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How to Identify Research Gap in Dental Microbiology

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WHAT IS DENTAL/ORAL MYCROBIOLOGY

1.

Oral
Microbes

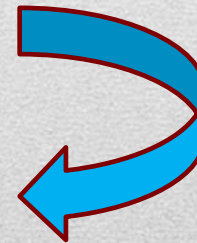


Most Complex
bacterial flora



700 bacterial
species identified
from human oral
cavity

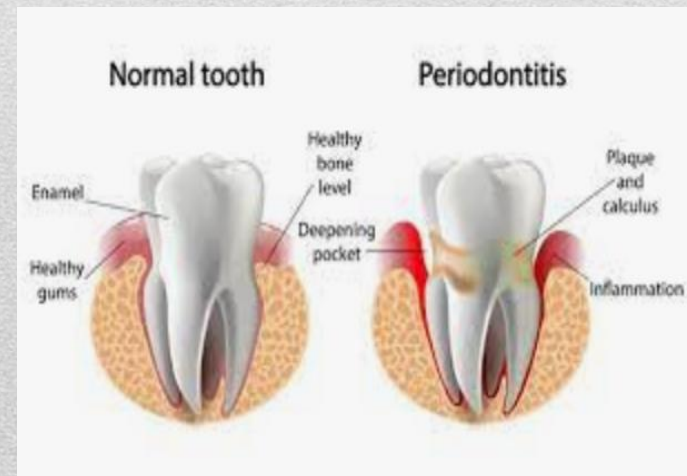
Majority in dental
plaque





WHAT IS DENTAL/ORAL MYCROBIOLOGY

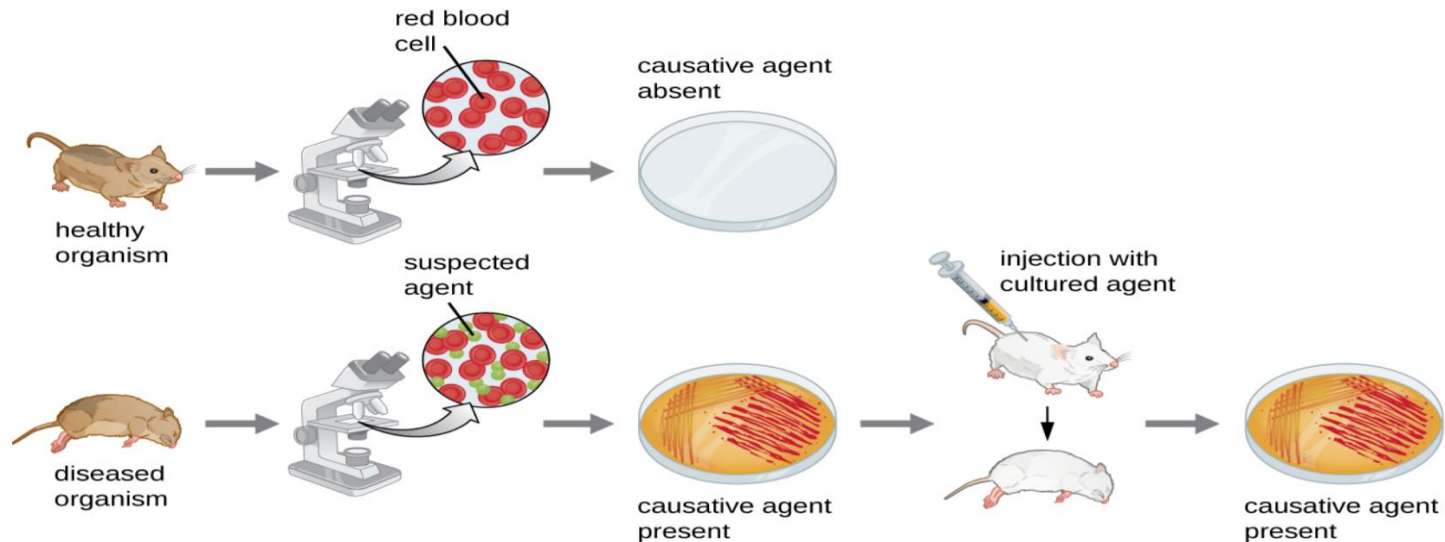
2. • The oral microbial flora is responsible for two major human oral diseases: dental caries (tooth decay) and periodontitis (gum disease)





3.

Oral microbiologists followed guideline of Koch's postulates :



1 The suspected causative agent must be absent from all healthy organisms but present in all diseased organisms.

2 The causative agent must be isolated from the diseased organism and grown in pure culture.

3 The cultured agent must cause the same disease when inoculated into a healthy, susceptible organism.

4 The same causative agent must then be reisolated from the inoculated, diseased organism.

The steps for confirming that a pathogen is the cause of a particular disease using Koch's postulates.



4.

- **The limitation of reductionism forced.**

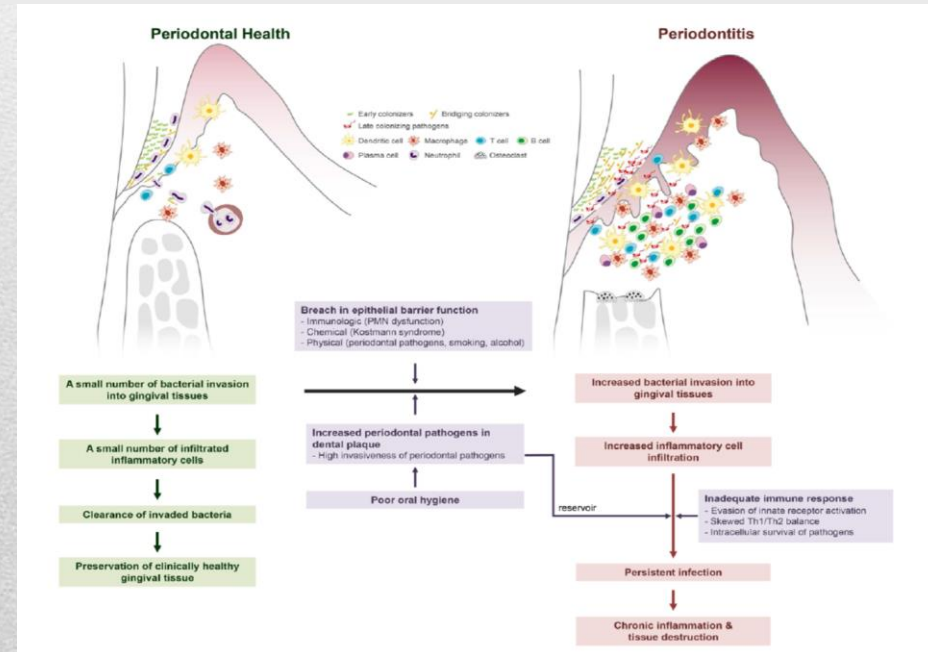
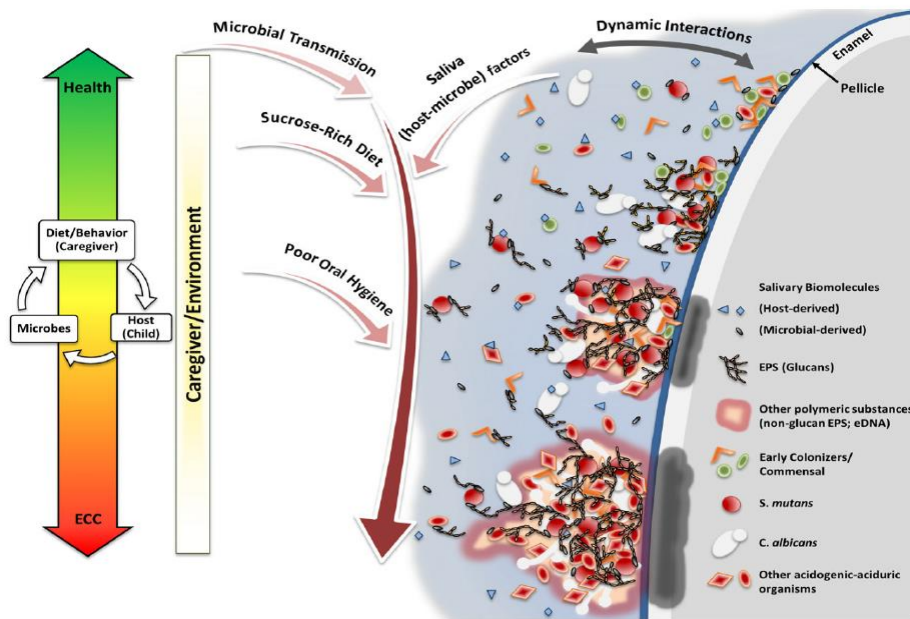


- **New concepts such as interspecies, interaction, microbial community, biofilms, poly-microbial diseases, etc**



WHAT IS DENTAL/ORAL MICROBIOLOGY

These new research directions have revealed many new physiological functions critical for the pathogenesis, which result from interactions between different components within oral microbial flora, and might not be observed with individual organisms.



The complex and dynamic host-microbe-diet interactions in the etiology and pathogenesis of early childhood caries. ECC, early childhood caries; EPS, exopolysaccharides.

Pathogenesis of Periodontitis



WHAT IS DENTAL/ORAL MYCROBIOLOGY

- **The new “system thinking”, empowered with the modern techniques for analyzing complex microbial community serves as a new foundation for studying oral microbial community, providing invaluable insight into the etiology of dental and periodontal diseases, developing new therapeutic and preventive tools for combating oral poly-microbial diseases.**



DENTAL/Oral Microbiology: Past, Present and Future

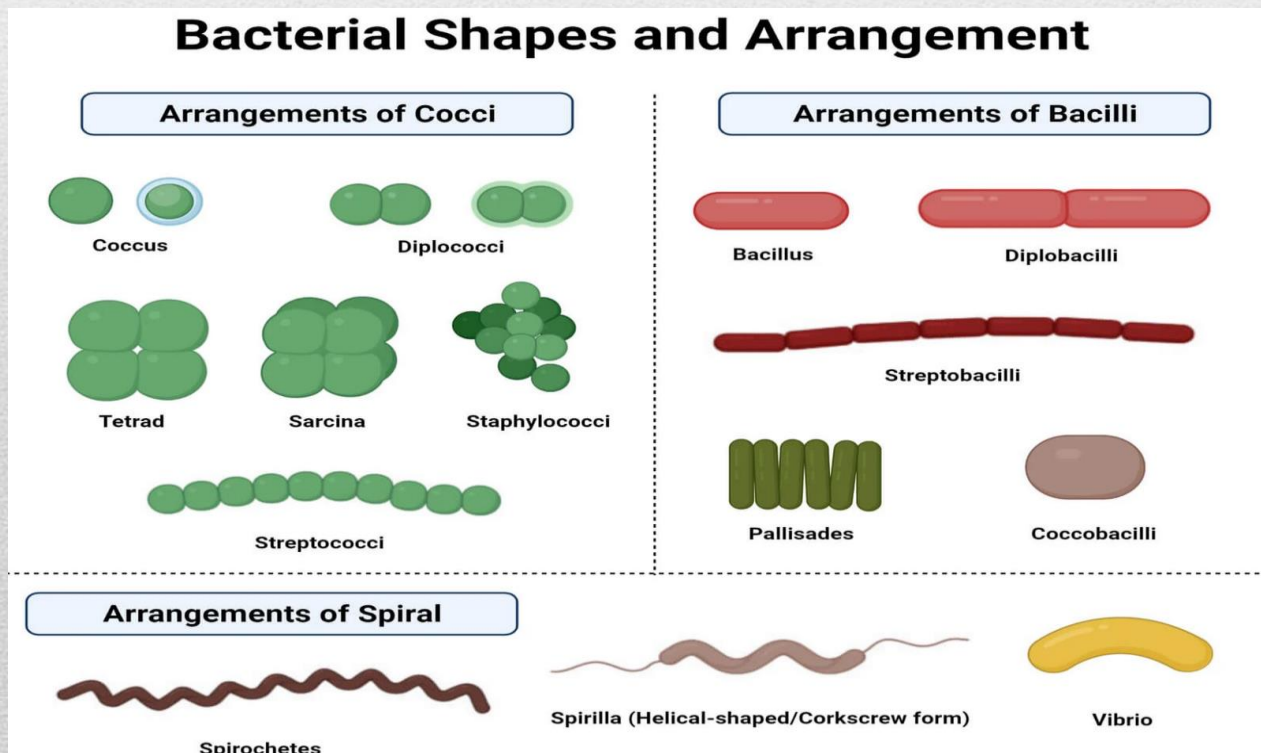
PAST :

- **1. The Initial Discovery of Oral Microbes**
- **2. Revealing the Infectious Nature of Dental Caries and Periodontitis**
- **3. Establishing Dental Plaque as the Cause of Dental Caries and Periodontitis**



1. The Initial Discovery of Oral Microbes

- The most abundant bacteria resided within oral cavity, including cocci, spirochetes, and fusiform bacteria (three basics of bacteria).





2. Revealing the Infectious Nature of Dental Caries and Periodontitis

- The focus of oral microbiology research : dental caries and periodontitis (as two of the most prevalent human oral diseases)
- Dental caries is a human oral disease with a long history.
- Dental caries major bacteria : *Streptococcus mutans*
- Periodontitis : widely regarded as the second most common disease worldwide.
- Periodontitis major bacteria : *P. gingivalis*, *A.actinomycetemcomitans*, etc



3. Establishing Dental Plaque as the Cause of Dental Caries and Periodontitis

- **Black's work, together with Miller's chemoparasitic theory established the important role of dental plaque in the etiology of dental caries and has become one of the essential paradigms of oral biology**
- **The progress in dental plaque study has become a major indicator of the development of oral microbiology.**



DENTAL/Oral Microbiology : PRESENT

- **1. Genetic Studies of Bacterial Isolates from Dental Plaque**
- **2. Getting a Closer Look at Dental Plaque**
- **3. Community Based Microbial Pathogenesis**



1. Genetic Studies of Bacterial Isolates

- The genetic studies, bio-informatic information obtained from whole genomic sequences of many oral bacteria, development and function of oral microbial community at the molecular level.
- The molecular genetic basis of biofilm formation of oral isolates using data from in vitro studies on either single, dual species or multispecies systems.
- Certain virulent organisms many different types of genes encoding a variety of functions are required for biofilm development and establishment within the dental plaque, including genes encoding virulence factors, general stress response pathways, quorum-sensing systems, two-component systems sensing environmental cues, and those encoding surface adhesions involved in cell–cell or cell-to-genes encoding surface interactions.



2. Getting a Closer Look of Dental Plaque

- The dental plaque has long been linked to the etiology of dental and periodontal diseases.
- The development of highthrough put tools for microbial community analysis.
- Directly examine nucleic acids isolated from samples of microbial communities.
- Microarrays and checkerboard DNA-DNA hybridization method, while others are PCR based, such as denaturing gradient gel electrophoresis (DGGE) or temperature gradient gel electrophoresis, terminal restriction fragment length polymorphism (T-RFLP), automated ribosomal intergenic spacer analysis, and denaturing high-performance liquid chromatography (DHPLC).
- These approaches were originally developed for analyzing environmental microbial communities and have been used to study human microbial ecology, including oral microbial analysis.



3. Community Based Microbial Pathogenesis

- Dental plaque is a microbial community with great structural complexity and genetic diversity. Its bacterial composition remains relatively stable despite regular exposure to minor environmental perturbations.
- This stability (microbial homeostasis) is due in part to a dynamic balance of both synergistic and antagonistic microbial interactions
- Multispecies communities like dental plaque can produce polymicrobial infections in which microorganisms interact in a synergistic fashion, leading to pathogenesis.
- Periodontal diseases represent one of the best-documented polymicrobial infections.



DENTAL/Oral Microbiology : FUTURE

- 1. The Future Direction of Oral Dental Plaque Study-Metagenomics**
- 2. Evidence Based Dental Caries Diagnosis**
- 3. New Approaches for Controlling Dental and Periodontal Diseases**



1. The Future Direction of Oral Dental Plaque Study- Metagenomics

- Metagenomics" : "the application of modern genomics techniques to the study of communities of microbial organisms directly in their natural environments, by passing the need for isolation and lab cultivation of individual species”.
- The advances in refinements of DNA amplification, bioinformatics, and enhanced computational power for analyzing DNA sequences have enabled the adaptation of shotgun sequencing, such as chip-based pyrosequencing, to metagenomic samples.



2. Evidence Based Dental Caries Diagnosis

- Early detection and quantification of cariogenic bacteria : take preventive measures to stop caries development, much like early detection of cancer markers.
- New antibody or nucleotide based bacterial detection techniques have been developed for the detection of cariogenic bacteria in chair-side or laboratory settings.
- In conjunction with nanotechnology development, there tests can be further developed into different forms of nano-chips for detection of multiple pathogens in the clinical settings



3. New Approaches for Controlling Dental and Periodontal Diseases

- Current preventive dental therapy is primarily focused on removing dental plaque
- The probiotic approach has been a popular methods used to affect microbial communities.
- Targeted antimicrobial therapy via a novel specifically targeted-antimicrobial peptides (STAMPs) technology.
- A “STAMP” is a fusion peptide with two moieties.
- The progress in oral microbiology will continue to provide in-depth understanding of the ecological tug-of-war between the indigenous microbial flora and the cariogenic, periodontal pathogens.
- Become a gateway leading to more specific and proactive therapeutic approaches in combating dental and periodontal diseases.



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