

Human Microbiota

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Summary

## INTRODUCTION:

Think of the gut as a system that has to do three things at the same time:

- \* Allow nutrients to be absorbed
- \* Live peacefully with normal microbiota
- \* Defend against harmful pathogens

Health depends on balance between:

- \* Microbiota
- \* Intestinal barrier
- \* Immune system

If this balance is disturbed, it leads to dysbiosis, infection, or inflammation.

## Gut microbiota:

The gut microbiota includes:

- \* Bacteria (most important)
- \* Viruses
- \* Fungi
- \* Archaea

**Bacteria are the dominant group both in number and function.**

### Distribution

- \* Stomach: very few organisms due to acid
- \* Small intestine: moderate number
- \* Colon: highest density and main site of interaction

### Important Bacteria

- \* **Bacteroides**: digest complex carbohydrates
- \* **Faecalibacterium**: produce short-chain fatty acids
- \* **Bifidobacterium**: important in early life, beneficial
- \* **Akkermansia**: supports mucus layer
- \* **Escherichia coli**: normal commensal but some strains are pathogenic

بفيدو

Diarrheic

# Functions of Microbiota

## 1. Digestion of complex food

The gut microbiota helps break down substances that the human body cannot digest on its own.

Example from slides:

*Bacteroides* → digest complex polysaccharides (carbohydrates)

## 2. Vitamin production and metabolites

Microorganisms produce important vitamins and metabolic products that benefit the host.

Example from slides:

*Escherichia coli* → produces Vitamin K

## 3. Maintenance of epithelial barrier

Microbiota supports the development and integrity of the intestinal lining, helping keep the barrier strong and functional.

Example from slides:

General role of microbiota in promoting epithelial development and barrier integrity (no single organism specified, but this is a collective effect)

## 4. Immune system development and regulation

Microbiota helps train and regulate the immune system, especially early in life.

Example from slides:

*Bifidobacterium* → contributes to immune maturation and maintaining normal immune tone

## 5. Protection against pathogens (Colonization resistance)

Normal flora prevent harmful organisms from growing and attaching in the gut.

Examples from slides:

Normal microbiota compete with:

*Salmonella*

Diarrheagenic *E. coli*

Commensal *E. coli* → occupies space and prevents harmful bacteria from colonizing

# Colonization Resistance

This is the ability of normal microbiota to prevent pathogen growth.

Mechanisms:

- \* Compete for nutrients
- \* Occupy attachment sites
- \* Create an unfavorable environment

Key idea: if normal flora are present, pathogens struggle to establish themselves.

Classic Example: *Clostridioides difficile*

- \* Antibiotics kill normal flora
- \* *C. difficile* proliferates
- \* Produces toxins
- \* Causes colitis and diarrhea

# Effect of Antibiotics

- \* Reduce commensal bacteria
- \* Decrease microbial competition
- \* Allow harmful organisms to grow

This explains antibiotic-associated diarrhea.

# Dysbiosis

Dysbiosis means imbalance in the microbiota.

Causes:

- \* Antibiotics (most important)
- \* Infection
- \* Diet changes
- \* Hospitalization

# Consequences

- \* Loss of colonization resistance
- \* Increased susceptibility to infection
- \* Barrier dysfunction

## Intestinal Barrier

The gut barrier consists of multiple components:

- \* Mucus layer
- \* Epithelial cells
- \* Tight junctions
- \* Antimicrobial molecules
- \* Immune cells
- \* Lymphoid tissue

Imm!

Function:

- \* Allows absorption of nutrients
- \* Prevents microbial invasion

## Epithelial Cells

Each cell type has a specific role:

- \* Enterocytes: absorption
- \* Goblet cells: mucus secretion
- \* Paneth cells: antimicrobial peptides
- \* M cells: antigen sampling
- \* Enteroendocrine cells: hormone secretion
- \* Tuft cells: immune signaling → Chem sensory
- \* Stem cells: regeneration

M Cells

- \* Located over Peyer's patches
- \* Take up antigens from lumen
- \* Deliver them to immune cells

They are essential for initiating immune responses.

## Innate Immunity

Main cells involved:

- \* Macrophages: phagocytosis and controlled response
- \* Dendritic cells: antigen presentation — ex: M cells above!
- \* Neutrophils: acute inflammation
- \* Innate lymphoid cells (ILC3): barrier defense (mucosal)
- \* Mast cells: inflammation
- \* Eosinophils: parasitic defense

# GALT Gut-Associated Lymphoid Tissue)

Includes:

- \* Peyer's patches
- \* Mesenteric lymph nodes
- \* Lamina propria immune cells

Function:

- \* Site where immune responses are **initiated**

The ileum is particularly important.

*L Peyer Dominant!!*

## Adaptive Immunity

- \* B cells differentiate into plasma cells that produce IgA
- \* CD4+ T cells coordinate immune responses
- \* Regulatory T cells (Tregs) maintain tolerance
- \* CD8+ T cells kill infected cells
- \* Intraepithelial lymphocytes provide local defense

*CD4+ → immune*  
*CD8+ → kill*

*Imp! questionable*

## Secretory IgA

- \* Main antibody in the gut
- \* Produced by plasma cells
- \* Transported into the lumen

Functions:

- \* Prevents microbial attachment
- \* Neutralizes toxins
- \* Minimizes inflammation

## Immune Tolerance

The gut must avoid reacting to harmless antigens.

Maintained by:

- \* Regulatory T cells
- \* Controlled antigen presentation
- \* Epithelial signaling

Failure leads to inflammatory diseases.

*antigen presentation*  
*[not controlled]*

# Probiotics

• عيوك سيمت بالبكتيريا النافعة  
صاي صي :

## Definition:

Live microorganisms used to improve gut health.

## Examples:

- \* Bifidobacterium
- \* Lactobacillus
- \* Saccharomyces

## Uses:

- \* Improve bowel function
- \* Help in C. difficile infection
- \* Support in inflammatory bowel disease

4 IBD  
(clinical use)

## Limitation:

Effectiveness is not always proven.

# Clinical Case Summary

- \* Patient receives antibiotics
- \* Normal microbiota decreases
- \* Colonization resistance is lost
- \* C. difficile grows and produces toxins
- \* Patient develops diarrhea and colitis

## Treatment:

- \* Vancomycin
- \* Fidaxomicin
- \* Severe cases: metronidazole
- \* Recurrent cases: fecal microbiota transplant



Mentioned above

## Final Revision Flow

- \* Microbiota support digestion, immunity, and protection
  - \* Colonization resistance prevents infection
  - \* Antibiotics disrupt microbiota → dysbiosis
  - \* Dysbiosis can lead to *C. difficile* infection
- \* Barrier includes epithelial cells and immune system
  - \* IgA is the main protective antibody
  - \* Tregs maintain immune tolerance

Wish us luck