Caries Process and Prevention Strategies: The Host

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Conflict of Interest Disclosure Statement

- The authors report no conflicts of interest associated with this course.

Introduction

This is part 3 of a 10-part series entitled *Caries Process and Prevention Strategies*. It has been established that a host must be present for caries to develop. In this course, three host factors - the tooth, saliva, and the oral cavity's immune response - are introduced, and their roles in the caries process are explained.

Course Contents

Overview

It has been established that a host must be present for caries to develop. Here, three host factors - the tooth, saliva, and the oral cavity's immune response - are introduced, and their roles in the caries process are explained.

Learning Objectives

Upon completion of this course, the dental professional should be able to:

- Discuss tooth structure.
- Describe how the mineral composition and structure of enamel relates to caries.
- Be familiar with the concept of enamel maturation.
- Explain what saliva is and how it is produced.
- Identify the major salivary glands.
- Explain the nerve control of saliva secretion.
- List the physical, chemical, and antibacterial properties of saliva.
- Describe the host's immune response in the dental caries process.

Glossary

ameloblasts – The cells in the embryonic tooth germ that produce enamel. Once tooth formation is complete, the ameloblasts are unable to produce further enamel. Therefore, if enamel is lost or damaged by caries, tooth wear, or trauma, it cannot be repaired or replaced.

cariogenic – The ability to cause dental caries. A cariogenic diet contains sugars. Some bacteria in dental plaque (*S. mutans*) are cariogenic. The mere presence of cariogenic sugars or cariogenic bacteria is not enough to cause the initiation of the caries process. Many other factors play a role, and taken together they may or may not contribute to the process that leads to dental caries.

demineralization – The chemical process by which minerals (mainly Calcium) are removed from the dental hard tissues – enamel, dentin, and cementum. The chemical process occurs through dissolution by acids or by chelation, and the rate of demineralization will vary due to the degree of supersaturation of the immediate environment of the tooth and the presence of fluoride. In optimal circumstances, the minerals may be replaced through the process of remineralization.

fluorapatite – A crystal structure in tooth mineral (Ca_{10} $(PO_4)_6$ F_2) resulting from the replacement of hydroxyl ions (OH-) in the hydroxyapatite structure with fluoride ions (F-). Fluorapatite (also commonly referred to as fluoroapatite, fluorhydroxyapatite or fluorohydroxyapatite) is stronger and more acid resistant than hydroxyapatite.

hydroxyapatite – Crystals of calcium phosphate - Ca_{10} $(PO_4)_6$ OH_2 - that form the mineral structure of teeth and bone. Enamel comprises approximately 98% hydroxyapatite (by weight). Much of the hydroxyapatite in enamel, however, is a calcium-deficient carbonated hydroxyapatite, the crystals of which are readily dissolved by acids. The addition of fluoride creates fluorapatite, which is less soluble and more acid-resistant.

parasympathetic nerves – The part of the nervous system that controls and regulates various organs and glands unconsciously, such as the secretion of salivary and lachrymal fluids.

remineralization – The chemical process by which minerals (mainly calcium) are replaced into the substance of the dental hard tissues - enamel, dentin and cementum. The process requires an ideal environment that includes supersaturation with calcium and phosphate ions, and adequate buffering. In the presence of fluoride, remineralization is enhanced.

sympathetic nerves – The part of the nervous system that controls the stress and fight-or-flight response. It controls the force of contraction and rate of the heartbeat, and dilates the pupils and the bronchioles.

Video: The Host

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Course Test Preview

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1. Which of the following is not a major tissue of teeth?

A. Enamel
B. Parathyroid gland
C. Pulp
D. Cementum

2. Which of the following is true about enamel?

A. It has a blood and nerve supply.
B. It contain no pores.
C. Its hydroxyapatite crystals are highly organized.
D. Water makes up 12% of its composition.

3. When a tooth erupts, it is not fully mineralized. Which ions are taken up from saliva to complete mineralization?

A. Calcium and Magnesium
B. Phosphorous and Carbonate
C. Fluoride, Calcium and Phosphorous
D. Magnesium and Cesium

4. What are the main differences between dentin and enamel?

A. Dentin has more organic matter, dentin is softer, and dentin is living tissue that can grow and repair.
B. Dentin has more organic matter, dentin's hydroxyapatite crystals are smaller, and enamel can be repaired and regenerated.
C. There are no significant differences.
D. Enamel contains tubules that connect it to pulp, dentin is harder, and enamel has more inorganic matter.

5. Which of the following is true about pulp?

A. It is formed by epithelial cells called ameloblasts.
B. One of its main roles is the creation of dentin.
C. It is devoid of blood vessels and nerves.
D. It is directly connected to enamel via tubules.

6. What is the main role of cementum?

A. To protect against tooth sensitivity.
B. To create dentin.
C. To anchor teeth to the body walls of tooth sockets.
D. To serve as a sacrificial source of minerals during a cariogenic challenge.

7. Which of the following are major salivary glands?

A. Parotid
B. Submandibular
C. Wharton's ducts
D. A and B

8. Which of the following traits differentiates the sublingual salivary glands from the parotid and submandibular glands?

A. The sublingual glands secrete mostly mucous and have excretory ducts.
B. The sublingual glands secrete mostly serous fluid and have excretory ducts.
C. The sublingual glands produce thicker saliva and have intercalated ducts.
D. There is no difference between sublingual glands and parotid and submandibular glands.

9. Salivary glands are innervated by the parasympathetic and the sympathetic branches of the autonomic nervous system. Which of the following pairings is correct for nerve control and secretion?

A. Parasympathetic stimulation favors mucoid secretion.
B. Parasympathetic stimulation favors serous secretion.
C. Direct sympathetic stimulation favors serous secretion.
D. Indirect sympathetic stimulation favors serous secretion.

10. Which of the following represents the physical role of saliva?

A. Cleanses the oral cavity.
B. Dilutes and removes organic acids from dental plaque.
C. Aids in digestion.
D. A and B

11. In humans, major and minor salivary glands secrete approximately what volume of saliva each day?

A. 5 liters
B. 2 liters
C. 1 liters
D. 0.01 liters

12. Which of the following act as pH neutralizing agents in saliva?

A. Sodium bicarbonate, phosphates, and sialin
B. Statherins, phosphates, and calcium
C. Sodium bicarbonate, hydroxyapatite, sialin
D. Hydroxyapatite and fluoride

13. Which of the following is an antibacterial property of saliva?

A. Mucins that trap, aggregate, and clear bacteria.
B. Lysozyme that deprives bacteria of iron.
C. Lactoferrin that activates bacterial clumping.
D. Salivary peroxide that triggers hydrogen peroxides.

14. The increase of which of the following results from an exposure to cariogenic bacteria?

A. Plasma cells
B. Antigens
C. Immunoglobulin
D. Opsonizes

15. Which of the following correctly describes secretory immunoglobin A (sIgA)?

A. sIgA is produced in salivary ducts and primarily inhibits adherence of bacteria.
B. sIgA is produced in gingival fluid and triggers phagocytosis.
C. sIgA is produced only in gingival fluid and inhibits adherence of bacteria.
D. sIgA is made of three molecules of light and heavy chains.

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Additional Resources

- No Additional Resources Available.

About the Authors

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Sue is currently Honorary Emeritus Professor in the School of Dentistry in the Institute of Life Course and Medical Sciences and Honorary Senior Research Fellow in the Institute of Population Health, University of Liverpool, United Kingdom. She has a background in microbiology and biochemistry, a PhD focused on dental plaque metabolism from the University of Liverpool, Chartered Biologist status and a member of the Royal Society of Biology.

Dr. Higham has supervised more than 50 postgraduate students and has published widely with approximately 400 peer-reviewed papers and book chapters. Her main research interests have been in the use of in vitro and in situ models and clinical trials to study dental diseases, together with the development of optical technologies for the quantification of mineral loss/gain in vivo. She has been involved in University teaching at all undergraduate and postgraduate levels since 1983. Dr. Higham was a scientific advisor for the European organization for caries research (ORCA) for many years and was a dentistry panel member for the Research Excellence Framework (REF) in the UK.

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Chris Hope, BSc (Hons), PhD, FHEA

Chris graduated with a degree in Microbiology at the University of Liverpool in 1994 and then went on to study for a PhD in Chemical Engineering at The University of Birmingham. This somewhat unconventional entry into dental research came via biofilm modeling which led to his appointment at the Eastman Dental Institute – University College London as a research fellow between 2000 and 2005.

In 2005, Chris was appointed as Lecturer in Oral Biology at the University of Liverpool where his experience of biofilm modeling complimented the research group themes of caries and plaque-related disease. Chris developed a biological model of dental caries which acquired enamel lesions in less than two weeks and continued his interests in imaging by studying the natural fluorescence of dental plaque and the lethal photosensitization of periodontal pathogens by means of their intrinsic porphyrins.

Chris served two terms on the British Society for Oral and Dental Research (BSODR) Oral Microbiology and Immunology Group (OMIG) management committee and was elected onto the management board of the BSODR in 2017. He has also previously served on the editorial board of the Journal of Medical Microbiology. Chris left academia in 2018.

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Robert Faller has in excess of 40 years in the Oral Care Research field. He retired from P&G after more than 31 years in Oral Care, where he focused on caries and enamel related research as P&G's chief cariologist. He is editor of *Volume 17 – Monographs in Oral Science: Assessment of Oral Health – Diagnostic Techniques and Validation Criteria*. He has written 3 book chapters, published 34 papers in peer-reviewed journals and has over 100 published abstracts on fluoride, caries, dental erosion, and various oral care technologies, along with 5 patents related to Oral Care and 6 Continuing Education courses. He currently resides in the UK and is a consultant to the Oral Care industry.

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