



Oral Biology
Dr. Lakshmi T.A
Department of Oral Pathology and Oral Biology
Saveetha Dental College & Hospitals, Chennai
Lecture - 15
Oral microbiome

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INTRODUCTION



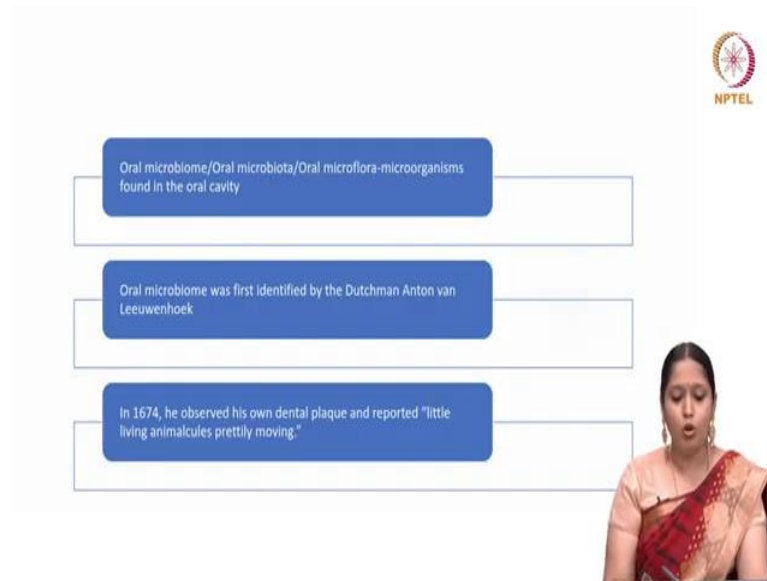
- Term "Microbiome" was coined by Joshua Lederberg, a Nobel Prize laureate to describe the ecological community of symbiotic, commensal and pathogenic microorganisms.
- Human oral microbiome is defined as all the microorganisms that are found on or in the oral cavity and its contiguous extensions such as the tonsils and the pharynx (Dewhirst et al.,2010)
- Several distinct microhabitats- dental surfaces, gingival crevice or sulcus, tongue(its papillae or crypts), different keratinized and non keratinized mucosal surfaces.
- Each of these habitat – specific ecological niches that select for distinct microbiota



Welcome to today's lecture. Today's lecture is on topic Oral Microbiome. So, the term oral microbiome was coined by Joshua Lederberg, a Nobel Prize laureate, he described it as ecological community of symbiotic commensal and pathogenic microorganisms. Human oral microbiome is defined as all the microorganisms that are found in or on the oral cavity and its contiguous extensions like tonsils as well as pharynx.

Several distinct microhabitats include dental surfaces, gingival crevice or sulcus, tongue, papillae, different keratinized, non keratinized mucosal surfaces and each of these habitats belongs to specific ecological niches that select for distinct microbiota.

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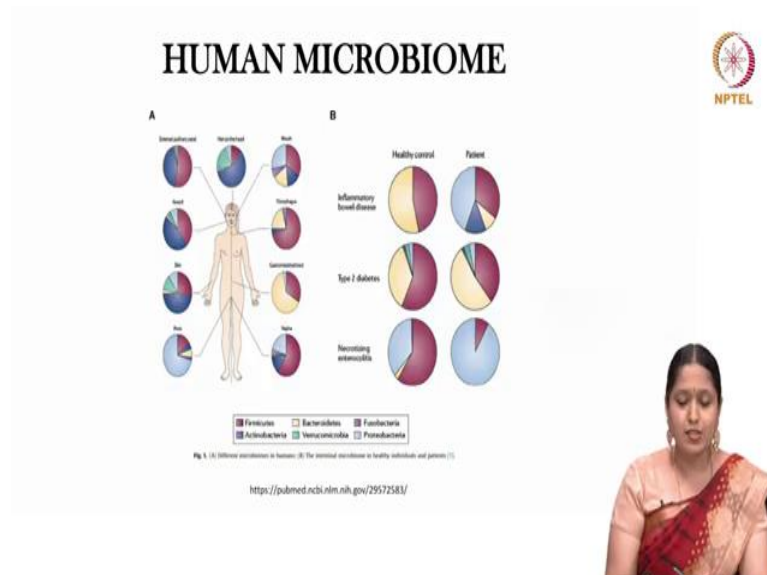
The slide features the NPTEL logo in the top right corner. It contains three blue text boxes with white text, each connected to a white rectangular frame. The text in the boxes is as follows:

- Box 1: Oral microbiome/Oral microbiota/Oral microflora-microorganisms found in the oral cavity
- Box 2: Oral microbiome was first identified by the Dutchman Anton van Leeuwenhoek
- Box 3: In 1674, he observed his own dental plaque and reported "little living animalcules prettily moving."

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Oral microbiome is also known as oral microbiota or oral microflora. It refers to organisms found in the oral cavity. Oral microbiome was first identified by Anton van Leeuwenhoek. In the year 1674 he observed his own dental plaque and he reported it as tiny little living animalcules prettily moving.

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The slide is titled "HUMAN MICROBIOME" and features the NPTEL logo in the top right corner. It is divided into two main sections, A and B.

Section A shows a human figure with pie charts representing the microbiome at various sites: Unrinsed mouth, Rinsed mouth, Nose, Ear, Skin, and Vagina. Each pie chart is color-coded to represent different bacterial groups.

Section B compares the microbiome of a "Healthy control" and a "Patient" for three conditions: Inflammatory bowel disease, Type 2 diabetes, and Necrotizing enterocolitis. Each comparison is shown as a pair of pie charts.

A legend at the bottom identifies the bacterial groups by color: Firmicutes (red), Actinobacteria (green), Bacteroidetes (blue), Euryarchaeota (orange), Proteobacteria (purple), and Verrucomicrobia (yellow).


Below the legend is the caption: "Fig. 1. (A) Different microbiomes in human; (B) The microbial microbiome in healthy individuals and patients [1]."
<https://pubmed.ncbi.nlm.nih.gov/29572583/>

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So, this is a picture of human microbiome, it shows different types of microbiomes present in human body like hair, on the head, oesophagus gastrointestinal, tract, genital organs, skin, nostril as well as the external auditory canal.

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DEVELOPMENT OF ORAL MICROBIOME



- Womb of the fetus is sterile
- Recent studies -intrauterine environment colonization, specifically the amniotic fluid by oral microorganisms- in up to 70% of the pregnant women
- The baby comes in contact with the microflora of the uterus and vagina of the mother during delivery, and later with the microorganisms of the atmosphere at birth
- Usually the oral cavity of the newborn is sterile
- The mouth is regularly inoculated with microorganisms from the first feeding onward, and the process of resident oral microflora acquisition begins




Now, let us see the development of oral microbiome. So, womb of the foetus is initially sterile. Recent studies have shown that intrauterine environment colonization was present especially in the amniotic fluid in almost 70 percentage of pregnant women. The baby comes in contact with the microflora of the uterus and vagina during delivery and later with the microorganisms present in the atmosphere at birth.


Usually, the oral cavity of the new born is sterile the mouth is regularly inoculated with microorganisms from the first feeding onwards and the process of resident oral microflora acquisition begins at this stage.

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DEVELOPMENT OF ORAL MICROBIOME




- At or shortly after birth, colonization begins.
- Initial colonizers immediately after birth are called the **pioneer species**, Eg:- Streptococcus salivarius.
- Oral cavity is invaded mainly by aerobes by the 1st year - Streptococcus, Lactobacillus, Actinomyces, Neisseria and Veillonella
- Once tooth eruption begins, these organisms can colonize on the non-shedding surfaces. More surfaces are established for colonization after eruption of all the teeth.




At birth or shortly after birth colonization begins. Initial colonizers immediately after birth are called as pioneer species. So, for pioneer species example is streptococcus salivarius. Oral cavity is invaded by aerobes by the 1st year which includes Streptococcus, Lactobacillus, Actinomyces, Neisseria and Veillonella. Once tooth eruption begins the organisms can colonize on the non-shedding surfaces. More surfaces are established for colonization after eruption of all teeth.

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DEVELOPMENT OF ORAL MICROBIOME

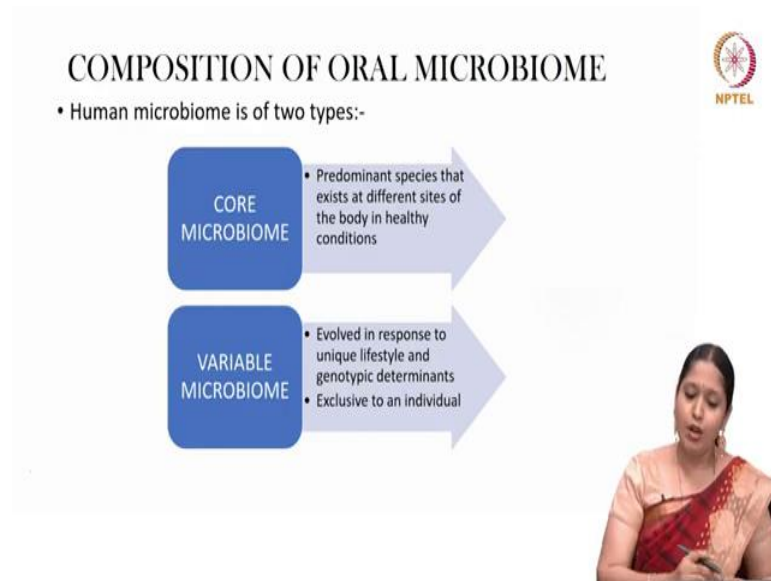


- Development of gingival crevices occurs for the colonization of periodontal microbes.
- Plaque accumulation is seen at different sites on the tooth such as smooth surfaces and pit and fissures, for different microbial colonies to be established.
- High species diversity and microbial succession develop by this process. With aging when all teeth are lost, the flora becomes similar to that in a child before tooth eruption.



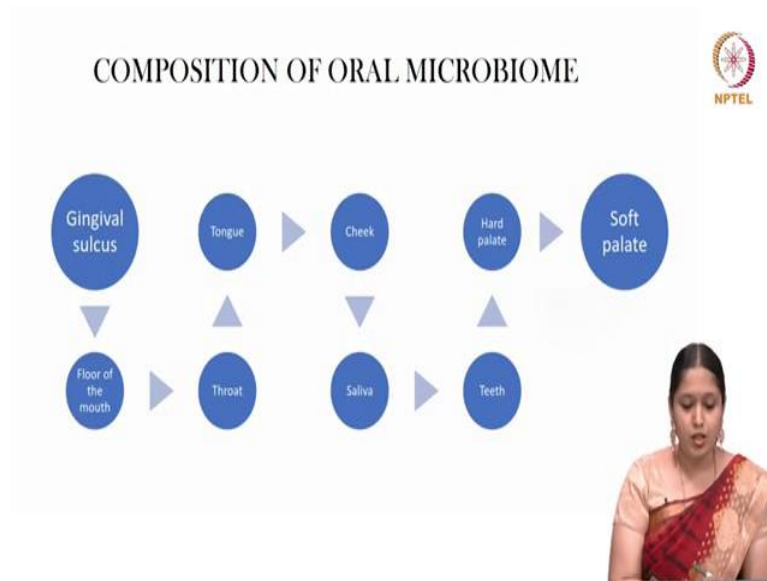
So, development of gingival crevices occurs at the later stage this is because for the colonization of periodontal microbes. Plaque accumulation is seen at different areas of the tooth like smooth surfaces as well as pit and fissures. High species diversity and microbial succession develop at this process. Once with aging all the teeth are lost then the oral microflora will become similar to that of the child before tooth eruption.

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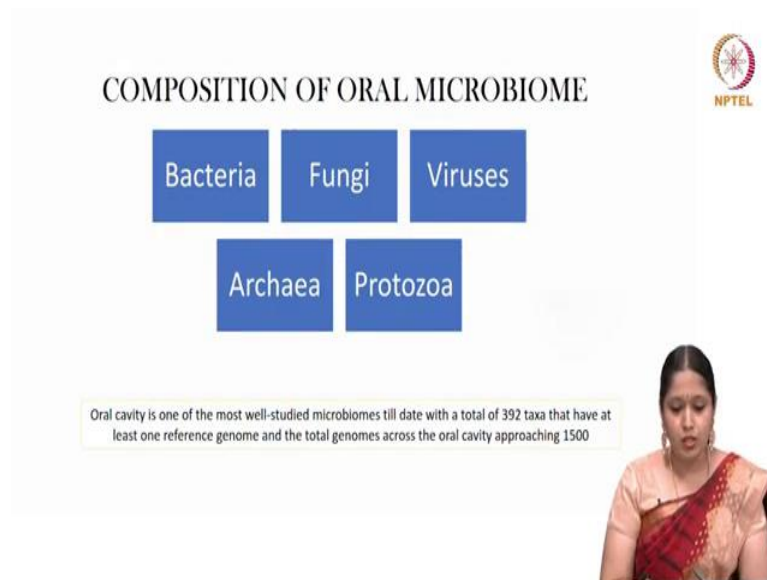
Now, coming to the composition of oral microbiome. Human microbiome is of two types; core microbiome and variable microbiome. Core microbiome represents the predominant species that exist at different sites of the body in healthy individuals. Variable microbiome is exclusive to an individual and it is evolved in response to unique lifestyle and genotypic determinants.

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So, oral microflora or microbiome, they are seen in gingival sulcus, tongue, cheek, hard palate, soft palate, floor of the mouth, throat, saliva and teeth.


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So, it also includes bacteria, fungi, viruses archaea and protozoa. Oral cavity is one of the most well studied microbiomes till date with a total of 392 taxa that have at least one reference genome and the total genomes across the oral cavity approaching 1500.


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COMPOSITION OF ORAL MICROBIOME



Approximately 700 species of prokaryotes have been identified


These species belong to 185 genera and 12 phyla-54% officially named, 14% unnamed(cultivated), 32%-uncultivated phylotypes




Approximately 700 species of prokaryotes have been identified. These species belong to 185 genera, 12 phyla and 54 percentage are officially named, 14 percentage are cultivated and 32 percentage are uncultivated phylotypes.

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12 PHYLA




Firmicutes	Fusobacteria	Proteobacteria	Actinobacteria
Bacteroidetes	Chlamydiae	Chloroflexi	Spirochates
SR1(fermentative anaerobe)	Synergistetes	Saccharibacteria (TM7)	Gracilibacteria (GN02)




So, the 12 phyla include firmicutes, fusobacteria, proteobacteria, actinobacteria, bacteroidetes, chlamydiae, chloroflexi, spirochates, SR1 which is fermentable anaerobe, synergistetes, saccharibacteria and gracilibacteria.

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BACTERIAL GENERA IN ORAL CAVITY

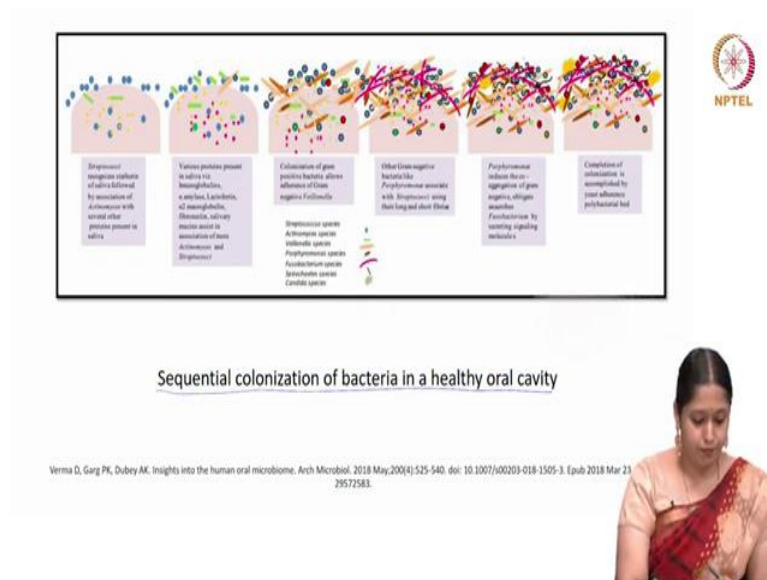
GRAM POSITIVE COCCI	• Abiotrophia, Peptostreptococcus, Streptococcus, Stomatococcus
GRAM POSITIVE RODS	• Actinomyces, Bifidobacterium, Corynebacterium, Eubacterium, Lactobacillus, Propionibacterium, Pseudoramibacter, Rothia
GRAM NEGATIVE COCCI	Moraxella, Neisseria, Veillonella
GRAM NEGATIVE RODS	• Campylobacter, Capnocytophaga, Desulfobacter, Desulfovibrio, Eikenella, Fusobacterium, Hemophilus, Leptotrichia, Prevotella, Seimonas, Simonsiella, Treponema, Wolinella



So, the bacterial genera in oral cavity includes gram positive cocci, gram positive rods, gram negative cocci and gram-negative rods. The gram-positive cocci include peptostreptococcus, abiotrophia, streptococcus and stomatococcus. Gram positive rods includes actinomyces, bifidobacterium, corynebacterium, lactobacillus and others.

Gram negative cocci; it includes Moraxella, Neisseria and Veillonella and gram negative rods include campylobacter, Capnocytophaga, Desulfobacter, Desulfovibrio, Eikenella species, fusobacterium, treponema and other species. So, these are the gram-positive cocci, bacilli and gram negative cocci and bacilli.

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So, this picture shows the sequential colonization of bacteria in a healthy oral cavity. So, initially streptococci will recognize the statherin which is present in saliva followed by association of actinomyces with several other proteins present in the saliva.

So, the initial colonizers are streptococci later on actinomyces will come and various proteins present in the saliva apart from statherin like immunoglobulins, alpha amylase, lactoferrin, alpha 2 macroglobulin, fibronectin, salivary mucins also assist in association of more actinomyces and streptococci.

So, after the colonization of gram-positive bacteria there it allows adherence of gram negative bacteria which is Veillonella, other gram negative bacteria like Porphyromonas also associate with Streptococci. Later on Porphyromonas will produce signalling molecules which induces co-aggregation of gram negative obligate anaerobes. Later once completion of colonization is accomplished by yeast adherence which leads to poly bacterial bed. So, this is a sequential colonization of bacteria in a healthy oral cavity.

other bacterial species and healthy mycobiome which is the fungal component predominantly includes *Candida* species and other species like *Cryptococcus*, *Penicillium*, *Saccharomycetales* as well as *Ascomycotoma* phylum.

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The slide features the NPTEL logo in the top right corner. A central text box contains the following bullet points:

- Oral habitats- highest alpha diversity in the body
- Oral sites-lowest beta diversity
- Taxonomic diversity within the sample is alpha diversity and that between the samples is beta diversity

In the bottom right corner, there is a small video inset of a woman in a red and gold saree speaking.

So, oral habitats have always got a highest alpha diversity in the body and it has got a lowest beta diversity. So, taxonomic diversity within the sample is called as alpha diversity and between the sample is called as beta diversity. Oral habitat has got highest alpha and lowest beta diversity.

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The slide features the NPTEL logo in the top right corner. The title 'FUNCTIONS OF ORAL MICROBIOME' is centered at the top. Below it, a text box contains the following content:

1. The oral microbiome usually exists in the form of a biofilm.

- ✓ maintains oral homeostasis
- ✓ protects the oral cavity
- ✓ Prevent disease development

In the bottom right corner, there is a small video inset of a woman in a red and gold saree speaking.

Now, let us see the functions of oral microbiome. So, oral microbiome usually exists in the form of a biofilm, it maintains oral homeostasis, it protects the oral cavity and it prevents disease development.

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FUNCTIONS OF ORAL MICROBIOME

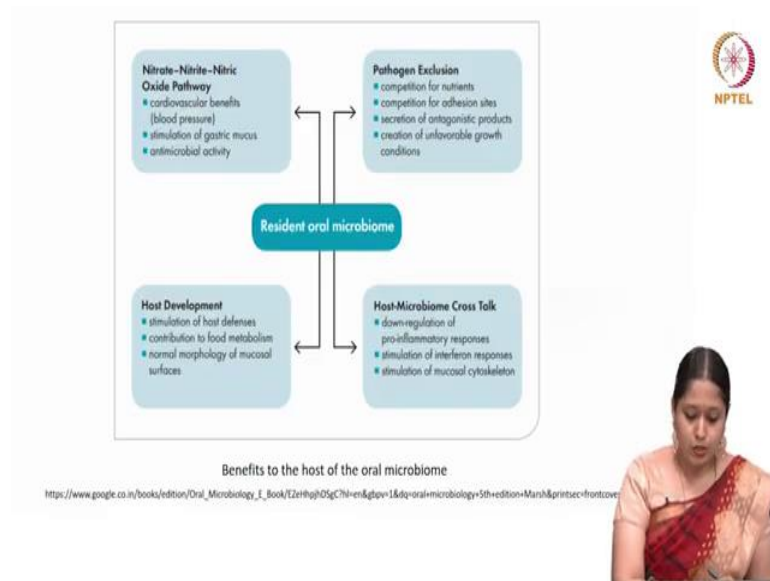
NPTEL

- 2. Critical, physiological, metabolic and immunological functions
 - ✓ Digestion of food & nutrition
 - ✓ Generation of energy
 - ✓ differentiation and maturation of the host mucosa and its immune system
 - ✓ control of fat storage and metabolic regulation
 - ✓ processing and detoxification of environmental chemicals
 - ✓ barrier function of skin and mucosa
 - ✓ maintenance of the immune system and the balance between pro-inflammatory and anti-inflammatory processes
 - ✓ promoting microorganisms (colonization resistance)
 - ✓ prevention of invasion and growth of disease.

Apart from that it also performs critical physiological, metabolic and immunological functions which includes digestion of food and nutrition, generation of energy differentiation and maturation of host mucosa and the immune system, control of fat storage and metabolic regulation.

Processing and detoxification of environmental chemicals, barrier function of skin and mucosa, maintenance of the immune system and the balance between pro inflammatory and anti-inflammatory processes, colonization resistance and prevention of invasion as well as the growth of the disease. So, these are the functions of oral microbiome.

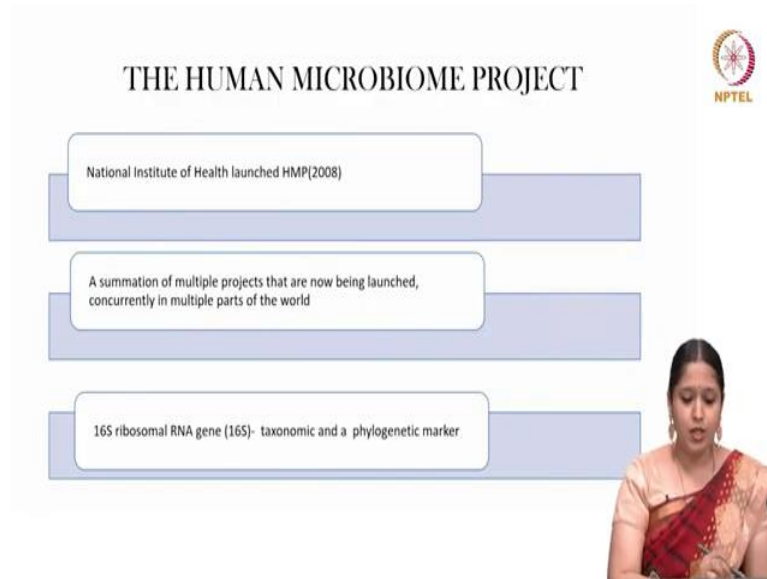
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So, what are the benefits to the host by the oral microbiome? It includes numerous benefits like cardiovascular benefits which helps in controlling blood pressure, stimulation of gastric mucus and the most important function is the antimicrobial activity. Apart from that the resident oral microbiome also helps in pathogen exclusion which competes for the nutrients, adhesion sites, antagonistic products as well as creation of unfavourable growth condition.

And it also helps in host development by stimulation of host defences and it also contributes to food metabolism and normal morphology of the mucosal surfaces, also it helps in host microbiome crosstalk.

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THE HUMAN MICROBIOME PROJECT

National Institute of Health launched HMP(2008)

A summation of multiple projects that are now being launched, concurrently in multiple parts of the world

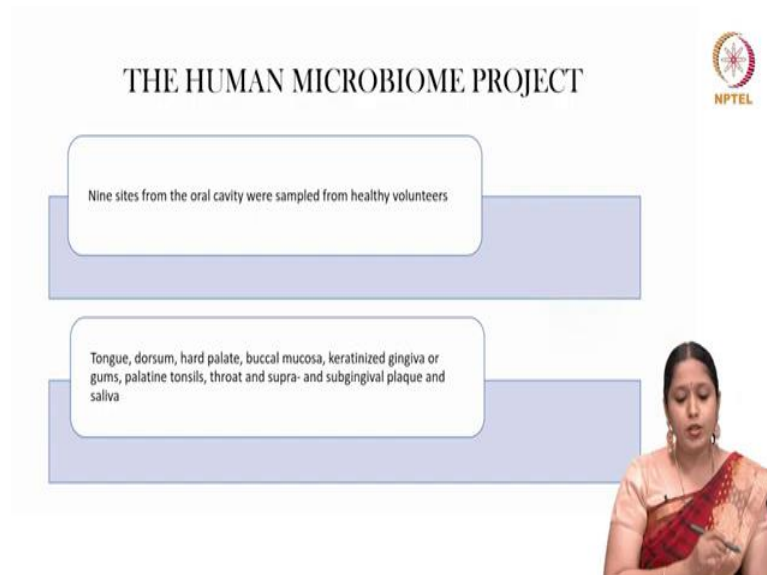
16S ribosomal RNA gene (16S)- taxonomic and a phylogenetic marker

NPTEL

The slide features a light blue background with three white text boxes containing the main points. The NPTEL logo is in the top right corner. A woman in a red and orange sari is visible in the bottom right corner of the slide frame.

There is something called as human microbiome project which was first launched in the year 2008 by National Institute of Health, it is nothing, but a summation of multiple projects that are now being launched concurrently in multiple parts of the world. And they consider 16S ribosomal RNA as the taxonomic as well as the phylogenetic marker.

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THE HUMAN MICROBIOME PROJECT

Nine sites from the oral cavity were sampled from healthy volunteers

Tongue, dorsum, hard palate, buccal mucosa, keratinized gingiva or gums, palatine tonsils, throat and supra- and subgingival plaque and saliva

NPTEL

The slide features a light blue background with two white text boxes containing the main points. The NPTEL logo is in the top right corner. A woman in a red and orange sari is visible in the bottom right corner of the slide frame.


So, nine sites from the oral cavity were sampled from healthy volunteers and those sites include tongue, dorsum of tongue, palate, hard palate, buccal mucosa, keratinized gingiva, palatine tonsils, throat, supra gingival and subgingival plaque as well as saliva.

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HUMAN ORAL MICROBIOME DATABASE (HOMD)

- HOMD - a repository of oral bacterial genome sequences and an in-depth resource consisting of the descriptions of oral bacterial taxa, a 16S rRNA identification tool
- Unique database launched in 2010- National Institute of Dental and Craniofacial Research for maintaining the information of oral-derived cultivable and noncultivable isolates
- eHOMD - 772 prokaryotic species, 70% cultivable, 30% uncultivable, 57% of culturable species assigned names

NPTEL

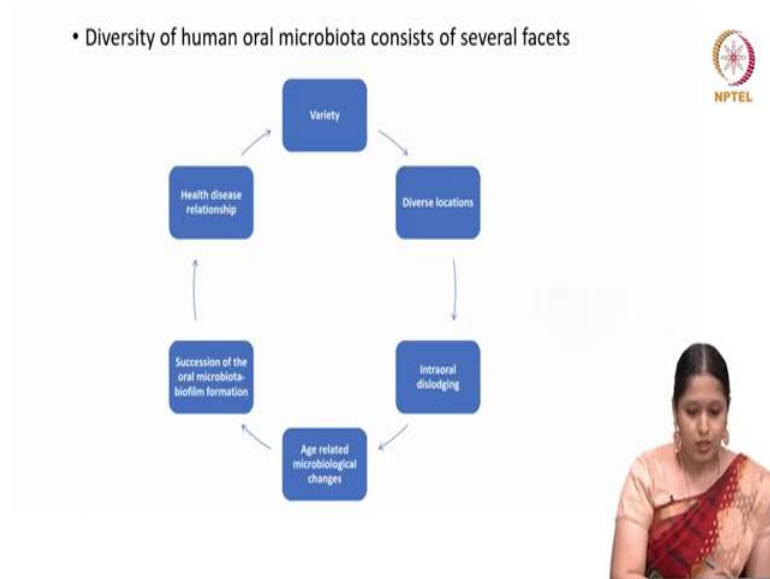


Another thing is human oral microbiome database. This is a unique database which was launched in the year 2010 by the National Institute of Dental and Craniofacial Research especially for maintaining the information of the oral derived cultivable and non cultivable isolates.

So, a human oral microbiome database is a repository of oral bacterial genome sequences and an in depth resource consisting of the description of oral bacterial taxa, a 16S rRNA identification tool.

There is something called as expanded human oral microbiome database which is also called eHOMD. It consists of 772 prokaryotic species, 70 percentage of cultivable, 30 percentage of uncultivable and 57 percentage of culturable species are assigned names.

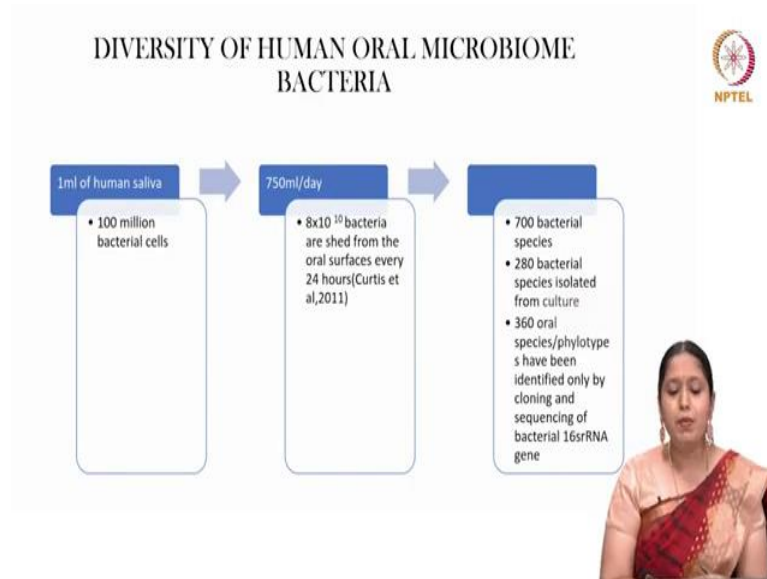
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So, diversity of human oral microbiota consists of several facets. First is variety as I mentioned before there are huge variety of micro-organisms inside the oral cavity, then diverse locations when you come to locations these microorganisms are present on soft tissue as well as hard tissue as well as on dentures and implants.

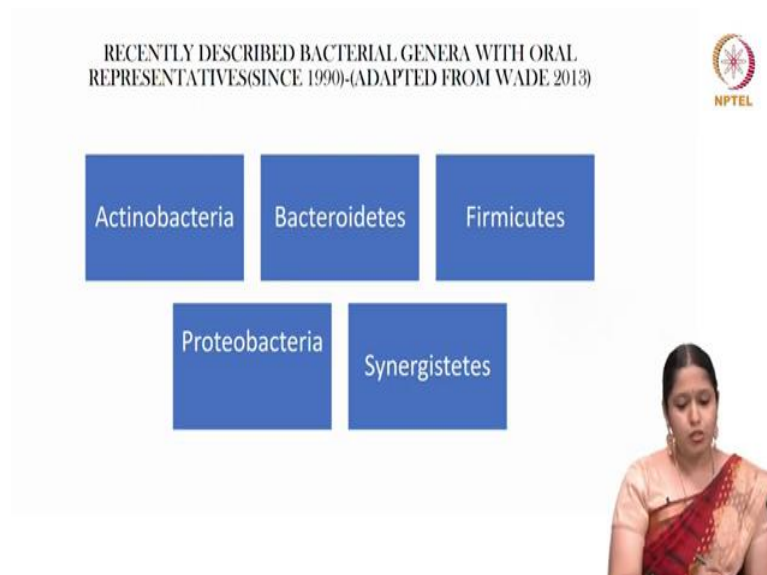
Next is intraoral dislodging—certain microbiomes are particular to a specific niche, but what happens is certain microorganisms like streptococcus mutans has the ability to dislodge from one place to another. So, they are seen in multiple sites. So, this is one of the properties, that is intraoral dislodging. Next is age related microbiological changes succession of oral microbiota that is biofilm formation and health disease relationship. So, these are all the different facets.

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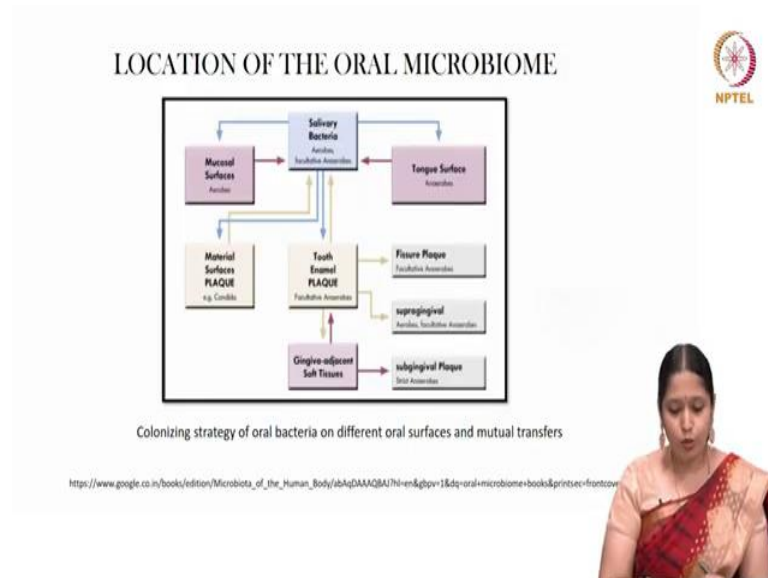
So, 1 ml of human saliva contains approximately 100 million bacterial cells and 750 ml of saliva is secreted per day. 8×10^{10} bacteria are shed from the oral surfaces every 24 hours and there are 700 bacterial species, 280 bacterial species isolated from culture, 360 oral species or phylotypes have been identified only by cloning and sequencing of bacterial 16S rRNA gene.

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So, this list includes recently described bacterial genera with oral representatives adapted from Wade 2013 which includes Actinobacteria, Bacteroidetes, Firmicutes, Proteobacteria and Synergistetes.

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Now coming to the location of oral microbiome, this picture shows the colonizing strategy of oral bacteria on different oral sites. So, salivary bacteria mainly include aerobes and facultative anaerobes tongue surface has got anaerobes, fissure plaque it has got facultative anaerobes, supra gingival it includes aerobes and facultative anaerobes tooth enamel has got a plaque.

So, it has got a facultative-anaerobes gingiva adjacent soft tissues under that subgingival plaque has got strict anaerobes. And also, material surfaces like plaque have got Candida species and mucosal surfaces has got aerobes.

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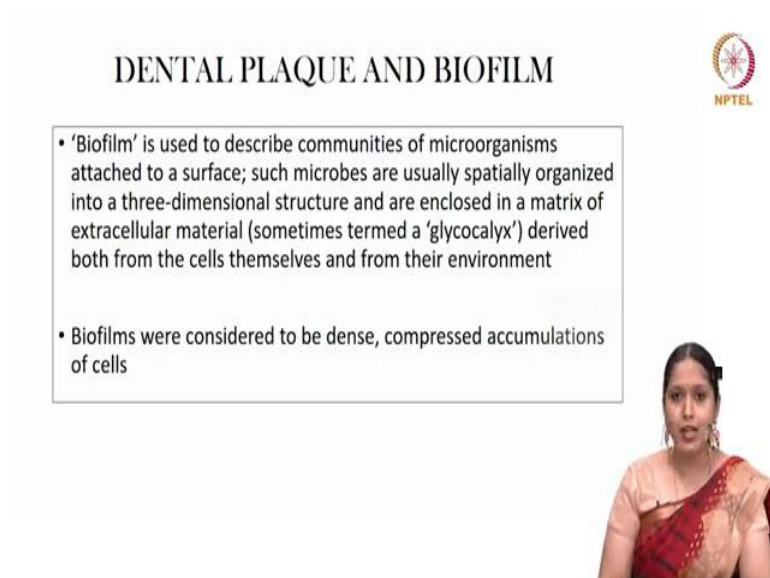
The slide is titled "PROPERTIES" in a large, bold, black font at the top center. In the top right corner, there is a circular logo with a star-like pattern and the text "NPTEL" below it. The main content is a list of six bullet points on a light orange background:

- High species diversity
- Surface attachment or co-adhesion
- Obligate anaerobes
- Fastidious nutrition/unculturable
- Slow growth
- Identification

In the bottom right corner, there is a small video inset showing a woman with dark hair, wearing a red and white patterned sari, speaking.

Now, what are the properties? Properties include high species diversity, surface attachment or co adhesion, obligate anaerobes, fastidious nutrition or unculturable nature, slow growth as well as identification.

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The slide is titled "DENTAL PLAQUE AND BIOFILM" in a large, bold, black font at the top center. In the top right corner, there is a circular logo with a star-like pattern and the text "NPTEL" below it. The main content is a definition of biofilm in a white box with a black border:

- 'Biofilm' is used to describe communities of microorganisms attached to a surface; such microbes are usually spatially organized into a three-dimensional structure and are enclosed in a matrix of extracellular material (sometimes termed a 'glycocalyx') derived both from the cells themselves and from their environment

Below the definition box, there is another bullet point:

- Biofilms were considered to be dense, compressed accumulations of cells

In the bottom right corner, there is a small video inset showing the same woman from the previous slide, wearing a red and white patterned sari, speaking.

Now, let us see the dental plaque and biofilm. So, a biofilm is described as a communities of microorganisms attached to a surface such as microbes that are usually spatially organized in a three-dimensional structure and they are enclosed in a matrix of extracellular material which sometime termed as a glycocalyx and they are derived both

from the cells themselves as well as the environment. So, biofilms were considered to be a dense compressed accumulation of cells.

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The slide features a diagram of a dental plaque biofilm structure on the left, showing layers from the tooth surface to the lumen. A legend on the right lists 23 numbered microorganisms. The NPTEL logo is in the top right corner. A URL is provided at the bottom: <https://www.sciencedirect.com/science/article/pii/S134886415000166>. A woman is visible in the bottom right corner of the slide frame.


- 1. *Streptococcus oralis* and *Streptococcus sanguinis*
- 2. *Streptococcus mitis*
- 3. *Streptococcus gordonii*
- 4. *Corynebacterium jeikeium*
- 5. *Aggregatibacter actinomycetemcomitans*
- 6. *Porphyromonas gingivalis*
- 7. *Prevotella buccalis*
- 8. *Veillonella sp.*
- 9. *Actinomyces visus* and *Actinomyces naeslundii*
- 10. *Blautia obeum*
- 11. *Actinomyces naeslundii*
- 12. *Corynebacterium jeikeium*
- 13. *Corynebacterium jeikeium*
- 14. *Corynebacterium jeikeium*
- 15. *Aggregatibacter actinomycetemcomitans*
- 16. *Actinomyces visus*
- 17. *Streptococcus mitis*
- 18. *Streptococcus mitis*
- 19. *Streptococcus mitis*
- 20. *Porphyromonas gingivalis*
- 21. *Prevotella buccalis*
- 22. *Streptococcus gordonii*
- 23. *Streptococcus gordonii*

Dental plaque is considered to be the first biofilm studied in the mouth. So, dental plaque is one of the best studied biofilms and displays all the characteristic features of a typical biofilm. So, in this picture you can see the tooth surface which is covered by salivary pellicle and the saliva has got various proteins and other materials like statherin, bacterial cell fragment, mucins, salivary agglutinants, alpha amylase and proline rich protein.


So, all these components will cause association of microorganisms first in early colonizers which predominantly includes streptococcus and then comes the late colonizers.

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GENERAL PROPERTIES OF BIOFILM


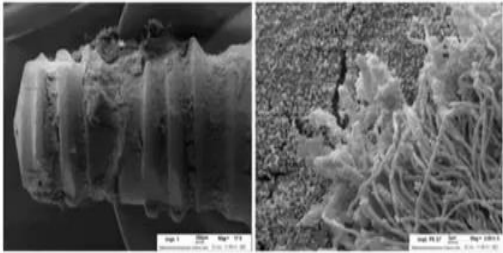


- Open architecture
- Protection from host defences, desiccation, etc
- Enhanced tolerance to antimicrobials
- Neutralization of inhibitors
- Novel gene expression
- Coordinated gene responses
- Spatial & environmental heterogeneity
- Broader habitat range
- More efficient metabolism
- Enhanced virulence




So, what are the general properties or ideal properties of a biofilm; it includes open architecture, protection from host defence, enhanced tolerance to antimicrobials, neutralization of inhibitors, novel gene expression, coordinated gene responses, spatial and environmental heterogeneity, broader habitat range, more efficient metabolism and enhanced virulence. So, these are all the ideal properties of a biofilm.

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Scanning electron microscope images of a highly diverse biofilm on an implant which had to be removed due to periimplantitis

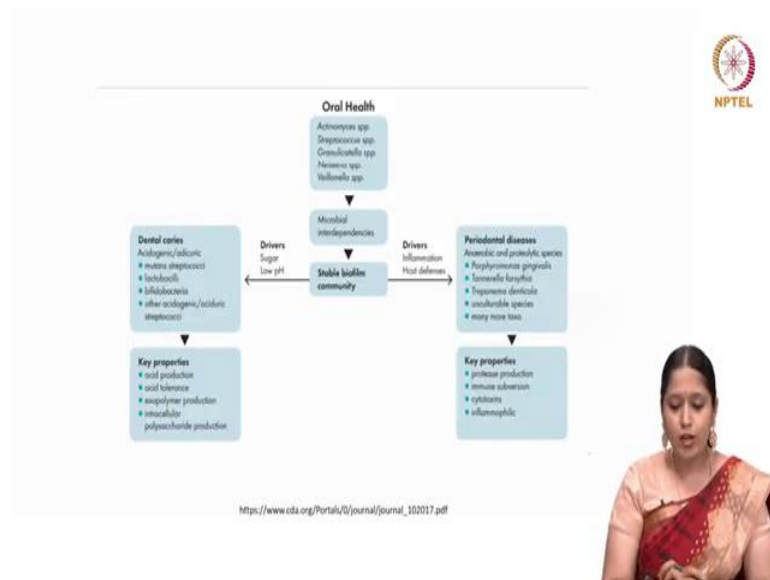


So, this is scanning electron microscopic picture of a highly diverse biofilm which is seen on an implant dental implant and later on this dental implant has to be removed because it caused periimplantitis.

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Now, let us see oral biofilms in diseases. So, normal healthy oral flora includes actinomyces, streptococcus and neisseria and veillonella species and it forms a stable biofilm community. But whenever there is a drive, external drivers like sugar as well as low pH what happens is it leads to a condition called as dental caries.

So, in dental caries- acidogenic or aciduric bacteria will be more predominant which includes mutant streptococci, lactobacilli, bifidobacteria and other acidogenic or aciduric streptococci.

So, the key properties will be there will be acid production, acid tolerance, exopolymer production and intracellular polysaccharide production, On the other side if another drivers or external stimuli comes like inflammation and host defence it leads to periodontal diseases, where there will be anaerobic as well as proteolytic species like *Porphyromonas gingivalis*, *Tannerella forsythia*, *Treponema denticola* and other unculturable species. And the key properties will be protease production, immune subversion, cytotoxins and inflammophilic.

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The ecological plaque hypothesis-in caries, if the biofilm spends more time at a low pH due to increases in sugar consumption (amount and/or frequency) then beneficial bacteria are inhibited and outcompeted by organisms that are adapted to growing under acidic conditions. These organisms include mutants streptococci, bifidobacteria and lactobacilli, but not exclusively. These acidogenic and acid-tolerating species can make even more acid and at faster rates, thereby increasing the risk of lesion development. The selection of these cariogenic bacteria also occurs if saliva flow is reduced, but the process can be reduced by dietary control, effective oral hygiene and the appropriate use of fluoride-containing oral care products

https://www.cda.org/Portals/0/journal/journal_102017.pdf

So, let us see the ecological plaque hypothesis how it is applicable to caries. So, in caries what happens is the biofilm spends more time because of the lower pH as a result of increased sugar intake, what happens is there will be reduction in the pH, the bacteria will produce acid which causes reduction in pH as a result it also depends upon increase in the sugar consumption either in the amount or in the frequency of sugar consumption.

So, what happens is the beneficial bacteria are inhibited and it will be out competed by organisms there are adapted to growing in acidic condition. So, these organisms mainly include mutant streptococci bifidobacteria and lactobacilli. So, these acidogenic and acid tolerating species can make more acid and at a faster rate this leads to condition called as

dental caries or tooth decay. So, what happens is because of stress there will be increased sugar frequency and there will be more frequent acid production.

Also there will be environmental change from neutral pH to low pH, there will be ecological shift from normal oral microflora to acid producing microflora or with those microflora which can tolerate under low pH like mutans streptococci, lactobacilli and bifidobacteria which leads to the disease from the normal health condition to caries risk condition.

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The diagram illustrates the Ecological Plaque Hypothesis. It shows a progression from left to right: Stress leads to Reduced plaque and Reduced inflammation. A host response leads to Increased plaque and Increased inflammation. Environmental change (low GCF flow) leads to High GCF flow, bleeding, raised pH and °C. An ecological shift leads to Gram-positive microbes (facultative, saccharolytic) and Gram-negative bacteria (anaerobic, proteolytic). Finally, Disease (Gingivitis/Periodontitis) is shown, with Gingival Health and Effective oral hygiene leading to Reduced plaque and inflammation, and Poor oral hygiene leading to Increased plaque and inflammation.

The ecological plaque hypothesis- In periodontal diseases such as periodontitis, plaque accumulation produces an inflammatory host response. If this response does not eliminate the microbial challenge, then inflammation causes substantial changes to the local environment that favor the growth of proteolytic, anaerobic and often Gram-negative bacteria. Disease could be prevented by not only targeting the putative pathogens, but also by interfering with the factors driving their selection. Tissue destruction can be accelerated by the existence of host risk factors, while disease risk could be reduced by the introduction of more effective oral hygiene practices.

https://www.cda.org/Portals/0/journal/journal_102017.pdf

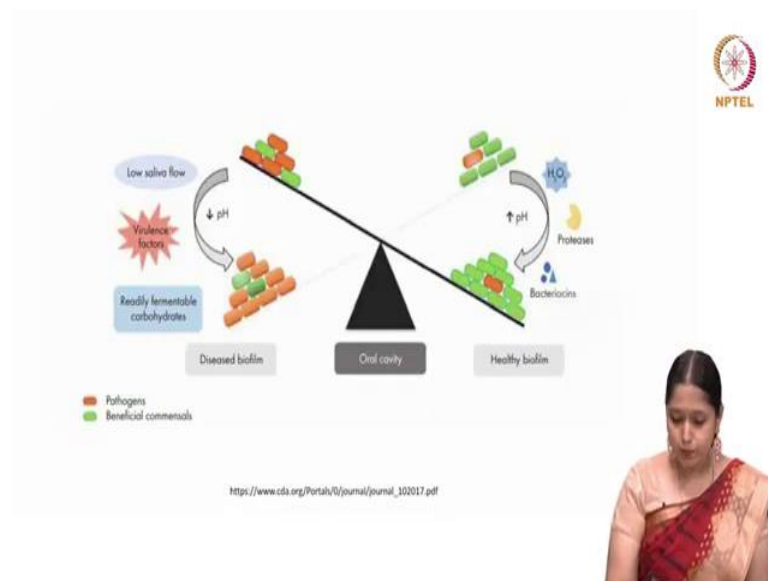
So, the ecological plaque hypothesis for the periodontal diseases. In conditions such as periodontitis plaque accumulation produces an inflammatory host response, always remember plaque accumulation causes inflammatory host response, if this response does not eliminate the challenge what happens is the inflammation causes substantial changes to the local environment that favour the growth of proteolytic, anaerobic and offer gram negative bacteria.

So, if the host immune response does not work there will be more number of proteolytic anaerobic as well as gram negative bacteria. So, what happens in case of periodontal disease? Stress will cause increased plaque and also host response from reduced inflammation to increased inflammation and environmental change from low gingival crevicular fluid flow to high GCF flow, bleeding and increased pH and there will be

ecological shift from gram positive microbiota facultative to gram negative bacteria anaerobic and proteolytic.

So, the normal gingival health is altered and it leads to periodontal diseases that is gingivitis and periodontitis. So, this is the ecological plaque hypothesis in relation to periodontitis.

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So, this picture also explains the healthy biofilm and a diseased biofilm. So, healthy biofilm has got more number of beneficial bacteria and there will be more pH and it is in a healthy condition, but what happens is because of low pH and more intake of sugar and it causes low pH and there will be acid production.


As a result, there will be more amount of readily fermentable carbohydrates and it forms a diseased biofilm. So, diseased biofilm has got lesser number of beneficial commensals and more number of pathogens.

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CONCLUSION




- Oral microbiome is crucial to health as it can cause both oral and systemic diseases.
- It rests within biofilms throughout the oral cavity and forms an ecosystem that maintains health in a state of equilibrium




So, to conclude oral microbiome is crucial to health because it can cause both oral as well as systemic diseases. If any alteration happens in the oral microbiome or the biofilm there will be disease. It rests within the biofilms throughout the oral cavity and it forms an ecosystem that maintains health in a state of equilibrium.

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So, these are my references.

Thank you.