorb:**
Vitamins produced by bacteria (gut flora)
- 2 **Reabsorb**
Water & compact material into feces
- 3 **Store:**
Fecal matter prior to defecation

Each part of the colon has its specific functions as follows:

<p>The ascending colon</p>	<ul style="list-style-type: none"> ❖ It is specialized in processing chyme delivered from the terminal ileum to the transverse colon. ❖ When radiolabeled chyme is instilled (put gradually) into cecum, half of the instilled volume empties from ascending colon into transverse colon in 87 min. ❖ This period is short in comparison with the transverse colon. ❖ The ascending colon is not the primary site of storage, mixing and removal of water. ❖ The importance of this segment is exposing the material to the colon bacteria 	
<p>The transverse colon</p>	<ul style="list-style-type: none"> ❖ Specialized in storing and removing water & electrolytes from feces (the storage and dehydration of feces). ❖ The labeled material is retained for about 24 hrs. ❖ It's the primary site for the removal of water and electrolytes and the storage of feces. ❖ The colon decides the limit of water absorption 	
<p>The descending colon</p>	<ul style="list-style-type: none"> ❖ It is a conduit between the transverse and sigmoid colon. ❖ Has the neural program for power propulsion (mass movement), involved in defecation reflex. will be discussed in the next slides ❖ Labeled feces begin to accumulate in the sigmoid colon about 24 hours after the label is instilled in the cecum. this means that the material doesn't stay in the descending colon at all (since we know that it takes the material 24 hours to reach the descending colon) 	
<p>The rectosigmoid region</p>	<ul style="list-style-type: none"> ❖ sigmoid and rectum are reservoirs with a capacity of up to 500mL. ❖ Together with anal canal and pelvic floor musculature maintains fecal continence (the ability to voluntarily control urinary and fecal discharge). ❖ In the anal part, we have internal sphincter (involuntary) by parasympathetic (pelvic nerve) and external sphincter (voluntary) by somatic nerves (pudendal nerve). ❖ The puborectalis muscle and external anal sphincter comprise a functional unit that maintain the fecal continence if the material is abundant and the urge to defecate has started. ❖ How do the Rectosigmoid Region, Anal Canal & Pelvic Floor Musculature Maintain Fecal Continence? <ul style="list-style-type: none"> ➢ Fibers of puborectalis join behind the anorectum and pass around it to form a U-shaped sling (physiological valve). ❖ If the material is small then the internal anal sphincter is what maintains continence. ❖ U shaped muscle that pass between the rectum and anal canal and form angle that act as valve that will contract and prevent the passage of faces during rest, but during defecation the muscle will relax and angle (valve) relax and disappear so faces can pass out 	

Secretions of the Large Intestine

The epithelial cells contain almost **no digestive enzymes**.

The secretion is mainly mucus, it has the following functions:

Secretions

01

It secretes bicarbonate ions, to neutralize any acids present.

Mucous attached to HCO_3 to neutralize any acids produced from bacteria of colon

02

It protects against irritation.

03

It helps to lubricate feces.

04

It provides a binding medium for fecal matter.

Effect of parasympathetic stimulation on secretion:

- ❖ PNS innervation:
 - Vagus → Proximal half of the colon
 - Pelvic nerves → Distal half of the colon
- ❖ Stimulation of the pelvic nerves from the spinal cord cause:
 - Increase in peristaltic motility of the colon.
 - Marked increase in mucus secretion.
- ❖ During **extreme parasympathetic stimulation**, so much mucus can be secreted into the large intestine that the person has a bowel movement of **roby mucus** as often as every 30 minutes; this mucus often contains little or no fecal material **excretions of mucus without feces**

Secretion of water and electrolyte during irritation:

- ❖ Whenever a segment of the large intestine becomes irritated (as occurs in bacterial infection) the mucosa secretes large amount of water & electrolytes in addition to the alkaline mucus.
- ❖ This would dilute the irritating factors and causes rapid movement of the feces toward the anus

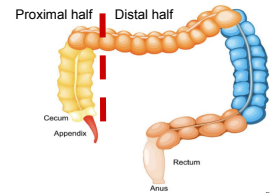
Nutrient digestion in the large intestine :

- ❖ Little digestion occurs in the large intestine.
- ❖ The large population of bacteria digests small amounts of fiber; produce gases and organic acids.
- ❖ Bacterial action produces nutrients: vitamin K, thiamin, biotin, vitamin B12, riboflavin.

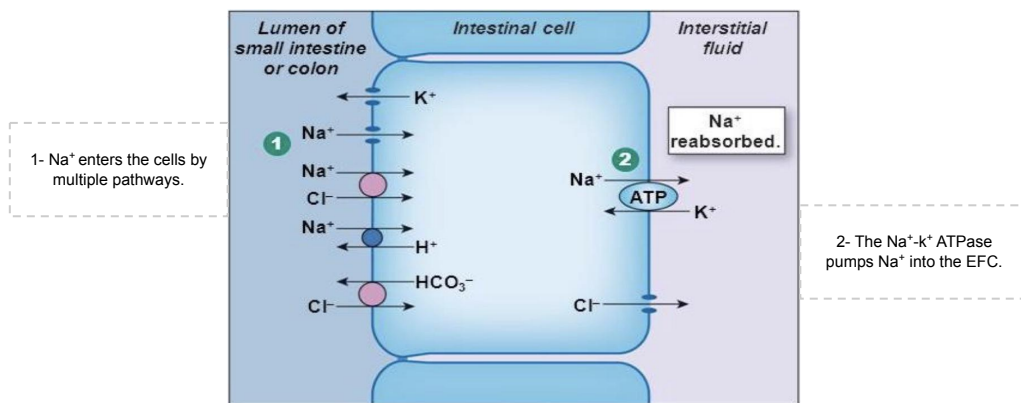


- Mucus secretions:
 - Act as lubricant to ease the passage of feces.
 - Provide an appropriate environment for bacteria by neutralizing the acidity.

Absorption



- ❖ Little absorption occurs in the large intestine. It has the capacity to absorb high amount of fluid and other substances but because it's mostly absorb by small intestine so only little amount will be absorb in large intestine .
- ❖ Physiologically divided into 2 parts: Most of the absorption occur in the **proximal half** of the colon (**1 absorptive colon**), Whereas the **distal colon** function is **feces** storage until a propitious time for feces excretion (**2 storage colon**).
- ❖ The large intestine can absorb a maximum of 5 to 8 liters of fluid and electrolytes each day.
- ❖ The mucosa, like that of the small intestine, has a high capability for active absorption of sodium, Cl and **water**.



Reabsorption in the large intestine includes:

Na	In the presence of Na ⁺ -K ⁺ ATPase at the basolateral membrane, Na ⁺ is actively absorbed and K ⁺ is secreted into the lumen of colon.* in diarrhea there will be hipokalemia
Cl	Cl is absorbed in exchange for HCO ₃ which is secreted.* in diarrhea there will be metabolic acidosis because of HCO ₃ excretions
H₂O	About 0.5- 1.5L/day is absorbed.* The net water loss is 100-200 ml/day
Vit.	Vitamin K, biotin, vitamin B ₅ , folic acid and some amino acids and short chain fatty acids resulting from bacterial fermentation of CHO are absorbed. It doesn't absorb vitamin B₁₂ it's absorbed in terminal ileum
Others	1-Organic wastes (Urobilinogen and Stercobilinogen).* 2-Bile salts*. 3-Toxins to get detoxified in the liver/Certain drugs as steroids and aspirin may be absorbed. and water



Waste gets reabsorbed and secreted into the renal system or they can be excreted again in the feces in the second cycle

Remember !! The main function of large intestine is to reabsorb water, if food moves through the large intestine too quickly it will result in diarrhea (watery stool), by contrast when food residue remains in the large intestine for long time, too much water can be reabsorbed this can result in constipation (hard stool) .

-Urobilinogen formed in the intestines by bacterial action on bilirubin.

-Stercobilinogen is a chemical created by bacteria in the gut. It is made of broken-down hemoglobin.

Motility



- ❖ The **proximal half** of the colon is concerned with absorption and the **distal half** with storage.*
- ❖ The transit of small labeled markers through the large intestine occurs in 36-48 hrs.*

1-Mixing movements (Haustrations):

- ❖ The motor events occur in the cecum and ascending colon.*
- ❖ Ring-like contractions (about 2.5 cm) of the circular muscle divide the colon into pockets called **haustra**.
- ❖ The contracting segment and **receiving (relaxing)** segments on either side remain in their respective state for longer periods.
- ❖ In addition, there is uniform repetition of the haustra along the colon.
- ❖ Net forward propulsion occurs when sequential migration of haustra occurs along the length of the bowel.
- ❖ **Doctor's explanation:** Haustrations are contraction that happen every 2.5 cm. haustration starts proximally and moves up 2.5 cm for every new contraction. new contractions relax the area that was contracted before them. This movement ultimately results in the elevation of material in the ascending colon. (THIS IS NOT THE PROPULSIVE MOVEMENT)

2-Propulsive movements (Mass Movements):

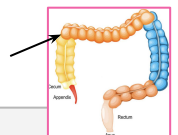
- Triggered by gastrocolic reflex and can lead to defecation urge
- Exactly like peristalsis but a lot stronger
- It's never called peristalsis despite the similarity.

- ❖ The motor events occur in the transverse & descending colon.
- ❖ It **starts** at the middle of transverse colon, **15 min after eating breakfast**.
- ❖ A constrictive ring occurs at a distended point, then 20 cm of the colon distal to the constriction contract almost as a unit forcing the fecal material mass down the colon.
- ❖ It is preceded by relaxation of the circular muscle and the downstream disappearance of haustral contractions.
- ❖ It is completed in about 30 sec.
- ❖ Another mass movement occur during the next 2 to 3 min. The whole series of mass movement persist for only 10-30 min.
- ❖ They will then return after a half day or a day later.
- ❖ When they have forced a mass of feces into the rectum the desire for defecation is felt
- ❖ **Initiation of mass movement could be due to:**
 - Gastrocolic & duodenocolic reflexes after meals, which result from distension of the stomach & duodenum.
 - **by the increased delivery of ileal chyme into ascending colon following a meal (gastrocolic reflex).**
 - Irritation of the colon e.g. castor oil.stimulation of enteric plexuses
 - Threatening agents such as parasites and enterotoxins can initiate mass movement.

When we take the breakfast the movement will be initiated and feces in the colon will excreted out, so more area for the new food that will come

3-Antiperistalsis:

- ❖ It starts at the junction of ascending and transverse colon and traveling towards the cecum.
- ❖ It mixes contents and help water absorption.
- ❖ **Antiperistalsis gives bacteria more time for fermentation and more time for absorption by the colon**



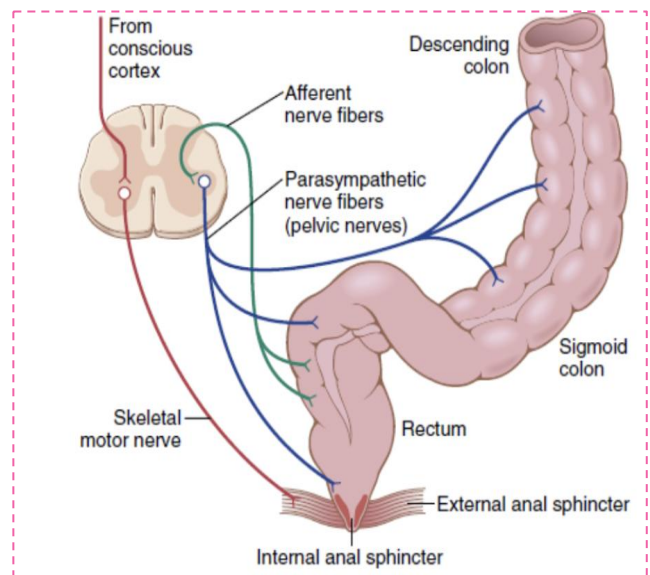
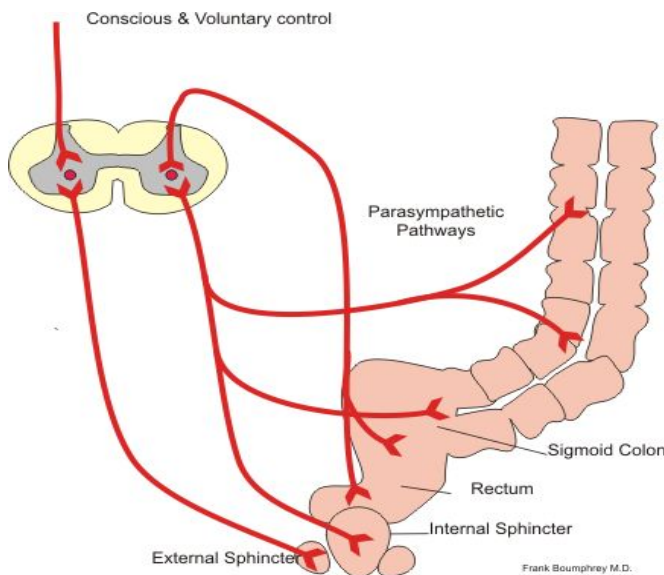
Control of colonic motility*

- ❖ The intramural plexuses (**enteric plexuses**) directly control the contractile behavior of the colon.
- ❖ **Stimulatory** enteric motor neurons use **acetylcholine** & **substance P** as neurotransmitters.
- ❖ **Inhibitory** enteric motor neurons release **VIP** & **NO** onto colonic smooth muscle cells.
- ❖ The extrinsic autonomic nerves to the colon modulate the control of the colonic motility by the enteric nervous system.

Sensory innervation and continence Rectum & anal canal

- ❖ The rectum is last portion of the digestive tract that terminates at the anal canal.
- ❖ Internal and external anal sphincters.
- ❖ It contains mechanoreceptors that detect distention and supply the ENS.
- ❖ The anal canal in the region of the skin is innervated by somatosensory nerves that transmit pain, temperature and touch signals to CNS.
- ❖ This region has sensory receptors of pain, temperature and touch.
- ❖ Contraction of internal anal sphincters and puborectalis muscle blocks the passage of feces and maintains continence with small volumes in the rectum.

Afferent and Efferent Pathways of the Parasympathetic Mechanism for enhancing the defecation reflex

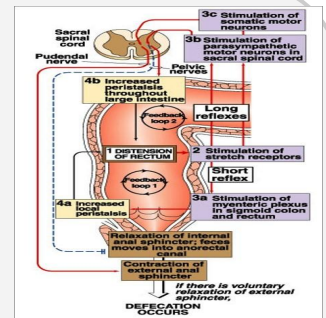


Defecation

- ① Most of the time the rectum is empty*.
- ① Both internal and external anal sphincters are maintained in a state of tonic contraction*. **To Prevent defecation**
- ① It is a spinal reflex, influenced by higher center*.
- ① Gastrocolic & duodenocolic reflexes initiate a mass movement in the colon that pushes feces into rectum*.
- ① Rectal distension sends signals to cerebral cortex producing the desire to defecate*.

Defecation Reflex:

- 1) Distension of the rectum **and sigmoid. when it's 25% full**
- 2) Stimulation of the stretch receptors in the rectum.
- 3) **A. Short reflex:** Stimulation of myenteric plexus in sigmoid colon and rectum.
B. long reflex: stimulation of parasympathetic motor neurons in sacral spinal cord.
C. stimulation of somatic motor neurons. **Contract external sphincter**
- 4) **Results in: increased local peristalsis. Relaxation of interna anal sphincter and contraction of external anal sphincter.** why external sphincter is contracted during defecation reflex? Because if the environment suitable for defecation it will relax and feces excreted out and the opposite if not.



if the surrounding circumstances are suitable*

- ❖ Defecation reflex will be allowed. Stretch of the rectal wall is signaled to SC by pelvic nerve.
- ❖ Efferent pelvic impulses cause reflex contraction of the rectum and relaxation of internal anal sphincter (IAS).
- ❖ This is followed by reduction in tonic impulses to external anal sphincter (EAS), so it relaxes voluntarily and feces leave the rectum assisted by voluntary straining and contraction of pelvic floor muscles.

if the surrounding circumstances are not suitable*

- ❖ The reflex is inhibited by the cerebral cortex.
- ❖ Maintained **voluntary** tonic contraction of EAS.
- ❖ Return of tonic contraction of the IAS.
- ❖ Accommodation of the rectum to distension.
- ❖ **The voluntary contraction of EAS causes temporary inhibition of the defecation reflex**

fecal incontinence

- The spinal reflex of defecation operates without interference from higher centers. **lose the ability to control defecation**

Causes:

- In infants (physiological)
- Spinal cord lesion
- Weakness of IAS and EAS
- Weakness of pulborectalis
- Altered rectal or anal sensation
- Diarrheal conditions (**causing peristaltic rush**)
- Diminished rectal capacity (**very rare**)



MCQ & SAQ:

Q1: which of the following is reabsorbed by the colon?

- A. vitamins
- B. water
- C. feces
- D. minerals

Q3: both of the anal sphincters' state:

- A. maintained tonic contraction
- B. maintained hypotonic contraction
- C. maintained tonic relaxation
- D. maintained hypotonic relaxation

Q5: urea is broken down by gut flora by:

- A. urease
- B. deconjugation
- C. decarboxylation
- D. carboxylation

Q2: Cl is absorbed in exchange for:

- A. Na
- B. K
- C. HCO₃
- D. H₂O

Q4: Specialized in storing and removing water & electrolytes from feces.

- A. ascending colon.
- B. sigmoid colon.
- C. transverse colon.
- D. Descending colon.

Q6: what is true about Propulsive movements:

- A. It starts at the junction of ascending and transverse colon and traveling towards the cecum.
- B. there is uniform repetition of the haustra along the colon.
- C. it is completed in 3 seconds.
- D. it is initiated by Gastrocolic & duodenocolic reflexes.

6: D
5: A
4: C
3: A
2: C
1: B
key:
answer

1- what forms the haustra?

2- explain the different types of defecation reflexes?

3- enumerate the substances reabsorbed by the large intestine.

4- Effect of parasympathetic stimulation on secretion.

A1: sacculaton of the colonic wall and forms haustra due to the muscle bands being shorter than the length of the colon.

A2: Short reflex: Stimulation of myenteric plexus in sigmoid colon and rectum. long reflex: stimulation of parasympathetic motor neurons in sacral spinal cord.

A3: slide 8.

A4: Stimulation of the pelvic nerves from the spinal cord cause:

- > Increase in peristaltic motility of the colon.
- > Marked increase in mucus secretion.

Leaders:

- Abdulaziz Alsuhami.
- **Yara Alasmari.**

Co-leader:

- Mayasem Alhazmi.

Organizers:

- Rawan baqader
- **Haya Alanazi**
- Shaden Alobaid
- Mayasem Alhazmi.
- Basel Fakeeha
- Leen Almadhyani

Note takers:

- Shaden Alobaid
- Raghad Albarrak
- **Homoud Algadheb.**

Revisers:

- Abeer Awwad.
- **Shayma Alghanoum**

MEMBERS:

- Abdulaziz Alamri
- **Basel Fakeeha**
- Ahmad Alkhayatt
- Aljoud Algazlan
- Almaha Alshathri
- Abdulrahman Barashid
- Nada Bin Obeid
- Tarfa Alkaltham
- Yara alzahrani
- Sarah AlQuwayz
- Abdulrhman Alsuhaibany
- Abeer Awwad
- Mohammed alkathiri
- ziyad alhosan
- Rand Alrefaie

- Omar Alhalabi
- Joud Alarifi
- Ibrahim Alnamlah
- Hamad Almousa
- Abdullah Alburikan
- Leen Almadhyani
- Abdullah Alanzan
- Bader Alrayes
- Faisal jazzar
- Khalid Almutlaq
- Yara Alomar
- Reem Alqahtani
- **Aljoharah Albnyan**
- Saud Alhasani
- Muneerah Alsadhan

