Reading Material for

Dental Hygiene – I

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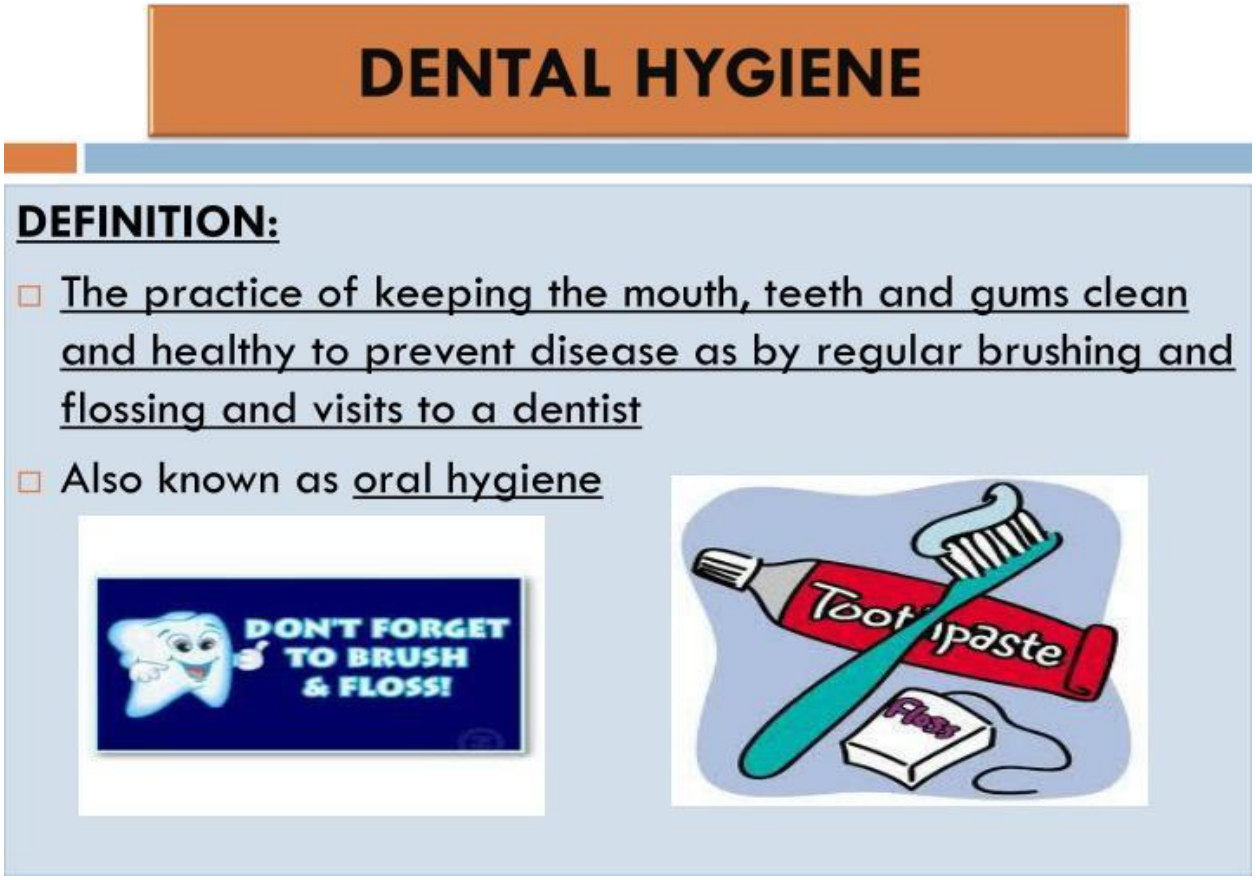
PREFACE

A two year post matric teaching program of Dental Hygiene for the students of Dental Hygienist. The purpose of this reading material is to provide basic education to the paramedics that fall in the domain of Dental hygienists. This reading material attempts to cover the basic theoretical knowledge required by the student about Dental Hygiene and procedures so that they can be performed under supervision in Dental Hospitals and Clinics.

Chapter: 1

Introduction to Dental Hygiene



Certain patients are prone to oral problems due to lack of knowledge. Good oral hygiene includes daily stimulation of gums and brushing of the teeth. There are also some pathological conditions in which good oral hygiene is required for healing and regeneration of oral tissues.

1.1. Dental Hygienist

A Dental hygienist is a “licensed health care professional who works with a dentist to help patients maintain good oral health and dental hygiene.”

As a dental hygienist, goal is to prevent and treat diseases that impact the teeth and gums. It also includes cleaning teeth, examining the teeth and gums, taking X-rays, recording medical histories, and educating patients regarding proper oral care.

Dental hygienist duties

The average dental hygienist's duties will vary from office to office and, occasionally, one state to another. Nonetheless, typical dental hygienist duties include:

- Using the appropriate dental instruments to perform routine cleanings
- Removing plaque, tartar, and stains from a patient's teeth
- Cleaning, sterilizing, and organizing dental instruments
- Reviewing and maintaining a patient's medical history
- Acquiring dental X-rays
- Inspecting the mouth for signs of oral cancer
- Examination the gums for signs of gum disease
- Providing any findings of symptoms of various diseases to the dentists so they can make a diagnosis
- Educating patients on preventative care and good dental hygiene practices
- Assisting the dentists with more complicated procedures, like administering anesthesia or removing stitches

History

First Licensed Dental Hygienist

In 1917, **Irene Newman** became the first licensed dental hygienist, and within the next three years, six more states followed and licensed dental hygienists. The ADHA was then established in 1923 with forty-six members, and the growth of the dental hygienist profession continued. By 1952, all fifty states had licensed dental hygienists.

As the dental hygienist programs broadenedworldwide, the ADHA implemented requirements for program admissions. In 1935, a high school diploma was made mandatory for licensure. By 1940, a two-year course of study was also required to become licensed as a dental hygienist. The ADHA then adopted the “Registered Dental Hygienist” label in 1940. Finally, the first regional board examination was given in 1968.

There has been a rise in registered dental hygienists over the years, but a decline in dentists. In 1950 dentists made up 51% of the dental profession, whereas dental hygienists only accounted for 2%. In 2000, these percentages rose 20% with a fifty-fifty

ratio of dentists to dental hygienists. The population seeking dental treatment annually has also increased over the years. In the 1950's less than one-third of the population was seeking annual dental visits. This number had climbed to over 67% by the early 2000's.

1.2. Medical and Dental History

Taking a history from a patient is a necessary skill for examinations and thereafter as a practicing doctor, no matter which area you specialize in.

Specific questions vary depending on what type of history you are taking but if you follow the general framework given below, you should gain good marks in these stations. In practice you may sometimes need to gather a collateral history from a relative, friend or care taker. This may be with a child or an adult with impaired mental state.

MEDICAL/DENTAL HISTORY FORM

It is important to know details about your medical history as these could affect the success of your dental treatment and how we can provide this treatment safely for you. The information you provide is confidential and will be handled in accordance with our privacy policy which is shown on the reverse of this form.

Title *(eg Mr/Mrs/Ms):* | Last Name:

Date of birth: | First name(s):

Home address: Postcode:

Postal address: Postcode:

Ph (hm): Ph (wk): Mob: Email:

Name of emergency contact person: Their Phone No:

I have confidential medical information that I do not wish to write down. I would prefer to speak to a dentist about this *(please tick box).* ☐

	No	Yes
Do you normally require antibiotic cover before dental treatment?		
Have you had any abnormal reactions to local or general anaesthesia?		
Do you smoke?		
Are you pregnant? *(Females only)*		
Are you being treated by a doctor at present?		
Are you taking any prescription or other medications at present?		
Have you been hospitalised in the last 12 months?		
Have you or anyone in your household returned from overseas travel in the last 10 days?		

List Medications:

Please list current medications:

Who is your medical practitioner? Ph:

Please list any drugs or medicines you are allergic to:

Please list any other known allergies (including latex, foods and preservatives):

DO YOU HAVE NOW, OR HAVE YOU EVER HAD, ANY OF THE FOLLOWING MEDICAL CONDITIONS?
Please tick either yes or no for each condition

	No	Yes		No	Yes		No	Yes
Steroid therapy			Kidney disease			Prosthetic implant eg artificial hip		
Rheumatic fever			Excessive bleeding			Cardiac pacemaker		
Epilepsy			Stroke			Stomach or digestive condition		
Asthma			Cancer			Hepatitis or other liver diseases		
Diabetes			Tuberculosis			Contact with blood-borne viruses		
Heart disorder/complaint			Thyroid disease			Bronchitis, emphysema or other lung diseases		
Bone disease, including osteoporosis			Nervous or psychiatric condition			Anaemia, leukaemia or other blood diseases		
Radiation therapy			High or low blood pressure			Any other conditions		

Any other condition(s) not mentioned *(please list):*

PLEASE LIST ANY CONCERNS OR PROBLEMS THAT YOU HAVE WITH YOUR TEETH OR MOUTH:

I have read and accept the privacy policy on the reverse of this form.

Your / Guardian's signature: Date:

OFFICE USE ONLY Reviewed by: (please print name) Signature: Date:

Figure: Sample Medical/Dental history record form

Chapter: 2

First Aid Training

Objective:

To learn and be able to provide first aid for various emergency situations

First aid is defined as helping behaviors and initial care provided for an acute illness or injury. It can be initiated by anyone in any situation including self-care.

Goal

To recognize when the help is needed and can it be acquired.

Objectives

The objectives of first aid can be encompassed in three short phrases.

- Preserve life
- Prevent further harm
- Promote recovery

They are often referred to as the three “P’s”. These objectives should be demonstrated at all times while you are dealing with a casualty and not just initially.

Priorities of First Aid

The priorities can be remembered by using DR AB(C)

D – is there any danger to you or the casualty?

R – does the casualty respond when you talk to them?

A – is the airway open?

B – can the casualty actually breath? A third letter C is sometimes used to remind the rescuer of the next stage. This refers to circulation and can be interpreted in the following ways. If the casualty is not breathing, C = chest compressions required. If the casualty is breathing, C = is there catastrophic bleeding? To assess the quality of the circulation, C = check pulse

2.1. Managing an accident

At any incident, the first aider will follow a plan of action. This will include assessing the situation and scene, assessing the casualty, getting help, treating the casualty and dealing with the aftermath. The time it takes, and methods used may change according to the circumstances and the severity of the situation, however, this process will always be carried out.

Assess the situation and scene

What has happened? Look for clues to tell you. Do not approach the casualty until you are sure it is safe to do so. You must recognize and manage any dangers to yourself and the casualty at all times. Remember that the danger to you may not be obvious. Think about the immediate space around your casualty. e.g. spillages on deck, broken glass, wood splinters. Think about the danger's peculiar to your own working environment.

Assessing the casualty

The initial assessment of the casualty is called the primary survey. This is the priority in any first aid situation. Does the casualty have an Airway? Is the casualty breathing? What injuries are there? What can the casualty tell you?

Getting Help

Good communication is vital in any first aid incident. When calling for help the information that will be required is: 1) The location of the incident 2) What has happened 3) What kind of help is required 4) How many casualties are there 5) What type of injuries have been sustained.

Treating the casualty

Constantly be aware of danger to you and your casualty. Everything you do must comply with the 3P's. Whilst treating the casualty you must always be aware of their "ABC".

Dealing with the aftermath

Dealing with the aftermath of any first aid situation encompasses two aspects: practical issues and emotional issues.

Practical issues include: 1) Completion of accident reports or log book entries. 2) Restocking the first aid kit and returning it to its storage point. 3) Cleaning up any body fluid spills safely. 4)Participation in any accident investigation. 5) Disposal of contaminated materials

Resuscitation

The initials DR ABC are used to remember the sequence of events.

D is for Danger

A is for Airway

B is for Breathing

C is for Circulation (compressions)

First make sure that you, the casualty and any bystanders are safe. Shout at the casualty as you approach them and see if they respond. They should be told to stay still. If there is no response to shouting, you should kneel by the casualty. Shout again while gently tapping and shaking their shoulders. If there is still no response, turn the casualty onto their back if they are not already in that position. At this point, if you have not already done so, you should shout for help.

Open the Airway

Make sure the casualty has an open airway. Keep one hand on their forehead and gently tilt the head back. Place fingertips under the chin and lift the chin up. This action opens the airway by moving the tongue away from the airway entrance.

Check for Breathing

With your head next to the face of the casualty, keep the chin supported and look, listen and feel for evidence of normal breathing for no longer than 10 seconds.

Can breath be felt on your cheek? Is there chest rise and fall? Can any sounds be heard? In the first few minutes after cardiac arrest, a casualty may be barely breathing, or taking infrequent, noisy, gasps. This is often termed agonal breathing and must not be confused with normal breathing. Agonal gasps are present in up to 40% of cardiac arrest casualties. If breathing is not normal, or if you have any doubts, act as if it is not normal, raise the alarm and ask for help including an AED if there is one available.

Commencement of Compressions

Kneel by the side of the casualty placing the heel of one hand in the center of their chest. Place the heel of the other hand on top of the heel of the first. Interlock fingers and raise them off the chest ensuring no pressure is applied on the ribs. No pressure should be put on the lower end of the breast bone or the upper abdomen.

Position yourself vertically over the casualty, and with arms locked straight, with hand, elbow and shoulder in line, press down on the breast bone to a depth of 5 - 6 cm.

After each compression, release all the pressure on the chest letting it return to its original position, but do not remove hands from the chest. Repeat this at a rate of 100 – 120 compressions per minute. Complete 30 compressions.

Figure: Steps of Chest compressions (CPR)

Deliver Breaths (Ventilations)

After 30 compressions, open the airway using the head tilt chin lift method. Pinch the soft part of the nose using thumb and index finger of one hand. Maintain chin lift with the other hand keeping the mouth open. Take a normal breath and place your lips around the casualty's mouth making sure there is a good seal. Blow steadily in the mouth and watch for the chest to rise as in normal breathing. This takes about 1 second. Take your mouth away and watch for the chest to fall as the air comes out. Repeat this once more. This completes two effective rescue breaths.

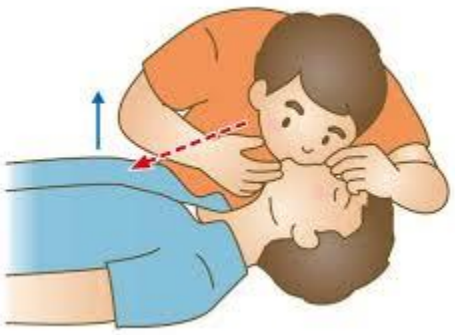


Figure: Mouth to mouth respiration

Continue with CPR

Return to the chest without delay and give 30 more compressions. Continue with a ratio of 30 compressions to 2 breaths. If you are unable to do rescue breaths, give continuous chest compressions only.

If an AED arrives

Switch on the AED

 Attach the electrode pads on the casualty's bare chest

 If more than one rescuer is present, CPR should be continued while electrode pads are being attached to the chest

 Follow the spoken/visual directions

 Ensure that nobody is touching the casualty while the AED is analyzing the rhythm. If a shock is indicated, deliver the shock

 Ensure that nobody is touching the casualty

 Push shock button as directed (fully automatic AEDs will deliver the shock automatically)

 Immediately restart CPR at a ratio of 30:2

 Continue as directed by the voice/visual prompts. If no shock is indicated, continue CPR immediately and continue as directed by the voice prompts

Figure: AED application

When to stop CPR?

Do not interrupt resuscitation until:

 You are told to stop by a health professional (or the master)

 You become exhausted

 You are in danger

 The casualty is definitely waking up, moving, opening eyes and breathing normally. It is rare for CPR alone to restart the heart. Unless you are certain the person has recovered, continue CPR. If you are certain that the casualty is breathing normally but is still unresponsive, place them in the recovery position

2.2.<u>DROWNING</u>

Where a casualty has been rescued from drowning, they have not been breathing and do not have oxygen in their blood to be circulated. In drowning incidents, after discovering the casualty is not breathing, give 5 rescue breaths and then continue with compressions and ventilations at a ratio of 30:2. If you are on your own, perform CPR for 1 min before going for help.

2.15. Recovery position

There are several variations of the recovery position, each with its own advantages. No single position is perfect for all casualties. The position should be stable, near a true lateral position with the head dependent, and with no pressure on the chest to impair breathing.

Remove the casualty's spectacles
 Kneel beside the casualty and make sure that both his legs are straight
Place the arm nearest to you out at right angles to his body, elbow bent with the hand palm uppermost
 Bring the far arm across the chest, and hold the back of the hand against the casualty's cheek nearest to you
 With your other hand, grasp the far leg just above the knee and pull it up, keeping the foot on the ground
Keeping his hand pressed against his cheek, pull on the far leg to roll the casualty towards you onto his side
 Adjust the upper leg so that both the hip and knee are bent at right angles
 Tilt the head back to make sure the airway remains open
 If necessary, adjust the hand under the cheek, to keep the head tilted and facing downwards to allow liquid material to drain from the mouth

 Check breathing regularly
 Be prepared to start CPR immediately if the casualty stops breathing

Figure: Recovery position after drowning rescue

2.2. EXTERNAL BLEEDING

Types of Bleeding

 Arterial bleeding is bright red and spurting

 Venous bleeding is dark red and flows, gushes or pools

 Capillary bleeding oozes

The type of bleeding will dictate the severity of the injury and the speed with which it needs to be controlled.

Signs and Symptoms

 Visible bleeding Evidence of injury Signs of shock

Management

The standard method for first aiders to control open bleeding is to APPLY DIRECT PRESSURE to the bleeding site.

The pressure needed for an arterial bleed should never be underestimated. Bandaging alone does not provide sufficient pressure.

There is no evidence to support the use of elevation of an extremity, or the use of pressure points to control bleeding.

 Identify wound location and type of bleeding

 Do not remove penetrating objects

 Wear gloves before blood contact if possible but do not delay

 Apply direct pressure to wound or to base of penetrating object

 Apply appropriate wound dressings and continue direct pressure

 Monitor dressing and circulation beyond injury

A tourniquet may be used in initial care when direct pressure is not possible during a mass casualty situation or in an unsafe environment. The first aider should be trained in their use.

2.3.HOT BURNS

Causes

 Dry heat

 Wet heat

 Electrical

 Chemical

 Radiation

 Friction

Severity

This is defined as the depth in relation to the area of burn. The complexity of a burn is affected by where it occurs on the body.

Depth

 Superficial red, tender, no blisters

 Partial red, tender, blisters

 Deep all layers, appearance varies (eg white, charred)

Area

The palm of the casualty is considered to be approximately 1% of their body surface. Its size can be used as a template to measure the total body area burnt.

Management

 Remove from source of heat

 Cool for at least 20 - 30 minutes

 Remove constrictions

 Cover with non-fluffy dressing

Special Considerations

 Do not remove burnt on clothing this may further damage tissue

 Monitor airway as it can swell quickly and stop breathing

 Rinse with cold water for mouth burns

2.4. SHOCK

Definition

Shock is reduction of the vital activities of the body caused by injury or illness. It is a physical condition and should not be confused with emotional shock. Its speed of onset will vary and may not depend on the severity of the injury. It may result in unconsciousness and death if not managed immediately.

Causes

Shock may happen as a result of:

 Pain

 Injury

 Allergy

 Infection

 Fluid loss e.g. bleeding, diarrhea, vomit, burns

 Medical conditions e.g. heart attack

Signs and Symptoms

These result from the effect of reduced blood supply to vital organs and the body's own efforts to compensate.

 Pale color

 Cold and clammy skin

 Profuse sweating

 Feel cold

 Feel faint or dizzy

 Anxiety or confusion

 Feel thirsty

 Nausea

 Pulse maybe weak and may be irregular

 Breathing rapid and shallow

 May be evidence of injury

Management

 Maintain airway

 Deal with the cause

 Lay down if injuries allow

 Elevate legs if injuries allow

 Loosen tight clothes

 Reassure

 Do not allow to drink or eat: they may vomit and their airway is at risk.

 Moisten lips only

 No smoking or alcohol

 Do not move unless absolutely vital

 Protect from the elements

 Cover with blanket

Chapter: 3

ASEPTIC TECHNIQUES

Objective:

To develop concepts regarding Sterilization, disinfection and how to achieve an aseptic environment.

Terminology

Different terms are used to describe various means of preventing infection. However, despite their differing definitions, terms such as disinfection and sterilization are often used interchangeably state. Medical asepsis is the attempt to keep patients, health care staff, and objects as free as possible of agents that cause infection.

- Antiseptic and disinfectant are terms that are often misused. Both refer to substances that can prevent the multiplication of organisms capable of causing infection.
- The difference is that antiseptics are applied to living tissue, whereas disinfectants are designed only for use on in animate objects.
- Sterility is the freedom from viable forms of microorganisms.
- Sterility represents an absolute state; there are no degrees of sterility.
- Sanitization is the reduction of the number of viable microorganisms to levels judged safe by public health standards. Sanitization should not be confused with sterilization.
- Decontamination is similar to sanitization, except that it is not connected with public health standards.

Types of infections and pathogens:

Infectious diseases are “illnesses caused by harmful organisms (pathogens) that penetrate into the body from the outer environment.”

Pathogens that cause infectious diseases are viruses, bacteria, fungi, parasites and, rarely, prions. One can get infectious diseases from other people, bug bites and contaminated food, water or soil etc.

Different terms are used to describe various means of preventing infection. However, despite their differing definitions, terms such as disinfection and sterilization are often used interchangeably. This can lead to the misconception that a certain technique or chemical has sterilized an object, when it has merely reduced the level of contamination. Therefore, the dental team must be aware of the precise definition of words used for the various techniques of asepsis. Sepsis is the breakdown of living tissue by the action of microorganisms and is usually accompanied by inflammation.

Thus, the mere presence of microorganisms, as in bacteremia, does not constitute a-septic state. Medical asepsis is the attempt to keep patients, health care staff, and objects as free as possible of agents that cause infection.

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Concepts:

Chemical and physical agents are the two-principal means of reducing the number of microbes on a surface.

Antiseptics, disinfectants, and ethylene oxide gas are the major chemical means of killing microorganisms on surfaces.

Heat, irradiation, and mechanical dislodgment are the primary physical means of eliminating viable organisms.

The microbes that cause human disease include bacteria, viruses, mycobacteria, parasites, and fungi. The microbes within these groups have variable ability to resist chemical or physical agents. The microorganisms most resistant to elimination are bacterial endospores. Therefore, in general, any method of sterilization or disinfection that kills endospores is also capable of eliminating bacteria, viruses, mycobacteria, fungi, mold, and parasites. This concept is used in monitoring the success of disinfection and sterilization techniques.

3.1. Sterilization and Disinfection

Sterilization:

Sterilization is defined as “a process of complete elimination or destruction of all forms of microbial life (both vegetative and spore forms)”.

Disinfection:

Disinfection is defined as “a process of complete elimination of vegetative forms of microorganisms except the bacterial spores from inanimate objects.”

3.2 Sterilization:

Techniques of Instrument Sterilization:

Any means of instrument sterilization to be used in office-based dental care must be reliable, practical, and safe for the instruments.

The three methods generally available for instrument sterilization are dry heat, moist heat, and ethylene oxide gas.

Heat is one of the oldest means of destroying microorganisms. Pasteur used heat to reduce the number of pathogens in liquids for preservation. Koch was the first to use heat for sterilization. He found that $1^{1/2}$ hours of dry heat at 100°C would destroy all vegetative bacteria, however, 3 hours of dry heat at 140°C was necessary to eliminate the spores of anthrax bacilli. Koch then tested moist heat and found it a more efficient means of heat sterilization because it reduces the temperature and time necessary to kill spores.

Moist heat is probably more effective because dry heat oxidizes cell proteins, a process requiring extremely high temperatures, whereas moist heat causes destructive protein coagulation quickly at relatively low temperatures.

As the spores are the most resistant forms of microbial life, they are used to monitor sterilization techniques. The spore of the bacterium Bacillus stearothermophilus is extremely resistant to heat and is, therefore, used to test the reliability of heat sterilization. These bacilli can be purchased by hospitals, dental schools and private offices, andrun through the sterilizer with the instruments being sterilized. A laboratory then places the heat-treated spores into culture. If no growth occurs, the sterilization procedure is considered successful. It has been shown that 6 months after sterilization, the possibility of organisms entering sterilization bags increases, although some individuals think that an even longer period is acceptable as long as the bags are properly handled. Therefore, all sterilized items should be labeled with an expiration date that is no longer than 6 to 12months in the future. A useful alternative technique for sterilely storing surgical instruments is to place them into cassettes that are double wrapped in specifically designed paper and sterilized as a set for use on a single patient.

Dry heat:

Dry heat is a method of sterilization that can be provided in most dental offices because the necessary equipment is no more complicated than a thermostatically controlled oven and a timer. Dry heat is most commonly used to sterilize glassware and bulky

items that can withstand heat but are susceptible to rust. The success of sterilization depends not only on attaining a certain temperature but also on maintaining the temperature for a sufficient time. Therefore, the following three factors must be considered when using dry heat:

(1) Warmup time for the oven and the materials tobe sterilized

(2) Heat conductivity of the materials, and

(3) An air flow throughout the oven and through the objects being sterilized.

In addition, time for the sterilized equipment to cool after heating must be taken into consideration. The time necessary for dry-heat sterilization limits its practicality in the ambulatory setting because it lengthens the turnover time and forces the dentist to have several duplicate instruments.

The advantages of dry heat are the relative ease of use and the unlikelihood of damaging heat-resistant instruments.

The disadvantages are the necessary time and the potential damage to heat sensitive equipment.

Moist heat

Moist heat sterilization is more efficient than dry heat sterilization because it is effective at much lower temperatures and requires lesser time. The reason for this is based on several physical principles. First, water boiling at 100°C takes lesser time to kill organisms than does dry heat at the same temperature because water is better than air at transferring heat. Second, it takes approximately seven times as much heat to convert boiling water to steam as it takes to cause the same amount of room temperature water to boil. When steam comes into contact with an object, the steam condenses and almost instantly releases that stored heat energy, which quickly denatures vital cell proteins. Saturated steam placed under pressure (autoclaving) is even more efficient than non-pressurized steam. This is because increasing pressure in a container of steam increases the boiling point of water so that the new steam entering closed container gradually becomes hotter. Temperatures attainable by steam under pressure include 109°C at 5 psi, 115°C at 10 psi, 121°C at 15 psi, and 126°C at 20 psi. The container usually used for providing steam under pressure is known as an autoclave. The autoclave works by creating steam and then, through a series of valves, increases the pressure so that the steam becomes super-heated. Instruments placed into an auto clave should be packaged to allow the free flow of steam around the instruments, such as by placing them in sterilization pouches or wrapping them in cotton cloth. Simply placing instruments in boiling water or free-flowing steam results in disinfection rather than sterilization because at the temperature of 100°C, many spores and certain viruses survive.

The advantages of sterilization with moist heat are its effectiveness, speed, and the relative availability of office-proportioned autoclaving equipment.

Disadvantages include the tendency of moist heat to dull and rust instruments, and the cost of autoclaves.

Sterilization with Gas

Certain gases exert a lethal action on bacteria by destroying enzymes and other vital biochemical structures. Among the several gases available for sterilization, ethylene oxide is the most commonly used. Ethylene oxide is a highly flammable gas, so it is mixed with carbon dioxide or nitrogen to make it safer to use. Ethylene oxide is a gas at room temperature, and can readily diffuse through porous materials, such as plastic and rubber. At 50°C, ethylene oxide is effective for killing all organisms, including spores, within 3 hours. However, because it is highly toxic to animal tissues, equipment exposed to ethylene oxide must be aerated for 8 to 12 hours at 50°C to 60°C, or at ambient temperatures for 4 to 7 days.

The advantages of ethylene oxide for sterilization are its effectiveness for sterilizing porous materials, large equipment, and materials sensitive to heat or moisture.

The disadvantages are the need for special equipment, and the length of sterilization and aeration time necessary to reduce tissue toxicity. This technique is rarely practical for dental use; unless the dentist has easy access to a large facility willing to gas sterilize dental equipment (e.g., hospital or ambulatory surgery center).

3.3 Disinfection

Techniques of Instrument Disinfection

Several of the dental instruments cannot with stand the temperatures required for heat sterilization. Therefore, if sterilization with gas is not available and absolute sterility is not required, chemical disinfection can be performed.

Chemical agents with potential disinfectant capabilities have been classified as being high, intermediate, or low in biocidal activity.

The classification is based on the ability of the agent to inactivate vegetative bacteria, tubercle bacilli, bacterial spores, non-lipid viruses, and lipid viruses. Agents with low biocidal activity are effective only against vegetative bacteria and lipid viruses, intermediate disinfectants are effective against all microbes except bacterial spores, and agents with high activity are biocidal for all microbes.

- Substances acceptable for disinfecting dental instruments include glutaraldehyde, iodophors, chlorine compounds, and formaldehyde. Among them, glutaraldehyde containing compounds are the most commonly used.
- Alcohols are not suitable for general dental disinfection because they evaporate too rapidly; however, they can be used to disinfect local anesthetic cartridges.

- Quaternary ammonium compounds are not recommended for dentistry because they are not effective against the hepatitis B virus and become inactivated by soap and anionic agents.

Certain procedures must be followed to ensure maximal disinfection, regardless of which disinfectant solution is used. The agent must be properly reformulated and discarded periodically, as specified by the manufacturer. Instruments must remain in contact with the solution for the designated period, and no new contaminated instruments should be added to the solution during that time. All instruments must be washed free of blood or other visible material before being placed in the solution. Finally, after disinfection the instruments must be rinsed free of chemicals and used within a short time.

PPE (Personal Protective Equipment)

"PPE", is equipment worn to minimize exposure to hazards that cause serious workplace injuries and illnesses.

These injuries and illnesses may result from contact with chemical, radiological, physical, electrical, mechanical, or other workplace hazards.

Personal protective equipment may include items such as

- Disposable Gloves
- Face mask
- Safety glasses
- Disposable gowns
- Disposable head covers

3.8. Immunizations

Immunization is “the process whereby a person is made resistant to a disease, typically by the administration of a vaccine.” Vaccines stimulate the body's own immune system to protect the person against subsequent infection or disease.
Infection prevention programs should also address occupational health needs, including vaccination of Dental Healthcare professionals (DHCP, management of exposures or infections in personnel requiring post-exposure prophylaxis or work restrictions, and compliance with OSHA blood borne pathogens standard.

1. Current CDC recommendations for immunizations, evaluation, and follow-up are available. There is a written policy regarding immunizing DHCP, including a list of all required and recommended immunizations for DHCP (e.g., hepatitis B, MMR (measles, mumps, and rubella) varicella (chickenpox), tetanus, diphtheria, pertussis (Tdap)

2. All DHCP are screened for tuberculosis (TB) upon hiring regardless of the risk classification of the setting.
3. Referral arrangements are in place to qualified health care professionals (e.g., occupational health program of a hospital, educational institutions, health care facilities that offer personnel health services) to ensure prompt and appropriate provision of preventive services, occupationally-related medical services, and post-exposure management with medical follow-up.
4. Facility has well-defined policies concerning contact of personnel with patients when personnel have potentially transmissible conditions.

3.9 Infection control Methods

Health Professionals

FDI urges all dentists and members of the dental team:

- To be physically protected (surgical respirators, masks, gloves, visors/face shields, protective eye wear and outerwear) as appropriate for the care being provided and the level of risk;

- To be knowledgeable about, and protected from, health problems occurring from the use of enhanced personal protective equipment
- To be appropriately vaccinated against infectious diseases as a priority, according to current guidelines issued by the relevant authorities
- Immediately initiate appropriate assessment to determine the need for post-exposure testing and prophylaxis following occupational exposure to blood-borne pathogens, including HBV, HCV and HIV.
- To be personally aware of signs and symptoms that indicate the possibility of blood-borne and other infectious diseases, and receive the necessary diagnostic tests when infection is suspected. FDI opposes any legislation that mandates universal screening of oral health professionals for blood-borne and other pathogens;
- To comply with medical advice and relevant regulations regarding continuation of, or limitations to, clinical practice, in particular that of exposure prone procedures if a blood-borne viral infection is diagnosed.

Patient

FDI believes that it is essential that all patients with communicable infections disclose their status to their dentist as part of the medical history to ensure safe and effective oral health care is provided. All patients should have access to oral health care regardless of their blood-borne or other infectious disease status.

FDI urges all dentists and members of the dental team:

- To be alert and triage/screen for signs and symptoms of blood-borne and other infectious diseases in their patients
- To advise all patients with a relevant medical history of the need for referral to the most appropriate health care provider commensurate with their disease status or condition suggestive of infection. Patients should receive appropriate evaluation and treatment in a supportive environment with full regard to privacy
- To have an appropriate protocol, in accordance with applicable relevant laws, for the confidential handling and sharing of patient information
- To inform patients of the applicable privacy policy in all settings where dental care is delivered
- To share information pertaining to the patient's medical condition with other health workers as permitted by relevant regulations and with the patient's consent
- To educate patients regarding various aspects of blood-borne and other infectious diseases in the context of the management of oral diseases.

Care of Instruments

Instruments must be properly taken care of if they are to function as they were intended, for as long as they were intended. A safe and efficient cleaning process will protect the investment you've made in high-quality dental instruments.

Chapter: 4

Regional Anatomy

Objective:

To learn the basic structure and functions of Oral Cavity and Temporomandibular joint

"The study of anatomy is based on regions or divisions of the body and emphasizing the relations between various structures (muscles and nerves and arteries etc.) in that region."

4.1. Systems of the body

This is a list of the main organ systems in the human body.

i. Cardiovascular system (heart, veins, arteries)
ii. Digestive system/excretory system
iii. Endocrine system (dealing with hormones)
iv. Integumentary system (skin, hairs, nails)
v. Immune system/ lymphatic system
vi. Muscular system
vii. Nervous system
viii. Urinary system
ix. Skeletal system
x. Reproductive system
xi. Respiratory system

4.2. Oral Cavity

The oral cavity, better known as the mouth, is the start of the alimentary canal. It has three major functions:

- **Digestion** – receives food, preparing it for digestion in the stomach and small intestine.
- **Communication** – modifies the sound produced in the larynx to create a range of sounds.
- **Breathing** – acts as an air inlet in addition to the nasal cavity.

Divisions of the Oral Cavity

The oral cavity spans between the oral fissure (anteriorly – the opening between the lips), and the oropharyngeal isthmus (posteriorly – the opening of the oropharynx).

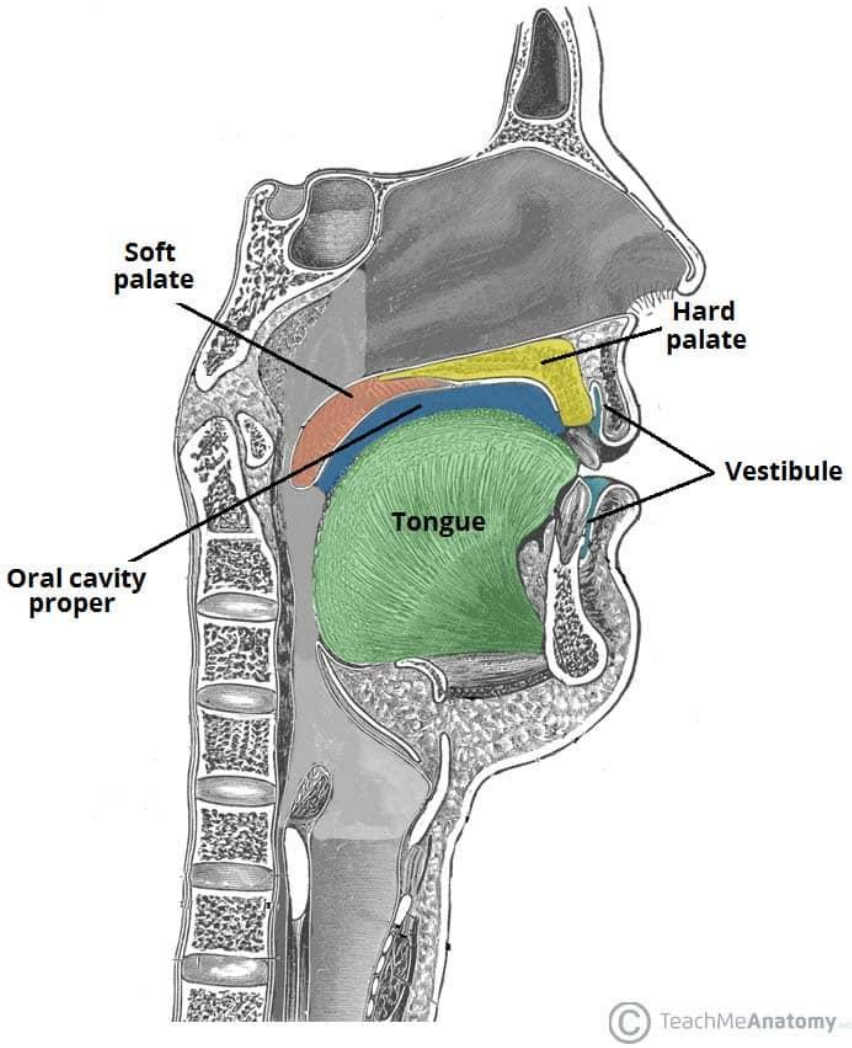
It is divided into two parts by the upper and lower dental arches (formed by the teeth and their bony scaffolding). The two divisions of the oral cavity are the vestibule and the mouth cavity proper.

Vestibule

The horseshoe-shaped vestibule is situated anteriorly. It is the space between the lips/cheeks, and the gums/teeth.

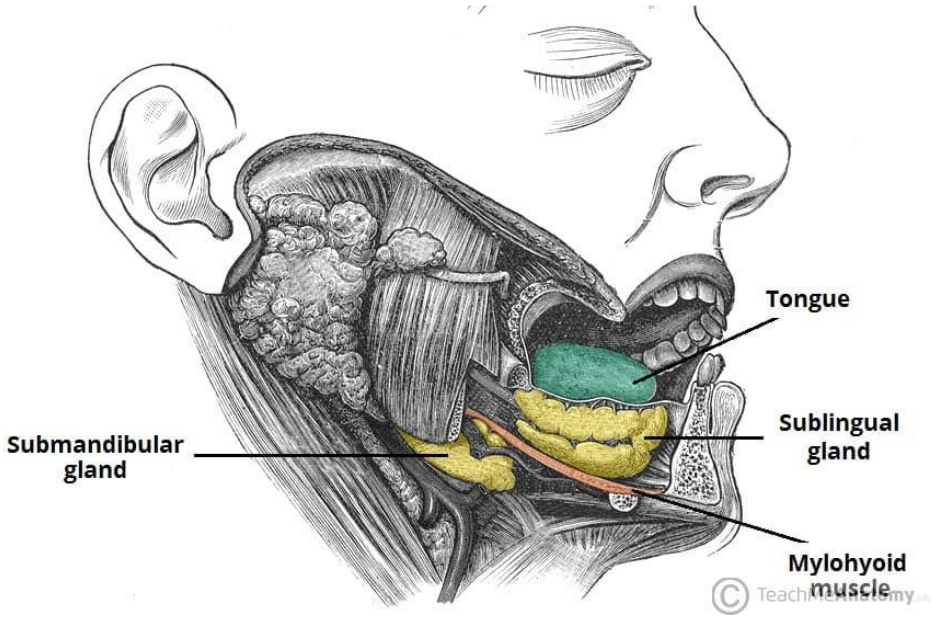
The vestibule communicates with the mouth proper via the space behind the third molar tooth, and with the exterior through the oral fissure. The diameter of the oral fissure is controlled by the muscles of facial expression – principally the orbicularis oris.

Opposite to the upper second molar tooth, the duct of the parotid gland opens out into the vestibule, secreting salivatory juices.



Mouth Proper

The mouth proper lies posteriorly to the vestibule. It is bordered by a roof, a floor, and the cheeks. The tongue fills a large proportion of the cavity of the mouth proper.



Roof

The roof of the mouth proper consists of the hard and soft palates.

The hard palate is found anteriorly. It is a bony plate that separates the nasal cavity from the oral cavity. It is covered superiorly by respiratory mucosa (ciliated pseudo stratified columnar epithelium) and inferiorly by oral mucosa (stratified squamous epithelium).

The soft palate is a posterior continuation of the hard palate. In contrast to the hard palate, it is a muscular structure. It acts as a valve that can lower to close the oropharyngeal isthmus, and elevate to separate the nasopharynx from the oropharynx.

Cheeks

The cheeks are formed by the buccinator muscle, which is lined internally by the oral mucous membrane.

The buccinator muscle contracts to keep food between the teeth when chewing, and is innervated by the buccal branches of the facial nerve (CN VII).

Floor

The floor of the oral cavity consists of several structures:

Muscular diaphragm – comprised of the bilateral mylohyoid muscles. It provides structural support to the floor of the mouth, and pulls the larynx forward during swallowing.

Geniohyoid muscles – pull the larynx forward during swallowing.

Tongue – connected to the floor by the frenulum of the tongue, a fold of oral mucosa, Salivary glands and ducts.

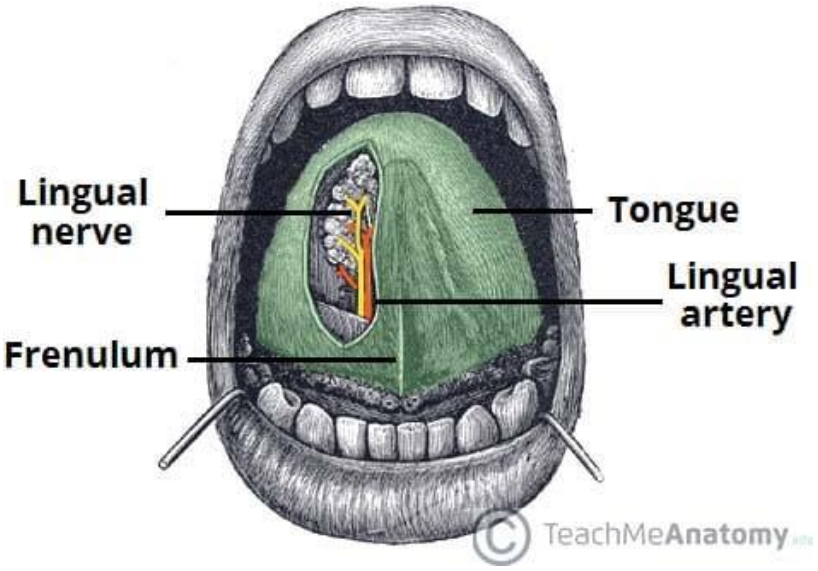
Innervation

Sensory innervation of the oral cavity is supplied by the branches of the **trigeminal nerve** (CN V).

The hard palate is innervated by the **greater palatine** and **nasopalatine nerves**, both of which are branches of the maxillary nerve (CN V2). The soft palate is innervated by **lesser palatine** nerve, another branch of the maxillary nerve.

The floor of the oral cavity receives sensory innervation from the **lingual nerve** – a branch of the mandibular (V3) division of the trigeminal nerve. The tongue is also innervated by special sensory fibers for taste from the **chorda tympani**, a branch of the facial nerve (CN VII).

The cheeks are innervated by the **buccal nerve**. It is also a branch of the mandibular division of the trigeminal nerve *(not to be confused with the buccal branches of the facial nerve).*



Lymphatic drainage of the oral cavity

The lymphatic drainage of the oral cavity is divided firstly into regional nodes and then into deep cervical nodes. For clarity, it should be noted that only the nodes that directly drain the anatomical structures of the oral cavity will be mentioned and are named after the area they drain.

Regional lymph nodes

The regional nodes are as follows:

- The parotid nodes are located upon the parotid gland and drain it
- The buccal nodes are located on the cheek over the buccinator muscle and siphon off the lymph that is collecting in the submandibular nodes. The submandibular nodes located on the lateral wall of the submandibular gland and drain the cheek, the upper lip, the lower lip, the maxillary sinus, the upper and lower teeth, the anterior two thirds of the tongue, the floor of the mouth, the vestibule and the gums. The submental nodes are found in the submental triangle below the chin and drain the tip of the tongue, the floor of the anterior part of the mouth, the incisors, the central part of the lower lip and the skin of the chin. The superficial cervical nodes lie on the external jugular vein and drain the skin over the angle of the jaw and the skin covering the lower portion of the parotid gland.

Deep cervical lymph nodes

The deep cervical nodes are as follows:

- The jugulo-digastric node sits postero-inferiorly to the jaw and drains the tonsils and the tongue
- The jugulo-omohyoid node is found close to the omohyoid muscle and drains the tongue.

Salivary Glands

Salivary glands produce saliva and empty it into your mouth through ducts, or small openings. They lubricate the mouth and throat, aid in swallowing and digestion and help shield your teeth from cavity-causing bacteria.

There are three major pairs of salivary glands including :

Sublingual glands: These are below either side of your tongue, under the floor of your mouth.

Submandibular glands: Located below the jaw; the submandibular salivary glands consist of two parts: the superficial lobe and the deep lobe. Like the sublingual glands, the saliva is produced in the submandibular glands enter the mouth from under the tongue.

Parotid Glands: The parotid glands are just in front of your ears. Parotid glands also have 2 parts; superficial and deep. The saliva produced by parotid glands enter the mouth from a small duct near upper molar.

Role of Salivary Glands:

- Cleaning effect via washing away food debris.
- Makes swallowing food easier.
- Antibacterial effect of fighting off bacteria entering the mouth.
- Lubricating effect that protects mucous membranes.
- pH buffering effect that prevents caries.
- Effect of promoting re-mineralization of teeth.

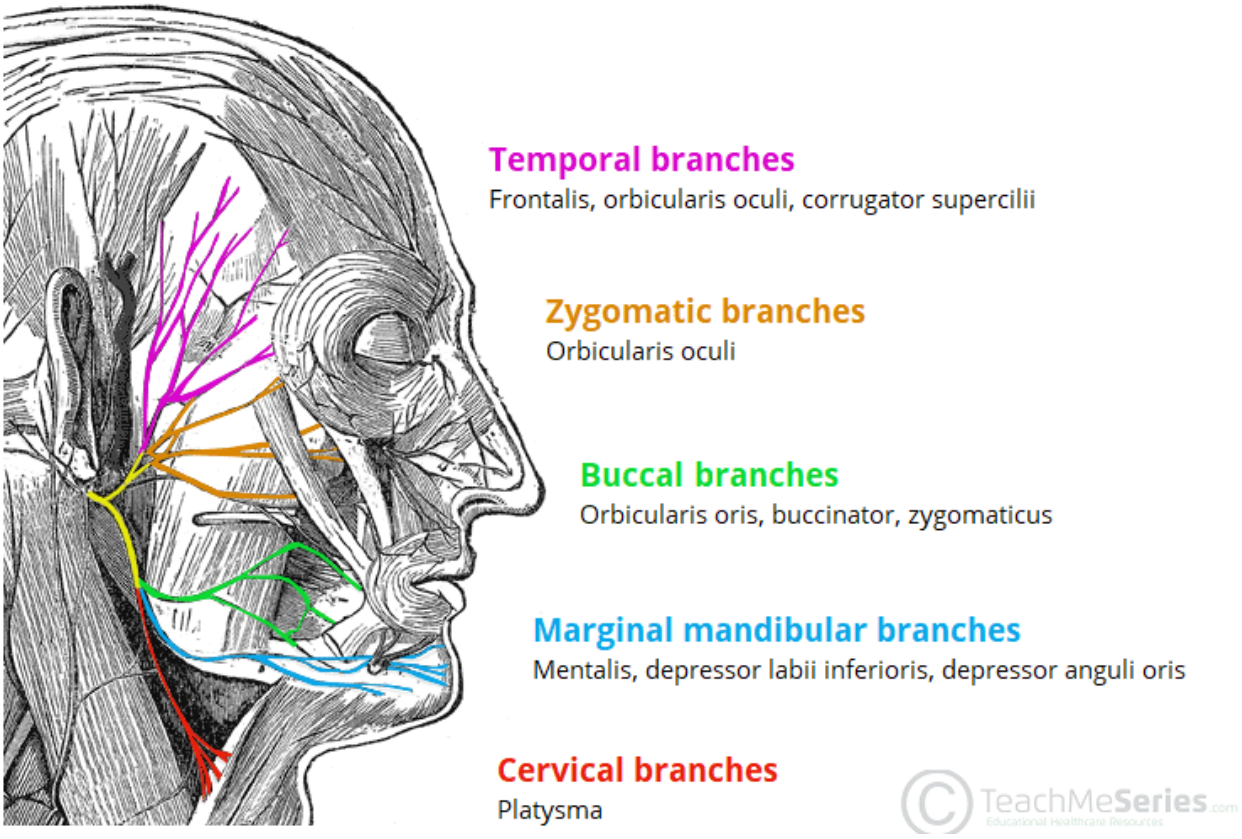
Muscles of face

The **muscles of facial expression** are located within the subcutaneous tissue of the face. They originate from bone or fascia and insert onto the skin. As they contract, the muscles pull on the skin to exert their effects.

These muscles develop from the second pharyngeal arch. As they migrate from the arch, they take their nerve supply with them. As such, they are all innervated by branches of the **facial nerve**.

The facial muscles can broadly be categorized into **three groups**

1. Orbital
2. Nasal
3. Oral.



Orbital Group

Comprises of two muscles that are associated with the eye socket. These muscles control the movements of the eyelids, important in protecting the cornea from damage. They are both innervated by the facial nerve.

Nasal Group

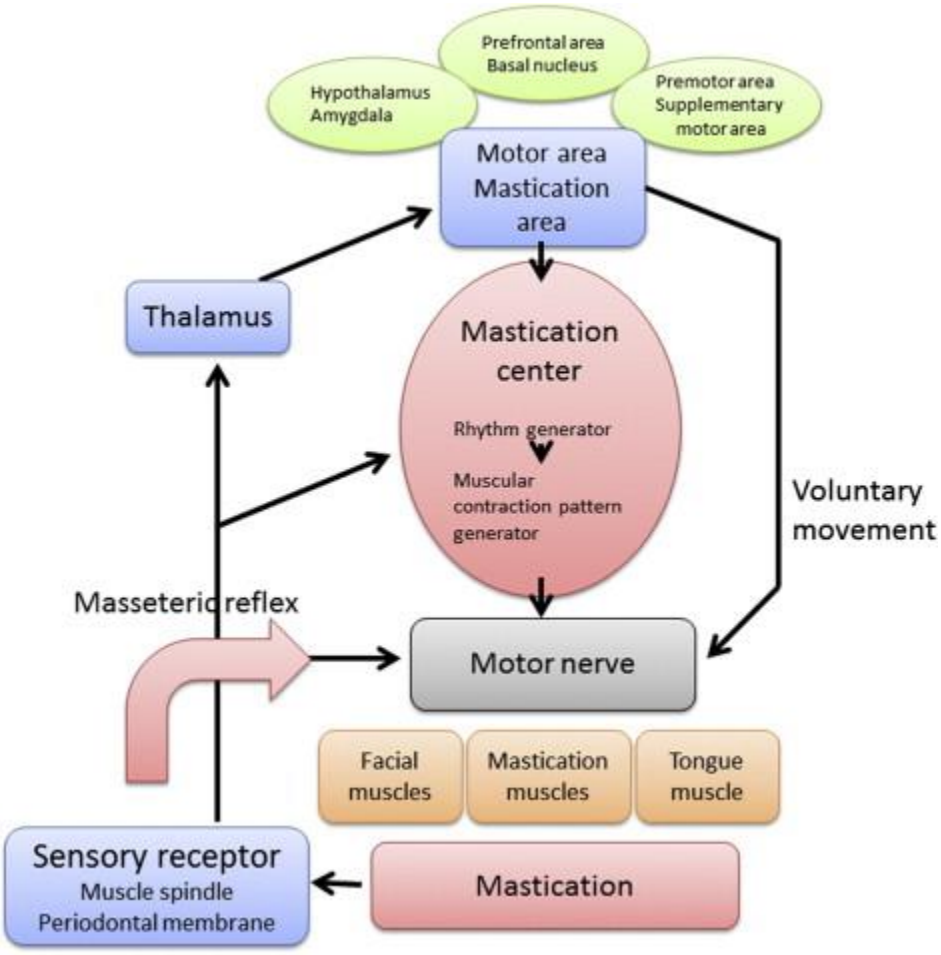
These are associated with movements of the nose and the skin surrounding it.

Oral Group

These are responsible for the movements of the mouth and lips. They are required in singing and whistling and add emphasis to vocal communication

Mastication

Mastication (chewing), in which food is crushed and mixed with saliva to form a bolus for swallowing, is a complex mechanism involving opening and closing of the jaw, secretion of saliva, and mixing of food with the tongue.



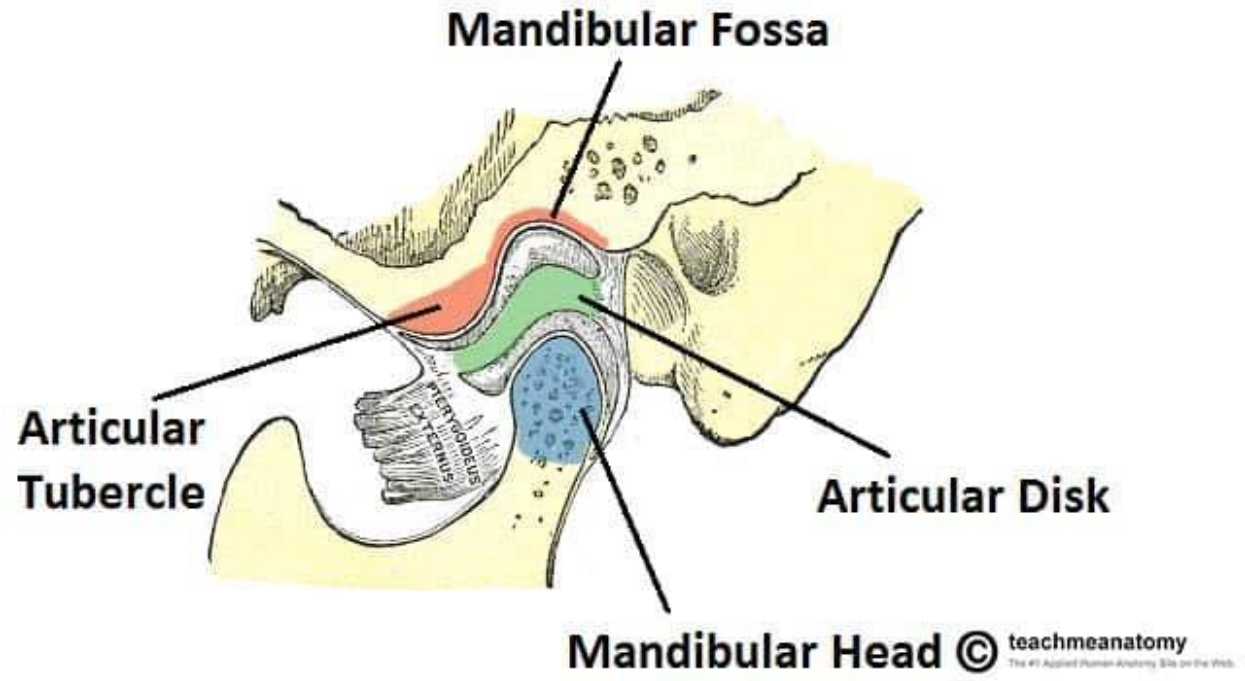
4.3 Temporomandibular Joint (TMJ)

The **temporomandibular joint** (TMJ) is formed by the articulation of the mandible and the temporal bone of the cranium. It is located anteriorly to the tragus of the ear, on the lateral aspect of the face.

Articulating Surfaces

The temporomandibular joint consists of articulations between three surfaces; the mandibular fossa and articular tubercle (from the squamous part of the temporal bone), and the head of mandible.

This joint has a unique mechanism; the articular surfaces of the bones never come into contact with each other – they are separated by an articular disk. The presence of such a disk splits the joint into two synovial joint cavities, each lined by a synovial membrane. The articular surface of the bones is covered by fibrocartilage, not hyaline cartilage.



Ligaments

There are three **extra capsular** ligaments. They act to stabilize the temporomandibular joint.

- **Lateral ligament** – runs from the beginning of the articular tubule to the mandibular neck. It is a thickening of the joint capsule, and acts to prevent posterior dislocation of the joint.

- **Sphenomandibular ligament** – originates from the sphenoid spine, and attaches to the mandible.

- **Stylomandibular ligament** – a thickening of the fascia of the parotid gland. Along with the facial muscles, it supports the weight of the jaw.

Movements

Movements at this joint are produced by the muscles of mastication, and the hyoid muscles. The two divisions of the temporomandibular joint have different functions.

i) Protrusion and Retraction
ii) Elevation and Depression

4.4. Facial Skeleton

The **facial skeleton** (also known as the viscerocranium) supports the soft tissues of the face.

It consists of 14 bones, which fuse to house the orbits of the eyes, the nasal and oral cavities, and the sinuses. The frontal bone, typically a bone of the calvaria, is sometimes included as part of the facial skeleton.

The facial bones are:

- **Zygomatic (2)** – forms the cheek bones of the face and articulates with the frontal, sphenoid, temporal and maxilla bones.

- **Lacrimal (2)** – the smallest bones of the face. They form part of the medial wall of the orbit.

- **Nasal (2)** – two slender bones that are located at the bridge of the nose.

- **Inferior nasal conchae (2)** – located within the nasal cavity, these bones increase the surface area of the nasal cavity, thus increasing the amount of inspired air that can come into contact with the cavity walls.

- **Palatine (2)** – situated at the rear of oral cavity and forms part of the hard palate.

- **Maxilla (2)** – comprises part of the upper jaw and hard palate.

- **Vomer** – forms the posterior aspect of the nasal septum.

- **Mandible (jaw)** – articulates with the base of the cranium at the temporomandibular joint (TMJ).

CHAPTER: 5

Dental Anatomy and Histology

Objective:

To learn how a tooth develops, types of dentition and how a tooth erupts

5.1. Types of Dentition

Deciduous teeth

These are the first teeth to erupt into the oral cavity. The primary dentition is comprises of 20 teeth. Often these teeth are referred to as deciduous teeth. These teeth will be exfoliated (lost) as the permanent teeth erupt. In each arch of the mouth, there are two central incisors, two lateral incisors, two canines, and four molars.

They start to erupt around 6 months of age and are usually all through when at around 29 months of age. This may vary, as everyone is different. Deciduous teeth do have roots, but the roots get resorbed by the underlying permanent teeth. This happens so the deciduous teeth become loose and start falling out.

5.2. Permanent teeth

The permanent dentition is comprises of 32 teeth. There are 16 teeth in the maxilla and 16 in the mandible. In each arch there are two central incisors, two lateral incisors, two canines, four premolars, and six molars. The permanent central incisors, lateral incisors, canines, and first and second premolars replace the primary dentition. The primary molars are replaced with the permanent premolars, and the permanent molars erupt posterior to those.

Eruption Times

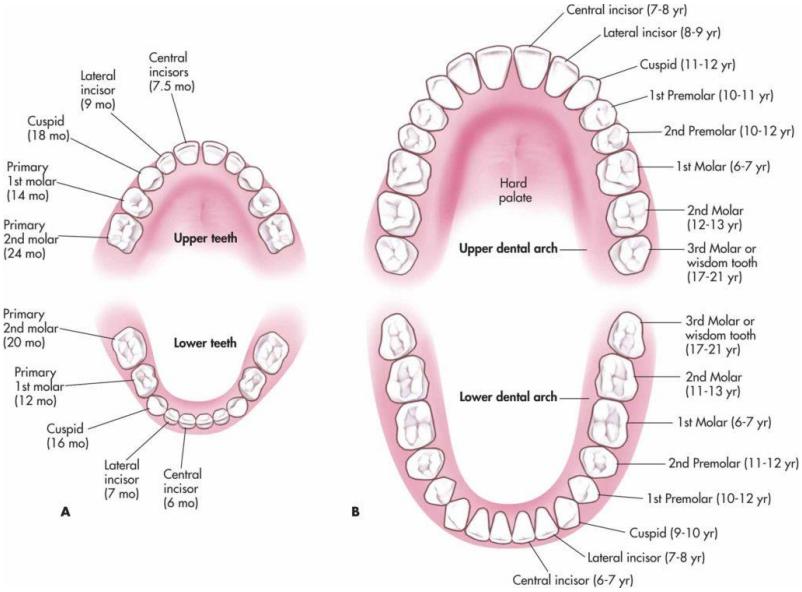


Figure: Eruption times of teeth

5.3. Tooth formation

The first stage begins in the fetus at about 6 weeks of age. This is when the basic substance of the tooth forms. Next, the hard tissue that surrounds the teeth is formed around 3 to 4 months of gestation. After the child is born, the next stage occurs when the tooth actually protrudes through the gum.

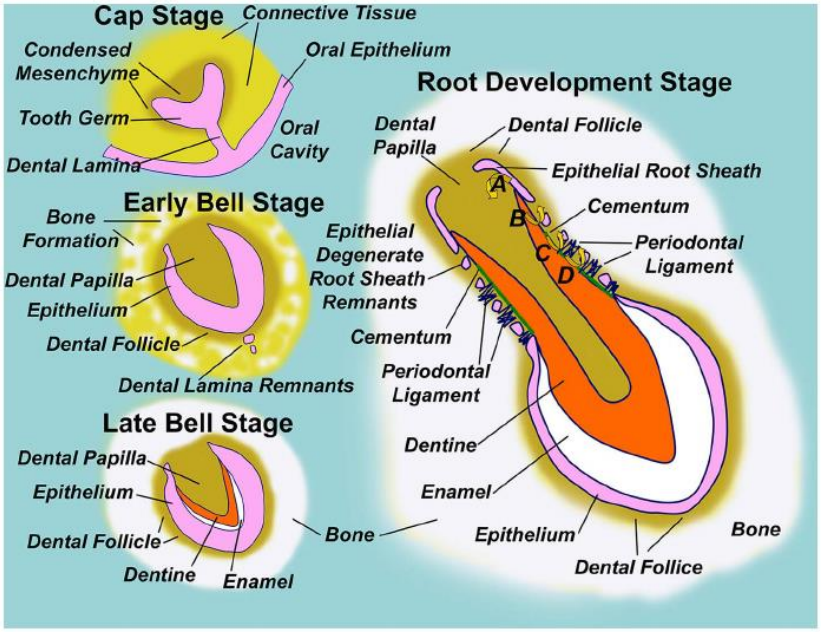


Figure: Stages of tooth development

5.4. Eruption Mechanism of Tooth

Histology of Oral tissues

The oral mucosa is formed by three layers, a surface squamous stratified epithelium, known as the *oral epithelium*, whose thickness and degree of keratinization depend on the location and functional requirements. Beneath is an underlying connective tissue, known as *lamina propria, and* a dense irregular connective tissue, the sub mucosa, which is found at the deepest level. The latter is absent in some oral cavity regions, where the lamina propria is directly bound to the bone or muscle.

The oral mucosa can be classified into lining mucosa, masticatory mucosa, and specialized mucosa, with distinctive histological, clinical, and functional features.

The variety of functions that the oral mucosa develops mainly includes protecting the underlying tissues from mechanical, chemical, and biological stimuli, secretion of essential substances, and a sensory function, which allows the perception of temperature, touch, pain, and taste.

5.4. Nutrition

Constituents of diet

A balanced diet is the best mode to stay healthy, however, it can be difficult to maintain if you don't know the right steps to take. A balanced diet is about adding all of the essential factors necessary for growth, so that every part of the body gets what it needs to function properly.

Essential nutrients

Essential nutrients are "ones that cannot be synthesized by the body and, therefore, must be supplied from foods." These nutrients are essential for normal body function and for growth. Essential nutrients are listed below

- Carbohydrates
- Vitamins (Vit A, B, C, D)
- Minerals
- Unsaturated fats Proteins
- Water

Major and minor nutrients

Macronutrients are required by the body in large amounts. Macronutrients provide energy to a living being for the function of the metabolic system. They provide massive energy has it is converted used to obtain energy. Macronutrients include fats, proteins, and carbohydrates

Micronutrients are required by the body in small amounts.

Micronutrient provides essential components for metabolism to be carried out. They also build and repair damaged tissues in order to control the body process. Micronutrients include calcium, iron, vitamins, iron, and minerals.

Nutritional deficiency

Nutritional deficiency occurs when the body is not getting enough nutrients such as vitamins and minerals.

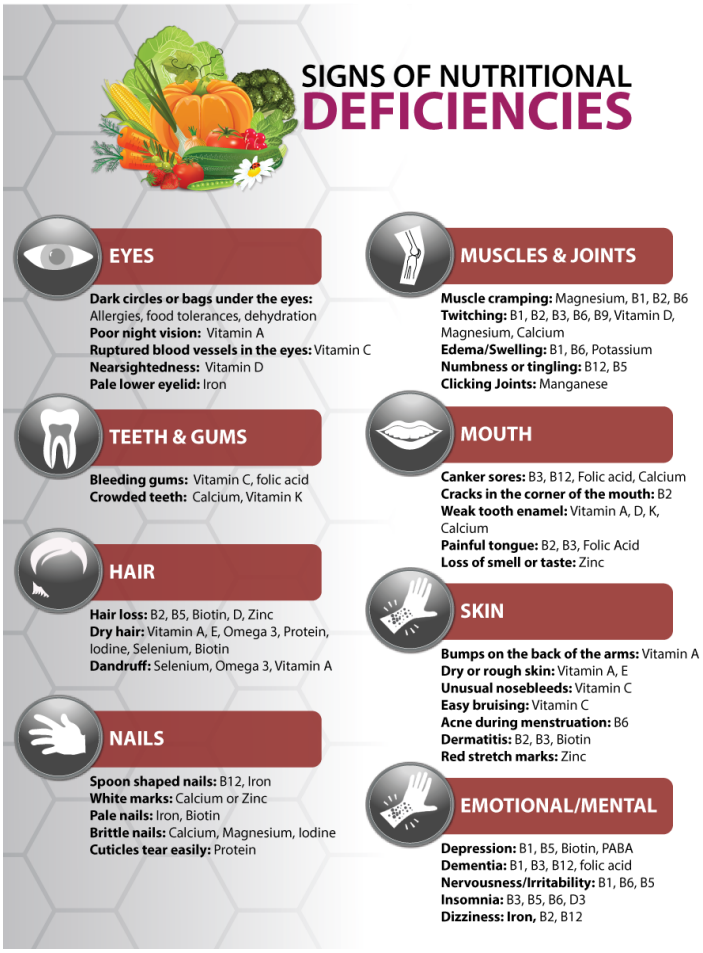


Figure: Signs of Nutritional deficiencies

Diet affecting teeth

A poor diet that consists of sugars, starches and carbohydrates contributes to a mouth that is more prone to gum disease, tooth loss, tooth decay and cavities.

A nutrient-depleted diet increases the production of plaque that produces an acid that destroys tooth enamel. Cavities are formed when the tooth enamel is broken down (a process called demineralization).

Your body naturally absorbs minerals from the food you eat to build up and strengthen teeth. This is called remineralization and it is aided through saliva and fluoride.

Cavities are formed when the rate of demineralization is faster than the rate at which minerals are being absorbed (remineralization).

Most foods are broken down later in the digestive system.

Fermented carbohydrates, such as those found in bread, crackers, cookies, cakes, and cereal, generally get broken into the simple sugars of glucose, fructose, maltose and lactose. These sugars in turn, aid and speed up the process of the plaque's enamel destroying activity.

5.5. Dental Problems during pregnancy

- During pregnancy, women may be more prone to gum disease and cavities.
- Pregnant women are more likely to develop gingivitis, an early stage of periodontal disease that occurs when the gums become red and swollen from inflammation that may be aggravated by changing hormones during pregnancy.
- 1 in 4 women of childbearing age have untreated cavities.
- Children of mothers who have high levels of untreated cavities or tooth loss are more than 3 times as likely to have cavities.
- Children with poor oral health status are nearly 3 times more likely to miss school because of dental pain.
- Regular and emergency dental care is safe at any stage of pregnancy.
- Women are encouraged to seek routine dental care during pregnancy.

Dental attention needed during pregnancy

Get regular dental checkups before and during pregnancy. At your checkups, tell your dentist:

- If you're pregnant or planning to get pregnant
- About any medicine you take. This includes prescription and over-the-counter medicines, supplements and herbal products.
- If your pregnancy is high-risk. High-risk means that you, your baby or both of you are at increased risk for problems during pregnancy. Your pregnancy may be high-risk if you have a chronic health condition, you have complications from a previous pregnancy or you have other conditions that can harm your health or the health of your baby.
- If your prenatal care provider has talked to you about your oral health

Dental checkups before and during pregnancy are important so your dentist can find and treat dental problems early. Regular teeth cleanings help keep your teeth and gums healthy.

Caring of Patient

Patient preparation

Dental practice in the modern times has come a long way. There is a standard practice and procedures are laid down to ensure patient safety and involvement in the whole treatment procedure in order to get maximum benefits of the treatment. Often it is noticed that in a clinical environment patients are anxious and stressed because it is a new environment and at times it is an unreasonable fear or anxiety which has to be dealt with in order to ensure seamless dental care delivery.

It is necessary to deal with anxious patients and make them ready for dental treatment as soon as they have walked in to the dental office.

Counseling the patient

Communication is very important of any kind of dental practice or other healthcare delivery. After the dental examination is done, our qualified dentists start communicating with the patients and communicate with the issue they have, the solutions planned and the process of delivery. While they explain the various stages of treatment whether it is a one-time treatment or several appointments are planned, it is clearly communicated to

the patient along with the inclusions. If the treatment is slightly invasive, it is also explained to the patients that what measures the dentist is going to take to make it painless and minimal invasion. While interacting with the patients the experienced staffs build an environment of trust and use verbal and non-verbal communications to soothe the patient and prepare mentally for accepting and participating the dental treatment.

Reassurance

Assuring and reassuring the patients with confidence and citing examples of similar other treatments which have been administered in similar cases and their positive outcomes brings tremendous positive vibes to the patients. Often an anxious patient is seen to believe and readily accept real life incidents and examples and becomes prepared to cooperate with the dentist and accept the treatment.

Distraction

Distraction is a very old and effective method of engaging the focus of the patient in something other than the phobia of the clinic or dentist. Often it has been very effective method with children who are scared of needles or the environment of clinics. Several methods to divert the attention of the patient and in turn making sure the dental treatment requirements are ready and then simultaneously inducing the patient in to the treatment process can be proven very effective.

5.6. Sedation

Sedation dentistry is widely administered to calm down a nervous patient. Several types of sedation options are available. The patient is explained about the available options. It could be an oral sedative or nitrous oxide mask. Before administering the sedation option, the dentist should clearly explain about the use of the sedation and that is to relax a patient and provide dental care in a pain freeway. When the patients are explained and involved in the decision making it empowers the patients and certainly results in better outcomes of the treatment process.

Equipment

As with any dental procedure, it is important to properly prepare the equipment beforehand. Equipment preparation includes items such as the receptor, bite block,

exposure settings, and patient selection. If the panoramic image is being taken with a direct digital system, which transfers the image directly to the computer, it is important that the proper patient is selected in the electronic health record prior to the exposure. Otherwise, the image will be stored in the wrong location.

Setting the proper exposure time prior to beginning the procedure will help improve efficiency and reduce the possibility of over-exposing the patient to unnecessary radiation. The results of one survey of general dentists found that clinicians did not always change the exposure time related to the patient's need. In fact 74% of respondents used the same exposure time for all patients. In order to properly protect patients, the exposure setting must be tailored for each individual patient. Most machines have settings that can be adjusted according to the stature of the patient. For example, when imaging a pediatric patient, the child exposure setting should be selected. Exposure settings should be adjusted accordingly as height and mass increases. There are usually two settings available for adult patients and one for children, which makes it possible to tailor the amount of radiation being produced.

Figure: Arrangement of Dental instruments/equipment

5.7. Appointments

Appointment scheduling will depend on the number of chairs and oral health professionals you have. A good strategy is to divide the day into 30-minute blocks for each dental chair. Dentists are generally able to predict the complexity of care needed by the patient and can designate an appointment as either simple or complex. Dentistry is procedural in nature, meaning that the dentist can treat only one patient at a time; therefore, the dental practice must be scheduled as an operating room. As each dentist works out of two dental chairs for optimal productivity, it is important that two complex procedures not be scheduled concurrently for the dentist. Scheduling a simple appointment in one chair while a more complex one is scheduled in the neighboring chair is manageable, especially if the program takes advantage of all staff working to the top of their licensure. An efficient appointment system will keep all of the chairs filled during the day, without making patients wait or staffs rush.

Chapter: 6

Emergencies in Dental Surgery

Objective:

To develop sound knowledge to recognize and manage the emergencies and dental surgery

6.1 Emergencies in Dental Surgery

Responsibilities of dental hygienist in an emergency:

Dental hygienists must be prepared to manage medical emergencies that may occur in the oral health care environment. Careful client observation and questioning during assessment will enable the dental hygienist to identify, prepare, and care for the client who experiences a medical complication. Knowledge of the principles of first aid, cardiopulmonary resuscitation (CPR), and basic life support is essential. Equally important is the ability to measure, assess, and record vital signs, recognize signs and symptoms of medical disorders and prevent further complications through appropriate intervention.

General Considerations

A. Medical emergency:

1. A medical emergency means a client experiencing an unforeseen, immediate, health-related difficulty that is potentially life threatening
2. Medical emergencies require prompt recognition and action by the dentist and the dental hygienist to maintain the client's health and, at times, life.

B. Dental hygienist's legal responsibility:

1. To provide quality care according to the standards of practice
   a. According to the established standards of care, dental hygienists may be held liable if they are inadequately prepared for medical emergencies within the oral health care environment
   b. Standards require current training in medical emergency management and CPR

2. To maintain complete records of medical emergencies in the health care setting
   a. Complete records describe the onset and management of the emergency, the client's vital signs, type of and response to treatment performed, type and dose of drugs administered, and time treatment is rendered
   b. Complete records document the incident and protect the oral health care team in the event of legal action.

C. Preventing medical emergencies

1. A thorough health history reveals conditions that predispose a client to medical complications. The general health history is taken at the first appointment and updated at each subsequent appointment
2. Information obtained from the health history is used to modify the client's care plan and reduce the likelihood of the client experiencing a medical complication or emergency in the oral health care setting
3. If more information regarding the client's health status is needed, the dentist or the dental hygienist should consult the client's general physician
4. The assessment and documentation of the client's vital signs (generally blood pressure, body temperature, pulse, and respiration rate) provide information regarding the client's health status
5. The probability of a stress-induced medical emergency in the oral health care environment may be reduced by careful appointment planning, stress management protocol, good client rapport, and stress reducing premedication

D. Preparing for medical emergencies:

Every health care setting should maintain a basic medical emergency kit that is accessible to all treatment areas; staff should be familiar with the kit's contents and location

BDA British Dental Association

Walsall Healthcare NHS Trust

MEDICAL EMERGENCIES IN THE DENTAL PRACTICE

MEDICAL EMERGENCY	SIGNS & SYMPTOMS	MANAGEMENT
Adrenal crisis	☒ Collapse; pallor, cold & clammy skin ☒ Hypotension & dizziness ☒ Vomiting & diarrhoea	☒ **A**irway **B**reathing **C**irculation **D**isability **E**xposure ☒ Call 999, state **"Addisonian crisis"**, SBAR ☒ Lie flat; administer oxygen 15 litres/min ☒ Patient's hydrocortisone emergency IM kit at hand: hydrocortisone 100mg IM.
Anaphylaxis	Signs & symptoms can include: ☒ Sudden onset ☒ Urticaria &/or angioedema; flushing & pallor ☒ Respiratory distress; stridor, wheeze &/or hoarseness ☒ Hypotension & tachycardia Anaphylaxis likely: ☒ Sudden onset & rapid progression of symptoms ☒ Life-threatening **A** &/or **B** &/or **C** ☒ Skin &/or mucosal changes	☒ **A**irway **B**reathing **C**irculation **D**isability **E**xposure ☒ Call 999, state **"Anaphylaxis"**, SBAR ☒ Lie flat, elevate legs (if breathing not impaired); administer oxygen 15 litres/min ☒ Administer adrenaline 500 micrograms IM (0.5ml of 1:1000) ☒ Repeat adrenaline at 5 minute intervals until an adequate response ☒ Paediatric doses of adrenaline: ☒ < 6 yrs - 150 micrograms (0.15ml of 1:1000); 6-12 yrs - 300 micrograms (0.3ml of 1:1000); > 12 yrs - 500 micrograms (0.5ml of 1:1000)
Asthma	☒ Breathlessness & expiratory wheeze ☒ Severe: inability to complete sentences in one breath, RR>25/min, pulse>110/min ☒ Life threatening: cyanosis or RR<8/min, ☒ pulse < 50/min, exhaustion, confusion, decreased level of consciousness	☒ **A**irway **B**reathing **C**irculation **D**isability **E**xposure ☒ Sit upright; if available, follow patient's personalised asthma action plan (PAAP) ☒ 2 puffs (100 micrograms/puff) β2 bronchodilator inhaler e.g. salbutamol; repeat doses may be necessary (early use of spacer device) ☒ Unsatisfactory/no response or if severe/ life threatening; Call 999, SBAR ☒ While awaiting ambulance: oxygen 15 litres/min; β2 bronchodilator via spacer given one puff at a time, inhaled separately using tidal breathing; according to response, give another puff every 60 seconds up to a maximum of 10 puffs
Cardiac Emergencies	Symptoms can vary but commonly: ☒ Chest pain or discomfort that suddenly occurs and doesn't go away. It may feel like pressure, squeezing or heaviness in your chest ☒ Pain that may spread to your left or right arm or may spread to your neck, jaw, back or stomach ☒ Feeling sick, sweaty, light-headed or short of breath **NB: Heart attacks in women commonly missed**	☒ **A**irway **B**reathing **C**irculation **D**isability **E**xposure ☒ Call 999, state **"heart attack"**, SBAR ☒ Comfortable position (usually sitting up) ☒ GTN spray 400-800mcg (typically1-2 activations) sub lingual ☒ Dispersible aspirin 300 mg to chew (unless there is clear evidence of allergy to it) **NB** Known angina: sit down, rest, GTN; no relief after a few minutes repeat GTN. Still no relief after a few minutes→heart attack protocol: call 999, SBAR & aspirin (see above)
Epileptic seizures	☒ Sudden collapse & loss of consciousness ☒ Rigidity & cyanosis ☒ Jerking movements of limbs ☒ Noisy breathing ☒ Tongue may be bitten ☒ Frothing at mouth ☒ Incontinence may occur	☒ **A**irway **B**reathing **C**irculation **D**isability **E**xposure ☒ Safe environment: prevent injury, do not put anything into mouth, do not restrain ☒ Administer oxygen 15 litres/min; note timings of seizure ☒ Once jerking movements cease: recovery position ☒ If available, follow Patient's Treatment Plan; Call 999 if necessary, SBAR **Prolonged convulsive seizures (5 minutes or more) or repeated rapidly:** Midazolam oromucosal solution can be given via the buccal route in adults as a single dose of 10mg (unlicensed in adults) (BNF, 2020) Paediatric doses of midazolam oromucosal solution: 1-4 years- 5mg; 5-9 years-7.5mg; 10-18 years -10mg
Hypoglycaemia	☒ Shaking/trembling ☒ Slurred speech & vagueness ☒ Sweating & pallor; blurred vision ☒ Tiredness/Lethargy ☒ Confusion/aggression ☒ Stroppy/moody ☒ Unconsciousness	☒ **A**irway **B**reathing **C**irculation **D**isability **E**xposure ☒ Offer 15-20g quick acting carbohydrate e.g. 4-5 Glucotabs® or 1.5 - 2 tubes of Glucogel Impaired consciousness/unable to swallow safely or unconscious: ☒ Call 999, SBAR, recovery position, glucagon 1mg IM ☒ Once consciousness returns, offer oral carbohydrate ☒ If able, measure blood sugar to help confirm correct diagnosis Paediatric dose of glucagon: < 8 years of age or < 25kg: 0.5mg IM
Red Flag Sepsis	In the context of presumed infection, if patient looks very unwell, family or carer is very concerned, there is ongoing deterioration or if physiology abnormal for this patient (check HR, SpO2 & BP): is **ONE** red flag present: ☒ **New deterioration in GCS/ AVPU** ☒ **Systolic B.P ≤90 mmHg (or ≥40 mmHg < normal)** ☒ **Heart rate ≥130 per minute** ☒ **Respiratory rate ≥25 per minute** ☒ **Needs oxygen to keep SpO2 92% (88% in COPD)** ☒ **Non-blanching rash or mottled/ ashen/ cyanotic** ☒ **Not passed urine in last 18 hours** ☒ **Recent chemotherapy (within last 6 weeks)** **NB** Refer to age-appropriate GDP Sepsis Decision Tool for guidance in children ≤ 12 years of age	☒ **A**irway **B**reathing **C**irculation **D**isability **E**xposure ☒ Refer to GDP Sepsis Decision Support Tool For Primary Dental Care (≥ 12 years of age) ☒ Call 999, state '**Red Flag Sepsis!**', SBAR ☒ Oxygen 15 litres/min ☒ Ensure paramedics pre-alert as '**Red Flag Sepsis**' **NB** Refer to age-appropriate GDP Sepsis Decision Tool for guidance in children ≤ 12 years of age
Stroke	**F**acial weakness **A**rm weakness **S**peech problems **T**ime to call 999	☒ **A**irway **B**reathing **C**irculation **D**isability **E**xposure ☒ Act **FAST** & call 999; SBAR ☒ Administer oxygen 15 litres/min ☒ Nil by mouth; appropriate position
Syncope	☒ Feels faint/dizzy/light headed ☒ Collapse & loss of consciousness ☒ Pallor, sweating, slow pulse, low BP ☒ Nausea/vomiting	☒ **A**irway **B**reathing **C**irculation **D**isability **E**xposure ☒ Lie flat, elevate legs & loosen tight clothing; oxygen? (not usually necessary) ☒ Once consciousness returns, offer glucose in water or sweet tea ☒ Slow recovery: consider alternative diagnosis; unresponsive: check signs of life

Figure: Medical emergencies in Dental Surgery

Chapter: 7

PHYSIOLOGY (Human Cell)

Objective:

To learn the structure, components and functions of a human cell

7.1 The Cell and its Functions

The cell is the basic unit of life. It is the smallest thing that we call living (without arguing about viruses), and the human body is made of 30 trillion of them. We started off as a single cell, and that cell divided in such a fashion and made a trillion-celled organism. Nearly all of the instructions for making trillions of cells– how to make them, when to make them, and where to make them– are found within every single cell. Each cell contains protoplasm. It is the jelly like substance found in every cell.

Protoplasm:

Different substance that makes the cell are called protoplasm. These are five basic structures: Water, Electrolytes, proteins, carbohydrates, and lipids.

Water:

It is the principal fluid medium of cells (70 to 85%) except fat cells. Cellular chemicals are dissolved in it. Chemical reaction takes place here or at surface of suspended particles.

Electrolytes:

Potassium, magnesium, phosphate, sulphate and bicarbonate, sodium, chloride, and calcium present in protoplasm are necessary for cellular mechanism and function.

Proteins:

Proteins are of two types:-

(i) Structural Proteins

Proteins that make up the cell and provide support to it are known as structural proteins. For example, components of cytoskeleton

(ii) Functional proteins

These are mainly enzymes. Some adhere to structures within the cell while others are freely dispersed in cytoplasm

Carbohydrates:

Provide a major role in cell nutrition and is mainly stored in the cell in the form of glycogen.

Lipids:

It is in the form of phospholipids and cholesterol. Lipids form a major portion of cell membrane which provides a barrier to the cell from surrounding extracellular environment.

Cell membrane (Plasma membrane)

Every human cell is surrounded by the plasma membrane. The plasma membrane separates the cell from its environment, and allows certain materials to enter or leave. Phospholipids and cholesterol form a lipid bilayer, creating a membrane. The double-sheet of lipid molecules acts as a barrier, separating the cell from the external environment. The other major component of the plasma membrane is proteins. Trans-membrane proteins span the plasma membrane. Some trans-membrane proteins regulate what goes in or out of the cell. Other trans-membrane proteins receive signals from other cells or the environment, and relay that information to the inside of the cell. Still others trans-membrane proteins mediate attachment to structures outside of the cell. Not all membrane proteins span the entire width of the phospholipid bilayer, and are located on the outer or inner surface of the plasma membrane.

Cytoplasm

Inside the plasma membrane is cytoplasm. Cytoplasm is the filling of a cell, sometimes referred to as Intra-Cellular Fluid (ICF). Cytoplasm includes nutrients and electrolytes absorbed from the fluid surrounding cells. In addition, the cytoplasm includes numerous proteins and glycoproteins synthesized by the cell. These molecules have other important functions, but they attract water from the Extracellular Fluid. The end result is cells have a gelatinous filling, rather than a watery one. This gelatinous filling is filled with a number of organelles.
Organelles (small organs)

The nucleus

The nucleus contains practically all of a cell's Deoxyribonucleic acid (DNA). DNA is the instructions for making a Ribonucleic Acid (RNA) copy, a process known as gene transcription. Most RNA is translated in the cytoplasm into proteins found inside and outside of a cell. In addition to instructing a cell what protein to make, DNA instructs when and where to make proteins. For instance, epithelial cells of the oral

mucosa do not make protein enzymes that secrete calcium and phosphate into ECM. On the other hand, epithelial cells that differentiate into ameloblasts do make these proteins. They do so by expressing the DNA for these enzymes, after being told to do so by neural crest cells. All cells in the human body have the same DNA (with a few exceptions), which means oral mucosa cells could secrete calcium and phosphate. However, different cells express different DNA at different times.

DNA can be divided into 2 basic regions. There are genes, each gene is more-or-less the instructions for a single protein. Genes are read in a linear fashion (like you are doing now). The rest of DNA folds up into 3-D shapes that provide instructions for when and where to express genes. These 3-D shapes are referred to as non-coding DNA. To make a protein using the instructions in a gene, other proteins called transcription factors bind to non-coding regions of DNA. From there, they unzip the nearby gene, and recruit enzymes that transcribe one strand of DNA into messenger RNA (mRNA). The mRNA then leaves the nucleus to be translated into protein. Not all transcription factors activate gene transcription. Proteins called repressors inhibit the expression of genes, too.

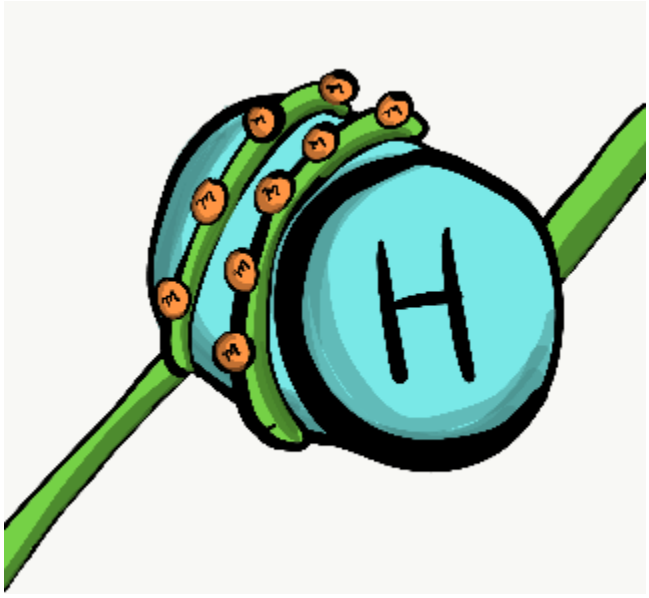


Figure. Methylated DNA wrapped around a histone.

Transcription factors turn genes on and off quickly. These on/off switches can respond to changes in a cell's environment. But when cells differentiate, they shut down genes they would not need more permanently. Rather than they allow transcription factors to act like on and off switches, unnecessary genes are methylated (-CH3 groups are attached to the DNA), packed up around histone proteins, and kept in long-term storage. The pattern of DNA methylation and histone packaging is copied during mitosis. This means the pattern of genes that are available or packaged away is inherited by both daughter cells. Because this inheritance is not a difference in the DNA

sequence, it is known as epigenetic inheritance. Epigenetic traits play an important role in cell differentiation and cell fate, covered in more detail in chapters 6 through 11.

There are 46 molecules of DNA in the nucleus– they are very long molecules, however, only 46 in number– 23 maternal and 23 paternal. During mitosis, these 46 molecules are duplicated and packaged up tightly into 92 chromosomes. This packaging involves re-using histones along nearly the entire length of a DNA strand, and allows chromosomes to be seen under the light microscope. DNA along with associated proteins (mostly histones) is known as chromatin. Most of the time, DNA is mostly unwound (un-needed instructions are wound around histones, the rest wiggles around randomly, free to be transcribed if instructed). This unwound DNA fills up the nucleus and is called Euchromatin. Condensed DNA is known as heterochromatin. Simple pneumonic can be used to memorize it.

Euchromatin----**E**xpressed DNA (part of DNA that is expressing itself for transcription for protein synthesis)

Heterochromatin----**H**ighly condensed (part of DNA that is tightly bound)

Ribosomes

Visible throughout the cytoplasm are small specks made of protein and RNA called ribosomes. These structures translate mRNA instructions that come from the nucleus. mRNA instructions guide the linkage of amino acids into a long protein. Groups of three mRNA nucleotides, called codons, instruct the ribosome which amino acid to add next to the protein. Like regulatory regions of DNA, ribosomal RNA (rRNA) isn't read linearly but folds into a 3-D shape. That shape, along with ribosomal proteins, creates active sites that catalyze the chemical reaction of mRNA translation. Free-floating ribosomes in the cytoplasm synthesize proteins that remain in the cytoplasm, such as keratin or enzymes that mediate apoptosis.

Mitochondria

The mitochondria are where the majority of Adenosine Tri-Phosphate (ATP) is produced. ATP is made of Adenosine, plus three phosphate (PO43-) groups– pay attention to the phosphate part, it is also a major component of bone, enamel, dentin and cementum. ATP powers almost all cellular processes, including the transcription and translation of mucous proteins within a salivary gland, the electrical signals sent by neurons in the tongue when food enters the oral cavity, and the contraction of myo-epithelial cells to cause salivation. Mitochondria burn glucose, using oxygen, and harness some of the energy released in the form of ATP. Mitochondria are different from other organelles in that they contain a little bit of their own DNA, which is inherited just from mother. Mitochondria contain two phospholipid bilayer membranes, versus one like other organelles. This extra membrane is used during ATP synthesis. The part to remember is that mitochondria use a proton (H+) gradient, which makes the

inside of mitochondria acidic. It is toxic to the rest of the cell should mitochondrial membranes become damaged.

Lysosomes

Lysosomes are small compartments surrounded by a phospholipid bilayer (a bilayer similar to plasma membrane). Inside lysosomes are acids and digestive enzymes. They are used to destroy stuff inside the cell when it wears out, or materials the cell phagocytosed from outside (e.g., debris, bacteria). When a cell dies and begins to break apart, neighboring cells are in danger of being damaged from the acids and enzymes found within lysosomes. In the oral cavity, epithelial cells only have a life-span of days before they wear out, so it is very important for these cells to neutralize acids and enzymes in their lysosomes before dying (part of a process called apoptosis).

Endoplasmic Reticulum

The Endoplasmic Reticulum (ER) is a series of interconnected tubes surrounded by a phospholipid bilayer– similar to lysosomes, only bigger, more tubular, and not full of acid. The smooth Endoplasmic Reticulum (sER) is where cells produce lipids and store calcium. The rough Endoplasmic Reticulum (rER) is covered in ribosomes. Proteins made by these ribosomes wind up inside the rER, travel to the Golgi apparatus, and are secreted (such as proteins in mucus) or stay within the plasma membrane (such as cell-junction proteins, or receptors for morphogen molecules).
Golgi apparatus

The Golgi apparatus is another set of tubes, similar to the rER. Small membrane-enclosed spheres called vesicles shuttle proteins made in the rER to the Golgi apparatus, where the proteins are modified. Often, these proteins have sugars attached to them, making them glycoproteins. New vesicles take these proteins to the plasma membrane, where they are either secreted or become a part of the plasma membrane. An example of a secreted protein is collagen, found in cementum, dentin and the PDL. Other secreted proteins include the glycoprotein fibronectin and the trans-membrane protein integrin, which play important roles in the healing of damaged gingival tissue.

Cytoskeleton

The cytoskeleton is a structural network within the cytoplasm. The cytoskeleton is composed of long structural protein fibers. Motor proteins, such as myosin and dynein, bind to cytoskeleton fibers and move. Depending on what the fiber and motor proteins are anchored to, this can cause the cell to change shape, to migrate, or move materials within the cell (such as vesicles or chromosomes). During dentinogenesis, it is critical for odontoblasts to secrete enzymes that catalyze mineralization of dentin from only one side of the cell (from the odontoblastic process). Otherwise, odontoblasts could become cemented within their own secretions. This involves moving vesicles along the

cytoskeleton, toward the apical surface of the cell. It is also important for mesenchymal stem cells to migrate over protein scaffolding during would repair in the oral mucosa. This involves changing the length of cytoskeleton proteins, which changes the cell's shape. Shortening the cell while extending the next pseudopod; pulls mesenchymal stem cells along fibers in the ECM.

Outside the cell

Ground substance

Ground substance is the name for material outside of the cell that has no particular shape when viewed under traditional microscopy. One part of ground substance is Extra-Cellular Fluid (ECF), which is the water and nutrients surrounding cells. This fluid is plasma when it is inside of a blood vessel, but once this fluid exits the blood and surrounds cells, it is called ECF. This fluid does not flow or drip, it is held in place by large solutes found in ground substance, including proteins, glycoproteins, and polysaccharides. Small solutes tend to diffuse away, down their concentration gradient. The large molecules of ground substance are stationary, and instead hold fluid in place, forming a gel. Ground substance doesn't look like much under a microscope, no more than if you looked really closely at jelly. These proteins, glycoproteins and polysaccharides are made and secreted by cells (these cells have a lot of rER and Golgi apparatus).

One of the glycoproteins found in ground substance is fibronectin. Cells may recognize, bind to and move along fibronectin if they have the correct integrin (a trans-membrane protein) spanning their plasma membrane. Fibronectin acts not only as a road along which cells travel, it is also a road map. Getting the right cells to the right place at the right time is very important both in wound healing and in development. In fact, what you learn about development is re-used (recapitulated) in wound healing.
Another important molecule found in ground substance is a large polysaccharide called hyaluronic acid. Like fibronectin, cells bind to and travel over hyaluronic acid (using a different type of plasma membrane protein). Hyaluronic acid has applcations in dentistry, such as helping cells of the gingiva stick to a dental implant to form a bacteria-resistant seal. We can't see fibronectin or hyaluronic acid without using modern imaging tricks, which is why they are listed as a part of ground substance, and not in the next section, fibers. Because cells migrate over ground substance proteins, we say that ECM proteins function as a scaffold. Without scaffolds, tissues grow only from their edges. This is fine if speed is not critical, such as when enamel and dentin are forming, while the embryo is safe inside a uterus. Following an injury, however, it is optimal for a wound to heal everywhere at once, not just from the edges. The body often puts down some form of scaffolding first, such as a scab. In dentistry, artificial scaffolds help the body heal faster, reducing the need for surgical replacements. Examples of artificial scaffolds include some bone grafting materials and periodontal membranes.
In addition to their structural role guiding cells to new locations, ground substance molecules provide cells with positional information. This information tells cells where they are located, and what they should be doing. For instance, when a stem cell binds

to fibronectin, fibronectin can instruct the stem cell to express different genes and differentiate into a specific type of cell. This can mean the difference between a stem cell differentiating into an odontoblast which creates reactionary dentin, or a fibroblast which creates scar tissue. Recruitment of cells to the correct location is fine, however, they need to know what to do when they get there. When we cover tooth formation and tooth repair, remember these functions of fibronectin and hyaluronic acid.

As we learn more about how ground substance instructs stem cells, we get better at helping teeth and periodontal tissues to repair themselves.

Fibers

Three stringy shapes were visible under a light microscope a century ago, and were grouped together as fibers of the ECM. Like fibronectin and other ground-substance molecules, fibers are secreted by cells called fibroblasts.

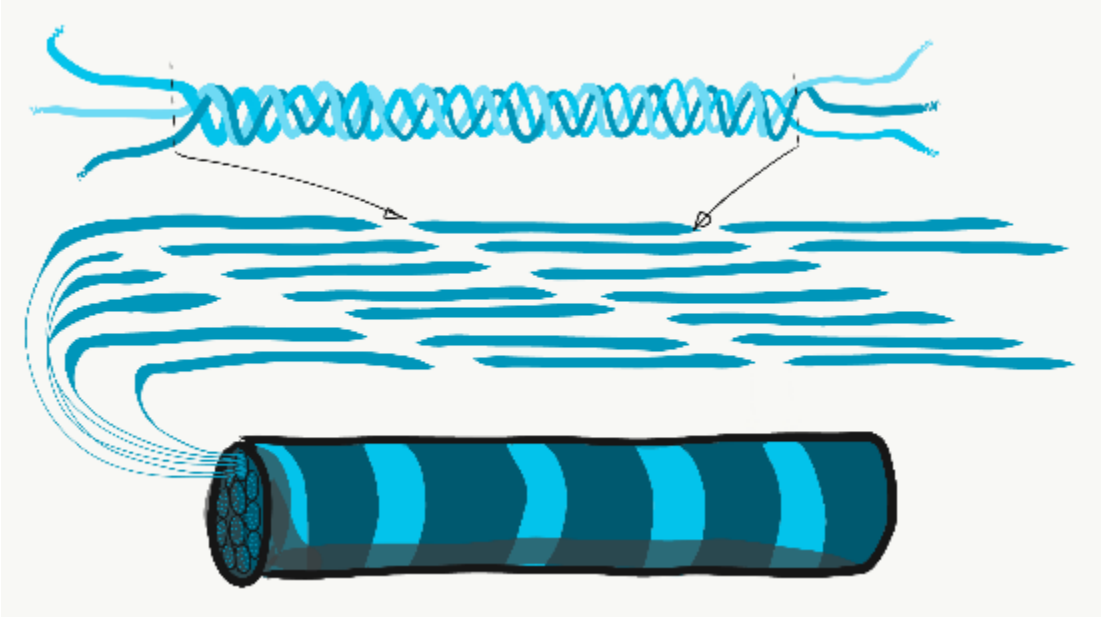


Figure: Collagen fibers are made of numerous individual proteins woven together, which are in turn woven together.

Collagen is the strongest of the three fibers. It is therefore referred to as a structural protein—it gives many organs their shape. Collagen is a large protein. Getting collagen from the rER (where it is translated) to the Golgi apparatus where it is modified, and finally secreted from the cell requires extra-large vesicles for transport. Collagen fibers are made of 3 coiled α-helicesthat are in turn coiled and cross-linked together, making a very strong macromolecule with the same basic shape as a rope. It is very strong if you pull on it from the ends, but bends if you apply force from the side. For instance, an area

of advanced caries on a tooth can be as soft as wet driftwood. It contains collagen fibers without the plentiful minerals that used to surround them. Collagen fibers are found in regions of the oral cavity where the ability to resist force is important, such as in dentin and the PDL. In fact, collagen is found throughout the human body, accounting for 25% of our protein content.

In addition to having a structural role, collagen acts as a scaffold. Similar to fibronectin and hyaluronic acid, cells use collagen fibers to migrate along. Like fibronectin, collagen also provides cells with positional information. This is possible because there are 28 different collagen genes which are assembled into slightly different versions in different locations (similarly, fibronectin comes in multiple isoforms thanks to alternative splicing. For example, IEE cells differentiate into ameloblasts after they come into contact with type IV collagen found in pre-dentin, rather than type I found in the basement membrane.

Reticular fibers, which are not shown in Fig. 1.11, look like a fine, spider web-like mesh under the microscope. Long after histologists first saw and named reticular fibers, molecular biologists discovered that reticular fibers are made of the collagen protein. Nevertheless, they have their own name, and receive equal footing with collagen fibers on the list of ECM fibers. This web-like network of protein is not as strong as collagen fibers, but provides enough of a frame for blood cells to rest in organs like the spleen and lymph nodes. Without reticular fibers, loose cells would sink to the bottom.

To summarize: collagen proteins can form collagen fibers, or collagen proteins can form other shapes that aren't fibers, including reticular fibers. Categorizing molecules as ground substance versus fibers is based on what things look like under a microscope. The collagen protein is a single molecule that is transcribed and translated from a gene. This won't be the last time where the lineage (in this case, genes) does not match the morphology (physical appearance).

Elastic fibers are thinner than collagen fibers, and look like fine hairs under the microscope. They are made from a different protein called elastin. As their name suggests, elastic fibers can be stretched and spring back to their original length. This is not something collagen does well. If you cannot put your palms on the floor while keeping your legs straight, the collagen fibers of your hamstring and gastrocnemius tendons are limiting your range of motion. Regular stretching exercises activate fibroblasts, which in turn lengthen collagen fibers. Elastic fibers are found in higher quantity in regions of the oral cavity that change shape during speech or swallowing, such as the soft palate.

7.2. Mitosis

Cell division, or mitosis, is the process by which one cell replaces itself with two copies. During mitosis, one cell divides into two identical daughter cells– there is no parent cell left after cell division. During development, we grow from a single cell into 30 trillion cells, therefore a lot of mitosis occurs. In the time it takes you to read this sentence, several billion cells in our body will go through mitosis to replace cells that just died. When a cell is not undergoing mitosis, it is said to be in interphase (in Fig. 1.15, interphase is G1, S and G2 combined). This is the time where a cell might be doing its job, such as secreting fibers or preparing for mitosis. Before mitosis can occur, a cell must have roughly double of everything. During mitosis, everything is divided in half between two new daughter cells.

Not all cells are capable of mitosis– in fact, most cells in an adult have differentiated. These cells are performing tasks, they are too busy to reproduce. We say these terminally differentiated cells have exited the cell cycle.

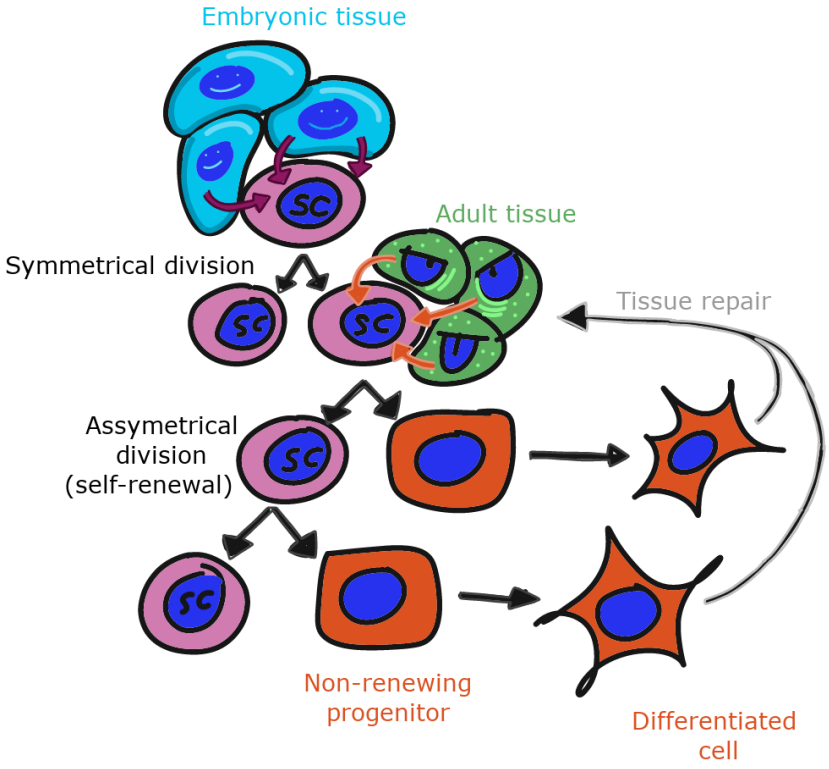


Figure: During early embryonic development, stem cells (SC) divide to produce two stem cells (symmetrical division). Later, stem cells typically undergo asymmetrical division, where mitosis produces one stem cell and one cell fated to become a terminally differentiated cell. Differentiated cells can produce new tissue, or repair damaged tissue, but do not form new cells.

To repair damage, tissues have stem cells. A stem cells is an undifferentiated cell that is capable of dividing and differentiating into one or more different types of cells. When an adult stem cell divides into two daughter cells, one daughter typically remains a stem cell, and the other differentiates into something else. A tissue therefore keeps a steady supply of stem cells, as long as the stem cells don't die before they undergo mitosis. As we get older, our tissues don't heal as well because some stem cells have died before they replaced themselves. After early development, when a stem cell dies, it is gone. Another stem cell does not undergo mitosis to produce two stem cells to replace it.

Stem cells are named based on how many different types of cells they can potentially become. The uni-potent stem cells of the oral epithelium become keratinocytes, and only keratinocytes. The multi-potent neuro-mesenchymal stem cells differentiateinto odontoblasts, cementoblasts, fibroblasts and osteoblasts (and might be referred to as partially differentiated). The omni-potent fertilized egg becomes every cell in a human, plus more.

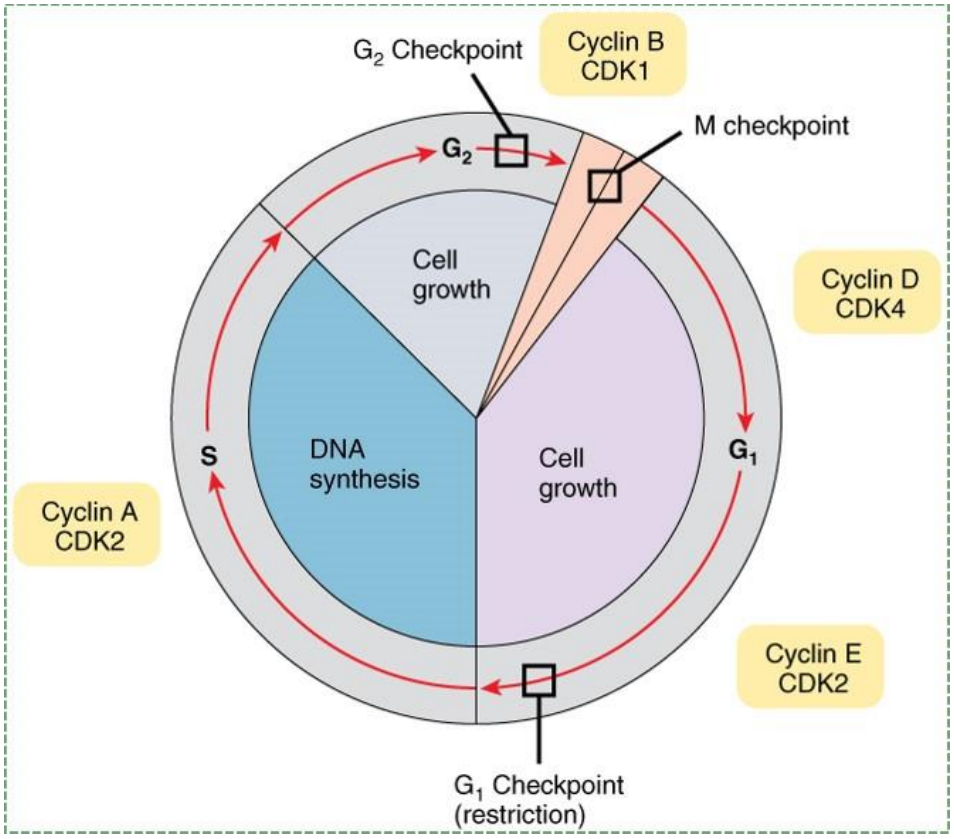


Figure: The cell cycle. Image credit: "Anatomy and Physiology Fig 18" by OpenStax is licensed under CC BY SA 4.0

To go through interphase and prepare for another round of mitosis, cells go through a series of cell cycle checkpoints. Checkpoints set up the base rate for cell division, which helps ensure that the correct amount of tissue growth occurs. This is like an hourglass, only instead of grains of sand accumulating in the base, it is phosphate residues accumulating on cyclin protiens. Cyclins are transcription factors that activate genes that allow progression through the checkpoint. Their activity is regulated by phosphorylation (carried out by enzymes called Cyclin-Dependent Kinases, or CDKs). The speed of this process can be increased or slowed down by external signals, such as growth factors. Growth factors are hormones that are secreted into the ground substance of a tissue. The density and stickiness of the ground substance influences how far the growth factor diffuses. If diffusion is limited, the growth factor only speeds up cell division in a localized area. This is important in the formation of new organs such as teeth, and for tissues such as bone and PDL fibers. Other growth factors might spread over a wide area, especially if they are secreted into the bloodstream. Secretion of Growth Hormone into the blood, for instance, allows different organs to grow at roughly the same speed.

Mutation in a gene for a growth factor, or the receptor for a growth factor, can lead to a gain-of-function. If a mutation to a gene causes a cell to receive a constant go-signal for passage through the cell cycle, we call the mutated gene an oncogene. In this book, we cover the role of Wnts in head and tooth development, but Wnts were first discovered for because they cause cancer. It takes just one mutated copy of an oncogene to gain a function. Some mutations can stop proteins from functioning. If those proteins are necessary for passage through the cell cycle, we call those tumor suppressor genes. One example of a tumor suppressor gene is Retinoblastoma protein (pRb), which normally halts progression from G1 to S phase. For a cell to lose the ability to stop at a cell cycle checkpoint, both copies of a tumor suppressor gene alleles must be mutated. A metaphor might be helpful here. In a car, it takes one foot to step on the gas too hard, but you would have to be missing two feet to not be able to hit the brakes (loss-of-function). Usually, cancers form when a single cell acquires mutations to multiple oncogenes and multiple pairs of tumor suppressor gene alleles. An allele is one of the two copies of a gene found in the same position on two homologous chromosomes. Even when all of these mutations happen in a single cell, there is another layer of protection covered in the next section.

7.3. Meiosis

Meiosis is a type of cell division in sexually reproducing organisms that reduces the number of chromosomes in gametes (the sex cells, or egg and sperm). In humans, body (or somatic) cells are diploid, containing two sets of chromosomes (one from each parent). To maintain this state, the egg and sperm that unite during fertilization must be haploid, with a single set of chromosomes. During meiosis, each diploid cell undergoes two rounds of division to yield four haploid daughter cells — the gametes.

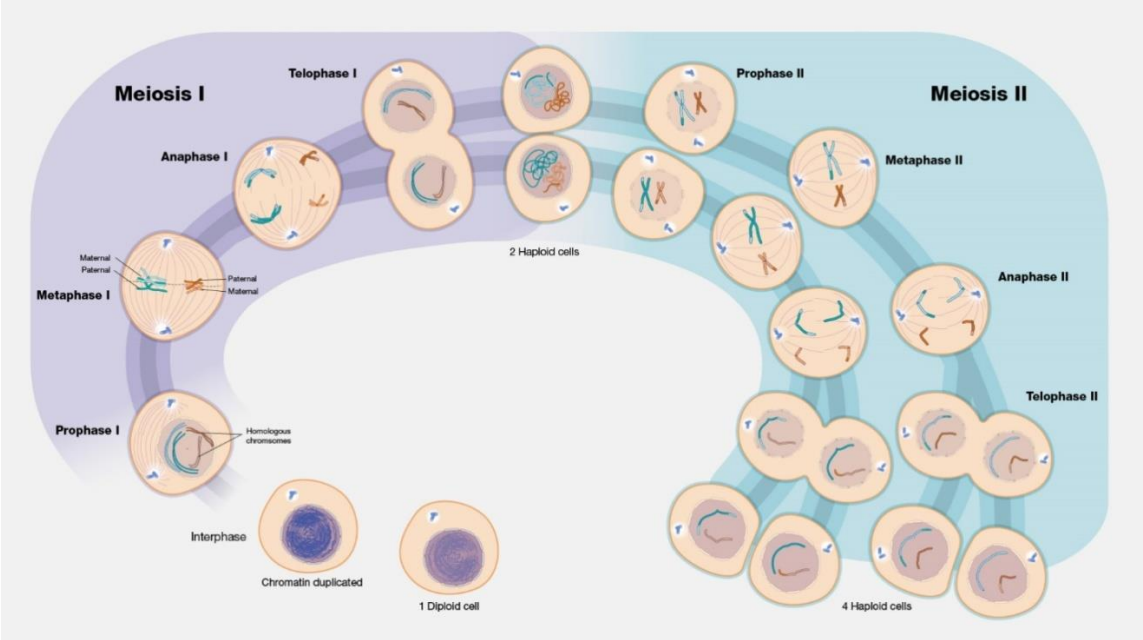


Figure: Meiosis

Humans have 46 chromosomes in almost every cell, 23 that came from one of our parents and 23 very similar chromosomes that came from the other one of our parents. It is really important to have the right number of chromosomes in a cell. If a cell has extra chromosomes or is missing a chromosome, that can have very substantial impacts on how it functions. We can think of meiosis as way cells very carefully count and divide their chromosomes so that each gamete, each egg or sperm, has exactly 23 chromosomes. Then when an egg with its 23 chromosomes is fertilized by a sperm with its 23 chromosomes, the resulting fertilized egg has exactly 46 chromosomes. And a new human that grows from that fertilized egg will have 46 chromosomes in all of its cells.

Sample Questions:

Q.1:

a) What is first Aid?

b) What are the objectives and priorities of First Aid?

Q.2: How will you manage a patient presented with external bleeding?

Q.3:

a)What are the A-septic techniques?

b) What is dry heat sterilization?

Q.4:

a) Name the various Salivary glands

b) Write down their functions

Q.5: Give an account of stages of tooth development with diagram

Q.6: What are the legal duties of a dental hygienist towards medical emergency situations?

Q.7: Describe Mitosis of a human cell. Illustrate your answer with Draw diagram.

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1. Ten Cates Oral Histology, Development, Structure and Function Antonio Nanci
2. Concise Dental Anatomy and Morphology by James L. Fuller, Gerald E Denehy, Thomas M. Schulein
3. Medical Physiology by Guyton and Hall
4. Online resources