PART VIII

VIDEO COMPANION GUIDE

8/22

Infection Control and Dental-Related Microbiology 1

Clinical Microbiology: Involves areas of infection control, preventing disease spread from patient to provider, provider to patient, and patient to patient through instruments, etc.

A. **Basic definitions: sterilization** versus **disinfection**

1. Sterilization: Absence of all life forms including SPORES
2. Disinfection: Reduction of numbers of microorganisms to low levels, with elimination of pathogens to the point that the instrument or material is safe

A major distinction between high-level disinfection and sterilization is the ability of sterilization to kill spores of spore-forming bacteria (*Bacillus* and *Clostridium*). (See below.)

Note that sterilization is a much higher level of safety and has definite parameters.

B. **Sterilization methods:** PROB: Rust, corrosion, Dulling

1. Autoclave (steam heat, pressure): 121°C, 20–30 minutes, 15 psi
2. Dry heat (Dri-clave): 160°C, 1–2 hours PROB: Time, melting
3. Ethylene oxide: room temperature, 8–12 hours (plus extra time to air out residue) PROB: time, residue
4. Combined heat/chemical (chemiclave): formaldehyde + alcohol, 132°C, 20–40 psi, 20 minutes

C. **Preparation of instruments:** All instruments, prior to sterilization, must be clean and free of debris. In particular, bloody or proteinaceous debris is especially dangerous. It can shield microorganisms from the sterilizing effects of heat.

D. **Failure to sterilize:** This can usually be traced to one of a number of common causes:

1. Autoclave was overpacked.
2. Time was insufficient, wrong cycle was used (wrapped instruments take more time than unwrapped, etc.).

NOTE

1) Autoclave is quickest and simplest and is used if there is no reason NOT to
2) Ethylene oxide is used for heat-sensitive materials
3) Dri-clave or ethylene oxide is used when sharp edges are important to maintain.
4) Autoclave tends to dull or corrode sharp edges.
5) Main problem of dri-clave and ethylene oxide (especially) is turnaround time.
6) Main problem of autoclave is dulling and corrosion, especially of carbide steel
7) Boiling can disinfect, but never sterilize
8) Cold is generally ineffective against most microorganisms.
9) "Cold sterilization" by chemicals other than those listed above (i.e.,glutaraldehyde soaking for 12 hours) is NOT sterilization, merely high level disinfection.

BEAD STERI. – 450 - 500°F
– 15 secs

3. Autoclave cycle was interrupted (power problem or shut-off)
4. Tissue/protein was left on the instruments / dry bld

E. **Sterilization monitors:** Ensure that the process has actually killed the microorganisms.

1. Two types: Process Indicator — insufficient
   Biologic Monitor

Color strip

a) **Process indicator** is a color change strip. Separate or part of autoclave bag. Color change of the strip (bar, arrow, circle, etc.) shows that temperature/pressure parameters were met for that autoclave run. Shows *physical* parameters only. Does not *directly* show that the organisms are dead.
   Usually loaded with each autoclave load.
   Not used as the legal requirement for sterilization monitoring

Spore strip

b) **Biologic monitor** is a strip made up of spores of *Bacillus* sp.
   1) Also known as "spore strip"
   2) This is the legal requirement for autoclave testing (CDC, OSHA, ADA, State DOH, etc.)
   3) Must test *weekly*
   4) Uses two strips: Test strip is autoclaved (often two test strips are placed in different sections of autoclave). These spores should always be killed during autoclave cycle.
   5) Control strip is not autoclaved. It is incubated and grown as a control to ensure that bacterial spores were alive to begin with.
   6) Standard autoclave report: Should be positive for control strip, negative for test strip(s)

Said grow spores!

c) **Spore-forming bacteria:** Two genera, *Bacillus* and *Clostridium*. Only *Bacillus* is used for spore tests. Various species of *Clostridium* are responsible for pseudomembranous colitis, tetanus, and botulism.

hard to kill in AUTOCLAVE

d) **Benchmark organism:** This is a term used to describe an organism that is used as a standard. *Bacillus* spores are the benchmark organisms for sterilization. If a process kills *Bacillus* spores, it will also kill the easier-to-kill bacteria, fungi, viruses, and protozoa.

F. **Disinfectants:** These are used to reduce the numbers of microorganisms, and to kill most pathogens. They are *not* sporicidal.

G. **Benchmark organism:** Disinfectants should be able to kill *Mycobacterium tuberculosis*. This is the benchmark organism for disinfectants. It is much harder to kill than most bacteria, viruses, fungi, and protozoa. This resistance is partially due to the waxy cell wall of *Mycobacterium*.

H. **Disinfectant guidelines:**

1. Should kill *Mycobacterium tuberculosis*

Legal Req.

SOAPS & DETERGENTS
emulsification of fats & grease on surf (hands)
resulting in ↓ # of microorg.

MERCURY-BASED CMPDS
merthiolate
mercurochrome
> combi.

IODINE-BASED CMPDS
iodophors
betadine

BLEACH
hypochlorite

PEROXIDE
oxidation of sulfhydryl grps

2. Should have an **EPA registration number** (Environmental Protection Administration)
3. Should have an **ADA seal of approval** (American Dental Assn.) (*not* required)
4. Should be **used according to all directions** (mixing, dilution, shelf-life, discarding, etc.)

Disinfectants work in a variety of ways. Some (*glutaraldehydes*) primarily alkylate DNA and RNA, some (*Iodophors*) primarily oxidize sulfhydryl groups, some (*alcohols*) primarily denature proteins, and some (*detergents*) primarily act by emulsifying lipids in cell membranes.

Soaps and detergents remove large numbers of microorganisms by emulsifying the fats and grease that attach them to surfaces (hands, countertops, etc.)

I. **Universal precautions:** dev'p in 1970's as reacted by CDC & ADA to HBV

1. **All patients are assumed infectious** (do not assume risk or lack of from patient appearance).
2. **All setups are done by procedure, not patient**. Extractions require sterilized instruments, a particular set of chair and light barriers, disinfection of chair, use of needle recappers, etc. This set of guidelines is dictated by the procedure (extraction), not the health condition of the patient (HIV+, diabetic, hepatitis B history, etc).
3. **Barrier methods** are used as appropriate (barriers block transmission by acting as a physical barrier): masks, faceshields, light handle covers, chair drapes, etc.
4. **Critical instruments** are sterilized (or disposable). These pierce mucosa or enter sterile areas of the body. Examples include elevators, forceps, scalpels, etc. DO NOT DISINFECT!
5. **Semicritical instruments** are sterilized OR high-level disinfected (or disposable). These instruments touch mucous membranes. The best dental example is the mouth mirror. In most practices, it is sterilized, but technically it is not a critical instrument.
6. **Handpieces** have been sterilized since about 1990. This is due to the finding that infective material might enter the tip and move backward to the inside of the handpiece. Therefore, outside disinfection is insufficient.

"touch & Splash" Surf.
- touching surf. & splashing some microorg

NOTE

Alcohols are generally good soaking disinfectants but poor surface disinfectants, as they evaporate easily.

Most dental surfaces can be disinfected, NOT sterilized. Instruments are sterilized. Hepatitis A (like Mycobacterium) is especially hard to kill on surfaces.

HEAT & MOST DISINF.
- causes protein denaturation, disrupt membs, destroy DNA & RNA

DRY HEAT
- protein den., disrupt membs. dehydrate microorg.

ETHYLENE OXIDE
- damage microorg. DNA & RNA through alkylation (substitution of alkyl grp for hydrogens)

FORMALDEHYDE / Formalin
- alkylation of DNA / RNA

GLUTARALDEHYDE
- protein den. & alkyl

PHENOLS & PHENOLIC CMPDS
- protein den.

GLOVES – most effective inf. control & INST.
& most effective procedure

7. **Handwashing** is one of the most crucial methods of infection control. Many studies show it to be the *single most effective measure*. Hands should be washed typically: on arrival at work, before patients, between each patient, before lunch, after lunch, before going to the bathroom, on returning from the bathroom, and before leaving work to go home.

J. **Brief history of universal precautions:**

1. 1970s: Hepatitis B "clusters" of infections were traced to specific dental offices. Specific recommendations (including most universal precautions) were developed.
2. 1980s: Emergence of HIV disease refocused dental field on infection control issues. Note that the standards developed for Hep B are equally effective for HIV.
3. CDC/OSHA/ADA and State Depts. Of Health (DOH) have combined all of the knowledge gained from the *1970s and 1980s into the current* network of regulations and practices used today.

K. **Clinically related HBV/HIV:**

1. It is much easier for a dental worker to contract HBV on the job than HIV (assuming that the worker is unvaccinated).
2. Approximate conversion rates (used to show relative risk) from one needlestick accident to a dental worker:

   HBV: 30%
   HCV: 3%
   HIV: 0.3%

   These figures are approximations. They show, however, that HIV is difficult to pick up in the clinical setting; HBV is not. Hepatitis B vaccination is extremely important.
3. Hepatitis B vaccine **must** be offered to all exposed dental workers.
4. Vaccine must be **free to worker**.
5. Current vaccination series is **three injections** (0 month, 1 month, 6 month).
6. You **cannot** contract any disease from the vaccination. The vaccine is *not made from human* blood products of any type (example of new vaccine: ***Recombivax***). **Older** vaccines (***Heptavax***) were made from human blood products. People did not contract any diseases but were fearful.

& NO DANGER!

Recent vaccines R made of YEAST
↳ extremely effective

GELLY ☆ ROLL

Practice Questions

1. In comparing the conversion rates of HIV and HBV needlesticks, it has been shown that:
   a) they are approximately equal in frequency
   b) HBV conversion is slightly greater than HIV
   c) HIV conversion is slightly greater than HBV
   d) HBV conversion is significantly greater than HIV

2. Which of the following is *most* resistant to sterilizing conditions?
   a) Oral yeast
   b) Hepatitis B virus
   c) Bacterial endospore
   d) *Mycobacterium tuberculosis* — diff. 2 kill rh surf.
   e) Human immunodeficiency virus

3. Disinfection of a smooth surface containing HIV virus can be accomplished by:
   a) heat and pressure only
   b) overnight exposure to glutaraldehyde only
   c) a variety of common disinfectants
   d) exposure to sodium hypochlorite only

4. In a dry heat oven, which of the following temperatures is sufficient for achieving sterilization in 1–2 hours?
   a) 81°C
   b) 100°C
   c) 121°C — steam
   d) 160°C

5. Which of the following is NOT a correct statement of universal precautions?
   a) Gloves should be worn during treatment procedures
   b) Protective masks should be worn during treatment procedures
   c) Instruments used on or near the mouth should be disinfected → it's not sufficient 2 disinfect MOST inst. STERILIZE 'em!
   d) "Touch and splash" surfaces should be disinfected
   e) Protective eyewear should be worn during treatment procedures

6. Which of the following may interfere with the ability of the autoclave to sterilize an instrument?
   a) Failure to remove debris from the instrument
   b) Overloading of the autoclave
   c) Allowing blood or debris to dry on an instrument
   d) Autoclaving without precleaning of instruments
   e) All of the above

7. Universal precautions are effective in preventing disease transmission from:
   a) Dental worker to patient only
   b) Patient to dental worker only
   c) Patient to patient only
   d) All of the above

8. According to recent CDC and OSHA recommendations, autoclaves should be tested to see that they are working correctly. This is best accomplished through the use of:
   a) Pressure monitors
   b) Temperature monitors
   c) Biologic monitors
   d) A combination of pressure and temperature monitors

Hepatitis Review

A. **Definition:** A nonspecific inflammation of the liver. Hepatitis may be viral (A, B, C, D, E, CMV) or caused by another microorganism or chemical (CCl_4).

B. **Signs and symptoms:** Almost any sign or symptom of general illness and discomfort can be associated with hepatitis. Thus, they are mostly nonspecific. Examples include:

Fever

Jaundice

Malaise – lack of energy

Weight loss

Chills

Hepatomegaly – swelling of liver

Decreased appetite

Nausea

Myalgia – muscle pain

Joint pain

Lymphadenopathy

Dark urine (increased bilirubin)

Increased transaminases

Increased alkaline phosphatase

Increased prothrombin time

All of these signs and symptoms can be traced to decreased liver function through damaged hepatocytes.

1. **Hepatitis A:**
   - RNA enterovirus OR ENTEROVIRUS 72
   - Single strand
   - Infectious hepatitis
   - Short incubation hepatitis (2–6 weeks)
   - Fecal/oral transmission
   a) **Sources:** Contaminated water, shellfish; spread of virus from feces of infected restaurant worker to hand to food to restaurant patron. Often found in groups of people (who ate at same restaurant, drank same polluted water source, army barracks, summer camp, etc.).
   b) **Immunity:** Complete after one exposure. No chronic stage.

EPA – Environmental Protection Agency
- A disinfectant registration

CDC – Centers for Disease Control
→ studies inf.-rel issues
→ provides recommendations

ADA – American Dental Ass.
- acts as an advisory capacity
- issues inf. control recom.

PHS – Public Health Service
- branch of HHSD
  ↳ Health & Human Services Dept.
- performs a variety of fxns
- funding of health centers prog.

HEP. B
- extremely dangerous
  a. inflam. effects of liver
  b. ↑ liver fxn
  c. chronic, extended destructive stage
  d. hepatic carcinoma

Tx 4 ACUTE HEP. B INF.
→ HBIG (a form of passive immunity)
* if given in time, can reduce severity of HEP. B. dis.
* Ab have no effect on VIRUS
* RECOMBIVAX – preventive vaccine w/c is best advice BA contact w/ [illegible]

OSHA – Occupational Safety & Health Administration
- br. of ↓ Dept. of Labor
↳ Bloodborne Pathogens Standard
  ↳ "exposure control plan"
  w/c details ↓ safety measures in place @ each worksite

HAV – can resist 1-400 conc. for 3 days OR 100°C boiling H_2O for 3-5 minutes

HBsAg

DANE PARTICLE
consists of a core & envelope w/ a diameter of 42 nm

22 nm spherical particle
22 nm wide filament
28 nm core only!

* all contain HBsAg

HEP. B. Tx
1. Heptavax (1970's) → purified HBsAg from bld
2. Recombivax (1980's)
→ (genetically engineered yeast cells 2 produce Ag)
* body dev'ps anti-HBsAg w/c cancel body 2 form anti-HBsAb

TEST
1. ELISA
2. RIA – Radio Immuno Assays

INDIC OF ANTI-HBs
1. prev. inf.
2. prev. vaccination
3. exposure to HBIg

* no Hepa. vaccines contain any core antigen of HBV

c) **Spread:** During active stage → w/o JAUNDICE
Often asymptomatic in young children. Antibody tests reveal former exposure when adult is tested. Patient reports (–) history, but lab reports (+) anti-HAV.
~~Self-limiting~~

d) Recent development of vaccine for hepatitis A

e) **Treatment:** Disease is self-limiting. Bed rest, increase food intake in AM, anti-emetics. Sometimes treated with Ig (immune globulin) within 1–2 weeks of exposure. ↑X: electron microscopy

f) **Clinic Note:** HAV is especially resistant to disinfectants on surfaces. Hard 2 KILL! ... than HBV

2. **Hepatitis B:**
~~DNA virus~~
~~Double strand~~
A.R.A. ~~Serum hepatitis~~ – spreading thru blood
~~Long incubation hepatitis~~ 1-6 mo.
Hepatitis B is of most concern (until recent rise of Hepatitis C) to dentists of all bloodborne pathogens.

a) **Sources:**
Contaminated medical/dental instruments, surfaces
Sexual contact
Blood contact (IVDA, etc.)
The ~~sources are similar to those of HIV~~, but HBV is much easier to contract (in the unvaccinated individual). Because of this, it should be considered ~~more dangerous than HIV~~, but it is often not regarded with sufficient concern. ~~Hepatitus B is a deadly disease~~. Prevention in the clinical setting is similar to that for HIV.

b) **Incubation:** 4–25 weeks (compare to Hepatitis A). AVE: 7-8wks / 90 days

c) **Possible results of HBV infection:**
1) Resolution – contrast, body becomes immune, then ok
2) Chronic carrier state (benign, persistent, unresolved)
HBsAg → 3) Chronic active (chronic, destructive) – slow, progressive liver damage
4) Carcinoma of liver
5) Death
Note that both 3) and 4) above often result in death.

d) **Some Notes:** → tx'd 4 HepB (8-6 mo.)
1) Chronic carriers test (+) for both HBsAg and HBsAb
2) Vaccinated dental workers ~~without disease exposure~~ should test (–) for HBsAg but (+) for HBsAb. ∴ ∅ HAV
3) Infected patients may have a brief window period in which they test (–) for HBsAg. During this time, they will test (+) for HBcAb.
4) ~~*"Diagnosis by Exclusion"*~~ is a term formerly used to describe the identification of NANB (non-A non-B) hepatitis patients. Most of these patients have been shown now to have ~~Hepatitis C~~, for

Anti HBc – confirmatory test
Window Period – difficult 2 ID HBsAg in bld.

which a test was developed recently. Prior to that time, a patient would report signs and symptoms of hepatitis, and *would be tested for* HBsAg, HBcAb, and HAV. If negative for all three, the patient would be diagnosed as having NANB hepatitis. (See Hepatitis C section.)

3. **Hepatitis C (NANB):** x no lab markers / no tests available
   RNA virus — Dx: by exclusion
   Single strand
   Variable incubation period
   a) This entity was formerly NANB or "transfusion hepatitis" because the leading cause of NANB hepatitis used to be (pre-1990) blood transfusions. Tests existed for both Hep A and Hep B, so that these patients were screened from the donor pool, but Hep C donors were not. Post-1990, a Hep C test does exist.
   b) Hepatitis C has the potential of being the next infection control crisis in Dentistry. Dx: ↑ enzyme levels in bld
      EX: ALT (alanine amino-transferase)

4. **Hepatitis D**
   Delta particle
   RNA virus
   ass. w/ Delta virus RNA w/ HBsAg
   Disease only present with concurrent Hep B infection
   a) Transmitted similarly to Hepatitis B. Requires Hep B enzymes for reproduction. Immunity to Hepatitis D means immunity to both *Hep B and Hep D*.
   b) **Lab Markers:** Hep-delta antigen and anti-Hep delta (antibody)

5. **Hepatitis E**
   Enteric virus like Hep A. — fecal/oral

Dx:
a. use of IV drugs
b. hep A outbrk

Diff'l Dx
a. hep
b. Inf. mononucleosis
c. immune disorders
   – lupus, serum sickness, r. arthritis

⊖ HBsAg
⊖ Anti HBcAg
⊖ HAV

NOTE

There is no current vaccine for Hepatitis C.

There is no current effective treatment for Hepatitis C.

Very high level of chronic disease state following infection is found in Hepatitis C.

NOTE

The chief prevention of Hep C is infection control and universal precautions.

REGULATIONS — OSHA (Dept. of Labor)
* concerned w/ WORKERS only!

OSHA – Occupational Safety & Health Admin.
↳ "exposure control plan"

HEPATITIS MARKERS

* HAV: Hepatitis A Viral Particle
  ANTI HAV (IgG): lifetime Antibody
  " (IgM): Indic. RECENT inf (4-6 months)
* HBV: Hepatitis B Viral Particle — "Dane Particle" ← normal viral type particle
* HBsAg: Surface Antigen — "Australian Antigen"
  (many types — Dane, rods, spheres) – "Current inf."
  HBsAb (Anti-HBsAg): Surf. Antibody, prev. inf., vaccine, HBIG
  HBcAg: core Antigen (no test) – ∴ indic. prev. inf.
  HBcAb (Anti-HBcAg): Core Antibody, prev. inf., confirmatory test
  HBeAg: Ass. w/ ↑ replication & ↑ infectivity] not completely understood
  HBeAb (Anti-HBeAb): Ass. w/ ↓ infectivity]

OSHA REGULATIONS

1. needle recapping of any type
2. NR by use of a recapper
3. NR by mechanical "scoop" technique
   ↳ w/ doesn't expose ∂ other hand of ∂ needle

Practice Questions

1. The presence of which of the following in a patient's serum affords protection against Hepatitis B?
   a) Anti-HBcAg
   b) Anti-HbsAg
   c) Anti-HAV
   d) Anti-HBeAg

2. Which set of terms is correctly linked?
   a) serum hepatitis, hepatitis A, short incubation hepatitis
   b) long incubation hepatitis, hepatitis B, infectious hepatitis
   c) NANB hepatitis, short incubation hepatitis, serum hepatitis
   d) Hepatitis A, infectious hepatitis, short incubation hepatitis

3. A "cluster" of hepatitis cases associated with blood transfusions is most likely:
   a) Hepatitis A
   b) Hepatitis B
   c) NANB Hepatitis – Hep C
   d) Hepatitis D

4. Negative results for which pair of lab tests will usually rule out active Hepatitis B?
   a) HBsAg and Anti-HBs
   b) HBsAg and HBcAg
   c) HBsAg and Anti-HBc
   d) Anti-HAV and Anti-HBs

5. Which of the following viruses is a DNA virus?
   a) Hepatitis A
   b) Hepatitis B
   c) Delta particle
   d) HbsAg
   e) None of the above

6. Which of the following are clinical signs and symptoms of hepatitis?
   a) Weight loss
   b) Hepatomegaly
   c) Cervical lymphadenopathy
   d) Myalgia
   e) All of the above

7. Which form of hepatitis is known as serum hepatitis?
   a) Hepatitis A
   b) Hepatitis B
   c) NANB Hepatitis
   d) Hepatitis D

8. Which form of hepatitis is LEAST likely to be spread through blood contamination?
   a) Hepatitis A
   b) Hepatitis B
   c) NANB hepatitis
   d) Hepatitis D

SITES OF INF.
1. bld 4. thymus
2. brain 5. spleen
3. testis

VIRUS Usually DETECTED IN:
1. bld 4. vaginal secretions
2. semen 5. tears
3. saliva

1° DIS. TRANSMITTER
1. sexual contact
2. IVDrug users

HIV

A. **Origin/history:** A syndrome (seemingly unrelated set of signs and symptoms) noted in a group of young American male homosexuals in the 1970s in the San Francisco area. The syndrome included oral and pharyngeal candidiasis, purple tumors (KI) on the skin and mucosa, unusual pneumonias (PCP), severe weight loss, etc. Only later would all of these symptoms be trace to the destruction of the immune system by the HIV virus.

B. **General description** of HIV virus:
- Retrovirus
- Lentivirus (slow-virus family)
- "pear-shaped" nucleoids
- RNA virus with reverse transcriptase enzyme

Various names for virus: HIV, HTLV-III (human T-cell lymphotropic virus), ARV (AIDS-related virus), LAV (lymphadenopathy virus).

C. **Target cells:** Mostly leukocytes, including T4 lymphocytes (helper), monocytes, macrophages, B lymphocytes, but NOT T8 suppressor lymphocytes.

D. **Staging:** As disease progresses: T4 (CD4 lymphocyte) count decreases, viral load (virus particle count) increases, T4/T8 lymphocyte ratio decreases.

E. **Risk groups:** Original risk groups included male homosexuals, IVDAs, sex partners of the first two groups, transfusion recipients, clotting factor recipients.

More recently, the HIV lab tests have eliminated the transfusion and clotting factor risk groups. There is some evidence of increased heterosexual transmission in the U.S. Note that the disease is primarily heterosexually spread in some other areas of the world.

F. **Body fluids and HIV spread:**
1. Contain HIV virus *and* most highly infectious: blood and semen
2. Contain HIV virus but not infectious: saliva and tears

The reason for the lack of infectivity of saliva and tears is not completely known. Evidence is commonly seen in the lack of transmission through dental procedures and through kissing.

G. **"Saliva in a Dental Setting."** This is a special OSHA term referring to the fact that although saliva itself is noninfectious, dental saliva is often mixed with blood as a result of the dental procedure. Therefore, it is often put in a separate infectious category.

H. **Signs and symptoms:** Early HIV disease may be asymptomatic. Some patients experience flu-like symptoms, diarrhea, malaise, or weakness

INCUB: 2-6 weeks after exposure.

NOTE

Spread of HIV is possible within the healthcare setting (see discussion of disinfection/sterilization).

SSS: 1. fever
2. lymphadenopathy
3. diarrhea
4. malaise
5. weakness
6. night sweats

I. **ARC:** This term (*AIDS-related complex*) refers to a stage after infection but prior to full-blown AIDS. It also may be known as *pre-AIDS* or *AIDS prodrome*.

1. Symptoms include night sweats, sudden weight loss, diarrhea (for weeks), and lymphadenopathy.

J. **AIDS:** *Note that this definition may change, and has changed over time.* Normally, a patient must have a (+) HIV antibody test and one or more *"AIDS-defining conditions"* to have AIDS. **HIV+ does not equal AIDS.**

AIDS-defining conditions include most of the following:

a) PCP pneumonia (fungus)
b) Pharyngeal or esophageal candidiasis (fungus)
c) Hairy leukoplakia (related to EBV infection)
d) *Cryptosporidium* diarrhea (protozoan infection)
e) *Cryptococcus* infection (fungus)
f) *Toxoplasmosis* encephalitis (protozoan)
g) *Mycobacterium* infections other than *M. tuberculosis* (i.e., *M. avium*)
h) *Mycobacterium tuberculosis* infection outside of the lungs
i) Kaposi's sarcoma (may be associated with CMV)
j) Severe wasting (emaciation)

Note that Kaposi's sarcoma was formerly found (prior to HIV disease) in older men of Mediterranean descent. It was initially surprising to find it in a much younger group of men without this ethnic background.

K. **Pediatric AIDS:** HIV virus is passed from mother to child through one of three ways.

1. **Blood mixing** (in placenta in late pregnancy)
2. **Through mucus in vaginal canal** (during birth)
3. **Nursing** (breast milk)

Signs and symptoms are similar to those of adult AIDS but may also include bacterial sepsis, hepatomegaly, splenomegaly, and *failure to thrive*.

L. **HIV testing:** Note that the standard HIV test is for the antibody to virus, *not* for virus itself. It shows exposure to the virus and the body's reaction to it.

1. The test is known as the **ELISA** test (**enzyme-linked immunosorbent assay**).
2. The ELISA test is **confirmed with a Western blot test.**
3. The Western Blot test serves to eliminate false-positive ELISA tests.
4. **Viral particle counts** (viral load) and **CD4 counts** (described previously) are used primarily to stage the disease process and decide when to begin particular treatments.

MISC.
a. Hairy Leukoplakia
b. Emaciation (wasting)
c. Dementia (Ass. w/ inf.)

HIV-Related Opportunistic Inf.

NOTE

Newborns testing positive for HIV antibody may or may not be infected. The antibodies may be received from the mother or may be made by the infant.

If the infant is not infected, the mothers antibodies will disappear later. If the infant is infected, the antibodies remain.

FUNGI – Pneumocystis carinii (PCP pneumonia)
a. Fungus vs. Protozoan
b. Cryptococcus (meningitis)
c. Coccidioides
d. Histoplasma
e. Candida (thrush/candidiasis)
- oral
- pharyngeal/esophageal

PROTOZOA
a. Toxoplasma
- toxoplasmosis encephalitis
- cryptosporidium (diarrhea)

BACTERIA
a. Mycobacterium TB (disseminated)
b. M. avium (& any other mycobact.)

VIRUS
a. CMV - cytomegalovirus
b. EBV - Epstein-Barr virus
c. Herpes - disseminate

TUMORS
a. Kaposi Sarcoma (KS)

DISINFECTANTS w/c kill M.Tb will also kill ↓ Ifs:
1. HIV
2. HBV
3. viruses
4. bacteria
5. fungi
→ on ↓ smooth surfaces!

GLOVES
1. vinyl – limited to exams
2. latex – ↓ procedures
3. nitril rubber – dental asst.

HIV DISINFECTANTS
1. Sodium hypochlorite / Bleach
2. Isopropyl alcohol – 35%
3. peroxide – 3%
4. ethanol – 50%
5. lysol – 5%

OSHA
1. Exposure determination
   a. Engineering Control → OBJECTS or Mechanisms
      - sharp cont.
      - needle recappers
      - eyewash stations
      - puncture-proof sharp containers
   b. Work Practice Control
      - handwashing
      - regulations prohibiting ↓ eating / drinking of food in tx rms
      - storage of food in refs w/ restrictions of bld
2. Personal Protective Equipt.
   → protective equipt
      - face mask
      - gloves

M. New treatments: Although Pharmacology is an NBDE 2 topic, you should be familiar with the basics of the following:

1. There are potentially three enzymatic ways to interfere with HIV growth and replication: **interference with *reverse transcriptase*, *integrase*, or *protease*.**
2. All original antiretroviral drugs affected reverse transcriptase (AZT, ddI, 3TC, etc.). Most of these medications are known as NRTIs (***nucleoside reverse transcriptase inhibitors***).
3. There are currently no drugs that affect integrase. **Protease inhibitors** are the latest class of drugs. They include *Indinivir (Crixivan)*, *Ritonavir*, *Saquinavir*, etc.

   Combination therapy involves use of combinations of RTIs and proteases. These combinations are sometimes referred to as "drug cocktails." They often involve two RTIs and one protease inhibitor. These combinations attack the virus at two separate points of the life cycle.

   Another related term is HAART (***highly active antiretroviral therapy***). Antiretroviral combinations are introduced early in the disease process.

N. Postexposure HIV follow-up:

1. Health care workers need special care following needlesticks and other accidents. This field is changing rapidly.
2. Exposure follow-up usually involves:
   a) **First aid** (soap and water or eye wash) – NSS → Hollow needle
   b) **Evaluation of wound** (deep or superficial, skin broken or not)
   c) **Evaluation of fluid** (is the fluid blood, another material mixed with blood, or noninfectious fluid?)
   d) **Evaluation of patient** (HIV^+, HIV^-, unknown? member of risk group?).
3. In deep wounds of bloody fluid with visible blood on the needle and an HIV^+ source (for example), early prophylactic use of antiretrovirals is now recommended for the healthcare worker. If the worker is unvaccinated, treatment for Hepatitis B may also be warranted (HBIG [*hepatitis B immune globulin*] and Hep B vaccine).

PNEUMOCYSTIS CARINII
- protozoan
- causes pneumonia in immunocompromised px
- an opportunistic organism
  * it will almost never cause dis. in ↓ healthy indiv & is only pathogenic for 2° AIDS px's inability 2 mount a proper immune response

Practice Questions

1. A deficiency in which of the following cells can predispose to candidiasis?
   a) Basophils
   b) Eosinophils
   c) Macrophages
   d) Plasma cells
   e) T lymphocytes

#IV – maybe caused by too much Antibiotic tx

2. Besides blood, other body fluids containing HIV virus and proving highly infective, include:
   a) Tears
   b) Semen
   c) Saliva
   d) All of the above

→ RNA retrovirus

3. In terms of basic biochemical behavior, HIV virus most closely resembles:
   a) HBV – DNA
   b) CMV
   c) Lentivirus
   d) Herpes simplex

Lentivirus from slow runs fam

4. In terms of modes of transmission, HIV virus most closely resembles:
   a) HBV
   b) Influenza A
   c) HAV
   d) Herpes simplex

5. Disseminated miliary tuberculosis results from spread of the tubercle bacillus by way of:
   a) The lymphatics
   b) The bloodstream
   c) The air passages
   d) Direct extension
   e) None of the above

6. The HIV enzymes presently inhibited by combination therapy are:
   a) Integrase and reverse transcriptase
   b) Reverse transcriptase and protease
   d) Protease and Integrase
   e) All of the above

7. For a patient already taking AZT, the best additional drug combination would be:
   a) Two reverse transcriptase inhibitors
   b) One reverse transcriptase inhibitor
   c) Two protease inhibitors
   d) One protease inhibitor and one reverse transcriptase inhibitor

8. Protease inhibitors act by:
   a) Denaturing cell proteins
   b) Inhibiting a cellular enzyme
   c) Inhibiting a viral enzyme
   d) Blocking protein receptors

8/22

Bacteriology of the Mouth—Normal Flora

A. The **most common** inhabitants of the oral cavity are the *non-beta-hemolytic Streptococci (viridans streptococci)*. They include:

1. *S. mutans* – dental caries (early caries
2. *S. mitis*
3. *S. sanguis*
4. *S. salivarius* – tongue

   a) These organisms are **facultative anaerobes**. They do not require oxygen but tolerate it. They are NOT strict anaerobes. They are gram-positive cocci.

   b) They may have preferred sites (tooth surface for *S. mutans*, tongue surface for *S. salivarius*).

   c) ***S. mutans*** **is the chief etiologic agent for caries (and the entire dental profession).**

   Characteristics of *S. mutans*: lactobacillus

   1) Aciduric (acidogenic) ←
   2) Attaches to pellicle, then plaque → salivary protein
   3) Plaque formation depends on *glucan (dextran)* formation – sticky polysac: sucrose = glucose + fructose
   4) Produces glucosyltransferase enzyme to produce glucans
   5) Preferred substrate is *sucrose*, which it metabolizes for energy *and* uses to produce glucans
   6) pH within plaque of less than 5, results in demineralization of tooth surface. → lactic acid

5. **Other aciduric bacteria:** *Lactobacillus* sp is also aciduric (acid-producing).

   a) It is often a colonizer of *late* carious lesions (unlike *S. mutans*, which begins them).

   b) The acid produced by aciduric bacteria may help to eliminate other bacterial species (in addition to dissolving enamel).

B. **Viridans Streptococci and SBE**

1. SBE is subacute bacterial endocarditis. It can be caused by viridans streptococci travelling in the bloodstream and lodging on artificial or defective heart valves.

   While most details of this are covered by NBDE 2, be familiar with the following:

2. SBE occurs when the patient has a susceptible condition (i.e., replacement heart valves), a procedure involving bleeding (i.e., tooth extraction), a bacteremia, colonization of the valves by bacteria, and subsequent valve damage.

Rx:
→ 2grams 1hr b4 procedure

3. Susceptible conditions include all replacement valve surgery, previous endocarditis, many congenital heart malformations, mitral valve prolapse with regurgitation, and rheumatic heart disease (and others).
4. Procedures inducing bleeding include extractions, scaling, prophylaxis, etc.

The drug of choice for antibiotic premedication of these patients is ***amoxicillin****. For the penicillin-allergic, the alternates include clindamycin, azithromycin, clarithromycin, cephalexin, and cephadroxil.*

Details of this premedication are primarily covered in NBDE 2.

C. **Other Streptococci:** Most other Streptococci are pathogenic. They include the hemolytic strep.

1. *S. pneumoniae* is an alpha-hemolytic strep. It is also called diplococcus or pneumococcus, and it causes pneumonia.
2. *S. pyogenes* is a beta-hemolytic strep. It causes scarlet fever, pharyngitis (strep throat), rheumatic fever, glomerulonephritis, and endocarditis (not SBE).

- non-plaque dis.
- IM & Ant. Hth.
- abscess from EXO
- drains from inside to outside of mth
- foreign-like feat.

Periodontal Disease Flora

don't include STREP

Although the complex nature of periodontal disease is not generally covered until NBDE 2, note the following general microbiology concepts concerning periodontology for NBDE 1.

A. **Periodontal pathogens are:**
   1. Normal sulcus flora
   2. *Not* tooth flora
   3. *Not* Streptococci
   4. Often gram-negative
   5. Often anaerobic
   6. Often capnophilic (carbon dioxide–loving)

B. Examples of common bacteria associated with periodontal disease include:
   1. *Bacteroides melaninogenicus*
   2. *Porphyromonas gingivalis*
   3. *Spirochetes*
   4. *Borelia*
   5. *Capnocytophaga*
   6. *Fusobacteria*
   7. *Eichenella corrodens*
   8. *Actinobacillus actinomycetemcomitans*

Periodontal disease is *not* caused by one specific organism, and instead is felt to be a process involving many capnophilic and anaerobic bacterial species, inflammation and exaggerated host response, and subsequent collagen attachment loss and bone destruction.

→ causes perio. when put in gngval pockets/sulcus

PERIODONTAL DIS. (adult Chronic)
- normal indigenous flora from Sulcus

JUVENILE PERIO. (JP)
- Actinobacillus Actinomycetemcomitans (Aa)

ACTINOMYCOTIC INF
- Actinomyces Israeli & A. naeslundi

EX - Dental inf., sinus tract to skin "sulfur granules" → yellow abscess

ANUG
Spirochetes

CANDIDIASIS
- candida albicans
EX: corners of mth - Angular chelitis under dent

4 COMMON ANTIFUNGALS
Rx: topical
Nystatin & Clotrimazole
systemic
Fluconazole & Amphotericin

FLUORIDE EFFECTS
↑ resistance of E to low pH
↑ Fluoroapatite (F- substitutes for OH- in Hydroxyapatite)
↑ remineralization (equilibrium shift)
demineralization vs remineralization
direct toxic to bact. (topical only) (1.2% = 12,500 ppm)
interferes w/ glucosyltransferase activity (glucan/dextran production)
ideal systemic fluoride = 1 ppm

GRAM ⊕ streptococci

Practice Questions

1. Which choice is *not* a possible anticaries action of flouride?
   a) Substitution of F^- for Ca^{2+} in hydroxyapatite
   b) Inhibition of bacterial enzymes
   c) Increased remineralization of enamel
   d) Increased resistance of enamel to low pH

2. Which of the following oral bacteria are aciduric?
   a) *Lactobacillus casei*
   b) *Actinomyces viscosus*
   c) *Streptococcus mutans*
   d) *Streptococcus salivarius*

   1) a and b
   2) a and c
   3) a and d
   4) b and c
   5) b and d
   6) c and d

3. Which of the following is the single most numerous group of microorganisms in the oral cavity?
   a) Enterococci
   b) Anaerobic streptococci
   c) Facultative streptococci
   d) Beta-hemolytic streptococci

4. The major cariogenic property of *Streptococcus mutans* is associated with its ability to produce which of the following enzymes?
   a) Hyaluronidase
   b) Chondroitinase
   c) Aminopeptidase
   d) Glucosyltransferase
   e) Fructosyltransferase

5. The bacterial population in the gingival sulcus (pocket) that influences the course of periodontal disease involves:
   a) Mostly aerobic bacteria
   b) Essentially a pure culture
   c) Bacteria not indigenous to the oral cavity
   d) Essentially the same organisms found in the healthy sulcus

6. Which of the following acids is the chief product of carbohydrate metabolism of *Streptococcus mutans*?
   a) Acetic
   b) Formic
   c) Lactic
   d) Butyric
   e) Propionic

7. Which of the following organisms represents a significant secondary invader of carious lesions?
   a) *Streptococcus pyogenes*
   b) *Lactobacillus casei*
   c) *Streptococcus mutans*
   d) *Staphylococcus aureus*

8. The pH at which enamel can be expected to begin to demineralize is closest to:
   a) 3
   b) 5
   c) 6
   d) 8

Review Test

1. Critical instruments used in or near the oral cavity which may become contaminated with blood and saliva must be:
   a) Disinfected between uses
   b) Sterilized between uses
   c) Cleaned between uses
   d) Can be either disinfected or sterilized between uses

2. The offering of hepatitis B vaccination for "exposed" employees is:
   a) Mandatory and must be free to the employee
   b) Mandatory, but the employee may have to contribute part of the cost
   c) Not mandatory
   d) Mandatory only for dentists

3. Which of the following is an antimicrobial agent that primarily inactivates cellular DNA?
   a) Phenols
   b) Chlorhexidine
   c) Ethylene oxide
   d) 70% isopropyl alcohol

glutaraldehyde &
- not an effective disinfectant
- topical, evaporates quickly, removes debris only

4. Sterilization of surgical instruments that are sensitive to heat can best be accomplished by using:
   a) Phenol
   b) An autoclave
   c) Ethyl alcohol
   d) Ethylene oxide

disinfectant

5. Sterilizaton refers to which of the following?
   a) Absence of all living forms
   b) Inhibition of bacterial growth
   c) Removal of pathogenic bacteria only
   d) Removal of pathogenic bacteria, viruses, and fungi

6. Which of the following guidelines is important in selecting and using a liquid disinfectant?
   a) The product should contain an EPA number
   b) The product should be mixed in strict accordance with printed instructions
   c) The product should state on the label that it kills *Mycobacterium tuberculosis*
   d) The product should display the ADA seal of acceptance
   e) All of the above

7. The major focus of OSHA regulations as they apply to the dental workplace is to protect:
   a) Patients
   b) Dental workers
   c) Both patients and dental workers
   d) Dental workers, patients, and patient's families

8. Universal precaution recommendations of CDC and ADA originated from previous efforts to control:
   a) HIV virus
   b) Hepatitis A virus
   c) Hepatitis B virus
   d) Non-A Non-B hepatitis virus

9. The form of hepatitis with the greatest likelihood of resulting in chronic disease is:
   a) Hepatitis A
   b) Hepatitis B
   c) Hepatitis C
   d) Hepatitis D
   e) Hepatitis E

10. The hepatitis B vaccination series consists of how many vaccinations at what intervals?
    a) Two vaccinations: initial and two months later
    b) Three vaccinations: initial, one month and two months after initial
    c) Three vaccinations: initial, one month and six months after initial
    d) Four vaccinations: initial, one month, two months, and six months after initial
    e) None of the above

12 – 15 yrs

11. Dry heat destroys microorganisms primarily by
    a) Lysis
    b) Oxidation
    c) Precipitation of salts
    d) Coagulation of protein - ppt, denature
    e) Acceleration of enzyme metabolism

12. Submerging dental instruments for 15 minutes in a cold disinfecting solution is unacceptable as a sterilizing method because disinfectants
    a) Are not sporocidal
    b) Are inactivated by soap
    c) Do not kill gram-negative organisms
    d) Have a limited antimicrobial spectrum

13. Biologic monitors, used for autoclave testing are composed of:
    a) Viruses
    b) Live bacteria
    c) Bacterial spores
    d) Fungal spores
    e) A combination of bacteria, virus, and fungi

14. A serum lab test for a dentist who has received Recombivax but has no history of hepatitis should show:
    a) HbsAg
    b) Anti-HBs
    c) HbcAg
    d) Anti-HbcAg

15. The type of infection most commonly transmitted by transfusion of properly screened blood prior to Lagonas is: (b4 1992)
    a) EBV
    b) Type A hepatitis
    c) Type B hepatitis
    d) Non-A non-B hepatitis (Hep C)

16. The ELISA tests detect:
    a) HIV viral particles
    b) HIV surface antigens
    c) Antibody to HIV surface antigens
    d) Electrophoretically separated viral proteins

17. Each of the following is useful in identifying viruses except the
    a) Nature of the viral nucleic acid
    b) Morphology of the viral capsid
    c) Ability to grow on various media → dont grow on MEDIUMS
    d) Ability of the virus to be inactivated by solvents such as chloroform

18. Detergents kill bacteria by interfering with the function of the cell
    a) Wall
    b) Capsule
    c) Membrane
    d) Ribosome
    e) Chromosome

19. Collagen degradation observed in chronic periodontal disease may result from the action of collagenase. This enzyme has been noted in which of the following microorganisms?
    a) *Bacteroides* sp
    b) *Streptococcus mutans*
    c) *Entamoeba gingivalis*
    d) *Streptococcus faecalis*
    e) *Veillonella alcalescens*

20. Which of the following is correct concerning anaerobic microorganisms in the oral cavity?
    a) They do not exist in this area
    b) They are always gram-positive organisms
    c) They are normal flora and opportunistic
    d) They cannot be isolated in culture
    e) They can be completely controlled by using antibiotics

The Tongue

A. **Papillae types:**

1. **Filiform:** Rows, anterior to middle in location, nonvascular, no taste buds, most numerous, cornified
2. **Fungiform:** Anterior only, vascular, with taste buds, longer than filiform
3. **Circumvallate (Vallate):** 10–12 only, in v-shaped row near border of anterior/posterior tongue, vascular, with taste buds, LARGEST — serous, Von Ebner
4. **Foliate:** On lateral tongue, rudimentary in man, no taste buds

* Note that circumvallate papillae are surrounded by serous-only glands known as Glands of Von Ebner.

B. **Foramen caecum:** This remnant of thyroglossal duct is located at the apex of the V formed by the circumvallate papillae.

C. **Other taste buds:** besides those found on the palate, epiglottis, and pharynx. These taste buds are innervated by CN X (vagus).

Tongue Innervation

A. **Anterior 2/3:** general sensation by CN V (trigeminal)
taste by CN VII (facial)

B. **Posterior 1/3, including circumvallate papillae:** both general sensation and taste: CN IX (glossopharyngeal)

C. **Most posterior tongue, valleculae, and minor taste buds:** CN X (vagus)

D. **Development of tongue:** from branchial arches 1–4, lingual buds (bilateral lingual swellings), tuberculum impar, and copula.

Lingual Bulge / Li. Swellings
"Bilateral Swellings"
Tuberculum Impar
Copula

DEV'T OF TONGUE

E. Each branchial arch has an associated cranial nerve:
   1. Arch 1—CN V
   2. Arch 2—CN VII (Chorda tympani)
   3. Arch 3—CN IX
   4. Arch 4—CN X

Tongue Musculature

A. Intrinsic (within tongue only)

B. Extrinsic (connect tongue to other structures) – w/ GLOSSAL

C. All intrinsic muscles of the tongue are innervated by CN XII (hypoglossal)

D. Almost all extrinsic muscles of the tongue are innervated by CN XII (hypoglossal). They include:
   1. Genioglossus
   2. Hyoglossus
   3. Styloglossus

E. The exception is palatoglossus, innervated by CN X (vagus) from the pharyngeal plexus

NOTE

Pay careful attention to the "exceptions"; they help memorization.

Practice Questions

1. Which papillae are smallest in number, contain Von Ebner glands, and taste buds?
   a) Filiform
   b) Fungiform
   c) Foliate
   d) Vallate
   e) Circumvallate

2. Which of the following structures is NOT involved in tongue development?
   a) First branchial arch
   b) Macula
   c) Tuberculum impar
   d) Second branchial arch
   e) Copula

3. Which cranial nerve innervates the intrinsic tongue muscles?
   a) CN VII
   b) CN IX
   c) CN V
   d) CN XII
   e) CN X

4. Which tongue-related muscle is NOT innervated by the hypoglossal nerve?
   a) Genioglossus
   b) Hyoglossus
   c) Intrinsic tongue muscles
   d) Palatoglossus
   e) Styloglossus

Salivary Glands

A. **Types**
   Mucous – closer 2d ducts
   Serous – farther "
   Mixed (mucous/serous)

1. Mucous secretions contain primarily mucin and water. Serous secretions are watery, with more salts and amylase (only found in serous secretions).
2. Mixed glands usually contain both types of cells (mucous and serous) in the same gland. Occasionally, one cell may produce two types of secretions.

B. **Structure**

1. In mixed glands, mucous cells are nearer the duct opening, and serous cells further back. Serous cells in mixed glands are often in "**demilunes**" or crescents surrounding the mucous cells. Their secretions pass by the enclosed mucous cells through "**secretory capillaries.**" or serous capillaries
2. Myoepithelial cells (basket cells) are presumed to help force out secretions through contractile action. They are located between secretory cells and the basal lamina.

C. **Ducts**

1. **Intercalated:** located closer to salivary production b4 striated ducts
2. **Striated:** located farther toward duct. Striated ducts modify salivary concentrations. The striated appearance is due to mitochondria in rows. These mitochondria provide energy needed for active transport of ions. Striated duct cells are generally columnar epithelium.

Specific Glands

A. **Major**

1. **Parotid:** Serous only, drains through **Stenson's duct**, located near maxillary second molar.
2. **Submandibular:** Mixed serous/mucous, drains through **Wharton's duct**, located in floor of the mouth.
3. **Sublingual:** Mucous only, drains through **Wharton's duct and Plica sublingualis** (row of small ducts found in floor of mouth).

B. **Minor**

1. Von Ebner: serous only, surrounding circumvallate papillae of tongue
2. Glossopalatine: mucous only, posterior to sublingual gland
3. Palatine: mucous only, posterior and lateral palate
4. Blandin-Nuhn: mixed, anterior lingual (tongue)
5. Labial: mixed, lip.
6. Buccal: mixed, cheek.

C. **Innervation of secretion:**

1. Parasympathetic:
   a. Parotid: From CN IX (glossopharyngeal) to otic ganglion to auriculotemporal nerve
   b. Submandibular and sublingual: from CN VII (facial), chorda tympani to submandibular (submaxillary) ganglion to gland
2. Sympathetic (all): From superior cervical plexus, travels with artery to gland

General Histology: Gland Types

1. Holocrine: Entire cell becomes secretion (ex: sebaceous)
2. Apocrine: Apex (only) of cell becomes secretion
3. Merocrine: (most common) secretion through membrane by exocytosis. Cell cytoplasm itself is not lost as part of the secretion.
4. Simple glands: One secretory section attached to one duct
5. Compound: Branched, with many secretory sections converging, eventually into one duct.

Practice Questions

1. Which cranial nerves carry the parasympathetic fibers controlling the major salivary glands?
   a) V, VII, and IX
   b) VII, IX, and X
   c) V, IX, and X
   d) IX only
   e) VII and IX

2. Which of the following is a pure serous gland?
   a) Blandin-Nuhn
   b) Palatal
   c) Sublingual
   d) Von Ebner
   e) Brunner

3. Demilunes surrounding mucous cells in the sublingual gland are composed of what type of cells?
   a) mucous
   b) serous
   c) mixed mucous/serous
   d) sebaceous
   e) striated

4. Salivary glands are found in the hard palate primarily in which regions?
   a) Posterior/medial
   b) Anterior/medial
   c) Anterior/lateral
   d) Posterior/lateral
   e) Midline

Muscles of Mastication

(Very important topic for anatomy and dental anatomy sections)

Major muscles of mastication

1. Masseter: attaches to zygoma, lateral ramus, angle, and coronoid process of mandible. Elevator (closer)
2. Medial pterygoid: attaches to medial section of lateral pterygoid plate, maxillary tuberosity, pyramidal process of palatine bone, medial ramus, and angle of mandible. Elevator (closer)
3. Temporalis: attaches to temporal fossa of temporal/frontal/occipital/sphenoid bones, coronoid process and ramus of mandible. *Elevator* (closer) and *retruder*, anterior and posterior fibers elevate, posterior fibers retrude
4. Lateral pterygoid: attaches to lateral pterygoid plate, anterior *condyle, TMJ disc and capsule (especially superior head of muscle). Depressor* (opener), *protruder* produces lateral motion

– Moves mand. LEFT & RIGHT

Innervation

A. All muscles of mastication are innervated by CN V (trigeminal), in particular by "motor branch" V3 (mandibular branch).

B. Also innervated by V3 are the mylohyoid, tensor tympani, tensor veli palatini, and the *anterior* digastric.

C. Related accessory muscles of mastication:

1. Digastric: (anterior) attaches to mandibular symphysis and fascial sling of hyoid. Innervated by V3.

   Accessory depressor (opener)

   (Posterior) attaches to mastoid notch of temporal bone and fascial sling of hyoid. Innervated by CN VII (facial)

   Accessory depressor (opener)

2. Mylohyoid: forms floor of mouth, attaches to mylohyoid line of mandible, hyoid bone, and median raphe. Innervated By V3.

   Accessory depressor (opener)

3. Geniohyoid: attaches to mental spine of mandible and hyoid bone. Innervated by CN XII (hypoglossal)

   Accessory depressor (opener)

midline of chin

NOTE

Masseter and medial pterygoid form "masseteric sling." Masseter is lateral, and medial pterygoid is medial.

GANGLIA Ass. w/ TONGUE / SALIVARY GL.

CN VIII – Submand. (Submax.)
– parasympathetic to submand subli. salivary gl.

CN VII – Sphenopalatine
– parasympathetic to lacrimal/nasal gl.

CN IX – Otic
– parasympathetic to parotid salivary gl.

CN VII – Geniculate
– taste from Ant. ⅔ of tongue

CN IX – Pterygopalatine (Petrosal
– taste from Post ⅓ of tongue

D. Pharyngeal constrictor muscles:
   1. **Superior**: attaches to pterygomandibular raphe (with buccinator) and basiooccipital bone
   2. **Middle**: attaches to pharyngeal raphe, hyoid bone, and stylohyoid ligament
   3. **Inferior**: attaches to pharyngeal raphe, thyroid cartilage, and cricoid cartilage

   All pharyngeal constrictora are innervated by CN X (vagus).

E. Other pharyngeal muscles:
   1. **Palatopharyngeus**
   2. **Salpingopharyngeus**
   3. Both are innervated by CN X (Vagus)

F. Other innervations reviewed:
   1. **Facial expression**: (including buccinator): CN VII (facial)
   2. **Digastric**: anterior: V3, posterior: VII
   3. **Tensor veli palatini**: V3
   4. **Levator palatini**: CN X (vagus)
   5. **Sternocleidomastoid**: CN XI (accessory)
   6. **Trapezius**: CN XI (accessory)

NOTE

All pharyngeal muscles are innervated by CN X except Stylopharyngeus, which is innervated by CN IX (Glossopharyngeal). It is the only muscle innervated by CN IX.

Review of Masticatory Muscle Functions

A. **Closing** (elevating): masseter, medial pterygoid, temporalis

B. **Opening** (depressing): lateral pterygoid, mylohyoid, digastric, geniohyoid

C. **Protruding**: lateral pterygoid

D. **Lateral motion**: lateral pterygoid. Right lateral pterygoid moves mandible *left*. Left lateral pterygoid moves mandible *right*.

E. *Cut* a lateral pterygoid, and mandible will move *toward* side of injury.

F. **Retruding**: temporalis, especially posterior fibers

Practice Questions

1. The major insertion of the temporalis is the:
   a) Coronoid process
   b) Angle of the mandible
   c) Condyle
   d) Body of the mandible
   e) TMJ articular disc

2. The contraction of both lateral pterygoids will cause:
   a) Forceful biting
   b) Forward movement of the condyle
   c) Elevation of the condyle
   d) Rapid retrusion of the mandible

3. The lateral pterygoid inserts into:
   a) Articular disc and coronoid process
   b) Mandibular angle and body
   c) Articular disc and mandibular angle
   d) Articular disc and condyle
   e) Condyle and mandibular ramus

4. The fibers of the temporalis pass:
   a) Medial to the zygomatic arch and insert into the coronoid process
   b) Lateral to the zygomatic arch and insert into the coronoid process
   c) Medial to the zygomatic arch and insert into the condyle
   d) Lateral to the zygomatic arch and insert into the condyle

5. Which muscle is innervated by CN VII?
   a) Temporalis
   b) Medial pterygoid
   c) Buccinator
   d) Tensor palatini
   e) Anterior digastric

Temperomandibular Joint (TMJ)

A. Characteristics/structure:
   1. Synovial joint (except for disc and articular surfaces)
   2. Upper and lower compartments, separated by disc
   3. Located where mandibular condyle articulates with glenoid (articular) fossa and articular eminence of temporal bone

B. Disc:
   1. Composed of fibrous connective tissue (may contain fibrocartilage with chondrocytes in older patients)
   2. Lateral section—thicker, vascular
   3. Central section—thinner, avascular

C. Lateral pterygoid connections:
   1. Into articular capsule
   2. Into articular disc

D. Accessory ligaments: general
   1. Functions unclear, not agreed upon
   2. May limit motion or have protective function

E. Accessory ligaments: details
   1. Lateral ligament—connnects zygoma to articular capsule
   2. Sphenomandibular—connects spine of sphenoid to lingula and ramus of mandible
   3. Stylomandibular—connects styloid process to posterior ramus

F. Innervation of TMJ:
   Auriculotemporal and masseteric branches of V3

Practice Questions

1. Protection of the TMJ, both during normal use and during trauma, is provided by:
   a) Strength of the fibrous connective tissue of the disc
   b) Synovial fluid
   c) Temporalis muscle
   d) Masseteric sling
   e) Accessory ligaments
   ✓ f) All of the above

2. Which of the following accurately describes the TMJ?
   a) It is a suture joint
   b) It has one synovial compartment
   c) It has two synovial compartments
   ✓ d) The upper and lower compartments are separated by the condylar head

3. The pain and prioprioception sensation for the TMJ travels in which nerve?
   ✓ a) Auriculotemporal
   b) Maxillary
   c) Vagus
   d) Temporal
   e) Inferior alveolar

4. On the posterior side of the articular eminence, you will find what tissue type at the surface?
   a) Elastic cartilage
   b) Osseous
   ✓ c) Fibrous connective tissue
   d) Fibrocartilage
   e) Hyaline cartilage

Bones: Histology and Formation

A. Common bone terminology (often confusing)

1. **Compact bone**: **lamellar bone, layered**, with osteons (haversian systems). Makes up **outer layer** of most bones
2. **Spongy bone**: with spicules (trabeculae), also known as **cancellous** bone. Makes up **inner layer** of most bones
3. **Bundle bone**: compact bone with Sharpey's fibers (collagen fibers, as in tooth socket and periodontal ligament)
4. **Woven bone**: **early bone of the intramembranous** type

B. Bone and cartilage cells

1. **Osteocytes:** found in lacunae of osteons, **mature cells**, may be former osteoblasts
2. **Osteoblasts:** **bone forming cells**, lay down bone matrix
3. **Osteoclasts:** multinucleated bone **resorbing cells**, stimulated by PTH
4. **Chondrocytes:** found in lacunae of cartilage

C. Haversian systems

1. Found in **compact bone**
2. **Concentric circles of bone** around central (haversian) canal → HC
3. **Lacunae with osteocytes** found in circular arrangement around central canal
4. Movement of materials through artery and vein in canal, also **canaliculi and volkmans canals** – perpendicular versions of HC

D. Distinctions between bone and cartilage = Fxn delivery of nutrients & pick up of wastes

1. Bone is more mineralized
2. Osteocytes versus chondrocytes
3. Diffusion easier through cartilage matrix (little or no diffusion through bone matrix)
4. Bone grows appositionally only (around edges)
5. Cartilage can grow appositionally or interstitially (from within)

E. Bone formation types

Endochondral: on a cartilage model

Intramembranous: on a primitive connective tissue model

Early intramembranous bone is "**woven**" **with collagen strands** in all directions.

BONE
- more mineralized
- osteocytes
- little to no diffusion thru bone matrix
- grows appositionally

CARTILAGE
- less mineralized
- chondrocytes
- easy diffusion thru cartilage matrix
- grows appositionally & interstitially

F. Locations of bone formation types

1. Endochondral-axial skeleton, appendicular skeleton (long bones), base of skull (sphenoid, etc.), mandibular condyle area
2. Intramembranous: flat bones of skull (frontal, parietal, etc.) and mandible (except condyle)

G. Ossification of long bones

1. Cartilage on articular end
2. Epiphysis: end, with no growth
3. Epiphyseal plate: growth area with new cartilage
4. Metaphysis: area of new bone, which has recently replaced cartilage
5. Diaphysis: shank of developed bone

H. Summary of major foramina

Most foramina of interest are in the sphenoid bone

I. Contents

1. Optic canal: CN II, ophthalmic artery, central retinal vein
2. Superior orbital fissure: CN V1, CN III, CN IV, CN VI, ophthalmic vein
3. Foramen rotundum: CN V2
4. Foramen ovale: CN V3, accessory meningeal artery
5. Foramen spinosum: middle meningeal artery
6. Foramen lacerum: no structures
7. Jugular foramen: (Note: this is located in the occipital bone): CN IX, CN X, CN XI

ENDOCHONDRAL
1. axial skeleton
2. appendicular skeleton
   - long bones
3. base of skull
   - sphenoid
4. mandibular condyle

INTRAMEMBRANOUS
1. flat bones of skull
   - frontal
   - parietal
2. mandible
   - except condyle

FORAMINA of INTEREST
- found in sphenoid bone

OPTIC CANAL
- CN II, Ophthalmic Art
  Central Retinal vein

SUP. ORBITAL FISSURE
- CN V_1, CN III, CN IV
  Ophthalmic Vein

ROTUNDUM
- CN V_2

OVALE
- CN V_3, Acc. Meningeal Art.

SPINOSUM
- Middle Meningeal Art.

LACERUM
- nothing

JUGULAR (in occipital bone)
- CN IX, CN X, CN XI
  Int. Jugular vein

Practice Questions

1. The motor division of CN V passes through:
   a) Foramen ovale
   b) Inferior orbital fissure
   c) Foramen rotundum
   d) Foramen lacerum
   e) Superior orbital fissure

2. Rough ER would be expected to be most prominent in which cell type?
   a) Osteoclast
   b) Osteocyte
   c) Osteoblast
   d) Chondrocyte
   e) Adipose cell

3. Hyaline cartilage is different from bone in which of the following ways?
   a) Cartilage is more highly calcified
   b) Only cartilage grows interstitially
   c) Only bone grows appositionally
   d) Only cartilage is connective tissue
   e) Only bone has cells in lacunae

4. During long bone formation, the major function of cartilage is to:
   a) Add flexibility to final bone
   b) Act as a region of growth of bone length
   c) Produce future osteoblasts
   d) Replace trabecular bone

5. If cartilage growth is disturbed during fetal development, which of the following bone areas will be most affected?
   a) Frontal and parietal bones
   b) Axial skeleton and base of skull
   c) Parietal and sphenoid bones
   d) Appendicular skeleton and petrous temporal bone
   e) Sphenoid and frontal bones

f. Temporal, parietal n both

6. The alveolar bone of the tooth socket (cribriform plate) consists of what bone type?
   a) Woven bone and trabecular bone
   b) Bundle bone and woven bone
   c) Lamellar bone and woven bone
   d) Bundle bone and lamellar bone / compact / haversian / bone w/ osteon
   e) Bundle bone, woven bone, and lamellar bone

Review of Bone-Related (and Other) Hormones/Sources/Histology

1. Parathyroid–principal cells—**PTH**—increases serum calcium (Ca^{++})
2. Thyroid–parafollicular cells—**calcitonin**—decreases serum calcium
3. Thyroid–follicular cells—**thyroxin, T3, T4**—increases BMR
4. Pancreas–alpha cells—**glucagon**—increases blood glucose
5. Pancreas–beta cells—**insulin**—decreases blood glucose
6. Anterior pituitary–acidophils—**GH (STH)**—stimulates long bone growth
7. Anterior pituitary–acidophils—**prolactin**—stimulates milk production
8. Anterior pituitary–basophils—**thyrotropin (TSH)**—stimulates thyroid
9. Anterior pituitary–basophils—**FSH**—stimulates ovary maturation and follicular growth
10. Anterior pituitary–basophils—**LH**—stimulates corpus luteum formation, ovulation
11. Anterior pituitary–chromophobes—**ACTH**—stimulates adrenal cortex (cortisol)
12. Posterior pituitary–Herring bodies—**oxytocin**—stimulates uterine contraction
13. Posterior pituitary–Herring bodies—**vasopressin**—increases water resorption by collecting tubules of kidney

NOTE

NBDE often refers to the anterior pituitary as adenohypophysis and the posterior pituitary as neurohypophysis

Practice Questions

1. Parafollicular thyroid cells produce which of the following?
   a) Thyroxine
   b) TSH
   c) T3
   d) Calcitonin
   e) Iodine

2. The rate of growth of the epiphyseal plate of long bones is most affected by secretions from which gland? - STH & GH - Calcitonin
   a) Hypophysis
   b) Parathyroid
   c) Alpha cells of pancreas
   d) Beta cells of pancreas
   e) Adrenal medulla

3. Osteoclasts are described in terms of cell morphology as:
   a) Anuclear
   b) Binuclear
   c) Multinuclear
   d) Thermonuclear
   e) Polymorphonuclear – neutrophils (multi-lobed nuclei)

4. Alpha cells (acidophils) of the hypophysis secrete:
   a) Glucagon
   b) Insulin
   c) Thyroxin
   d) GH
   e) ADH

5. The pancreas can be described histologically as:
   a) Follicles of secretion surrounded by islets
   b) Islands of special cells within areas of exocrine alveoli
   c) Follicles of secretion surrounded by ducts
   d) Alternating endocrine and exocrine cell layers

EXOCRINE DUCT AREA
- pancreatic amylase / lipase
- islets of Langerhans & special cell

REVIEW TEST 2

1. Which pair of muscles is innervated by cranial nerve V?
   a) Masseter, buccinator – VII
   b) Mylohyoid, geniohyoid XII
   ✓ c) Lateral pterygoid, medial pterygoid
   d) Anterior digastric, posterior digastric – VII
   e) Levator palatini, tensor palatini – V
   ↳ X

2. Which muscle is most involved in condylar and articular disc movement?
   a) Medial pterygoid – internal
   b) Buccinator
   c) Temporalis
   ✓ d) Lateral pterygoid – external
   e) Masseter

3. When the posterior fibers of temporalis contract, the major mandibular motion will be:
   ↳ horizontal
   a) Opening
   ✓ b) Retrusion – pulling in
   c) Closing
   d) Protrusion – lat. pterygoid
   e) Elevation

4. Which muscle forms the bulk of the floor of the mouth, inferior to the tongue?
   a) Geniohyoid
   b) Anterior digastric
   c) Posterior digastric
   ✓ d) Mylohyoid
   e) Superior pharyngeal constrictor

5. Which nerve supplies motor innervation to the buccinator?
   a) CN VII – facial
   b) Inferior alveolar of CN V
   c) CN XI
   d) Buccal nerve of CN V
   e) CN IX

6. The pterygomandibular raphe joins which two muscles?
   a) Two sides of the superior pharyngeal constrictor
   b) Buccinator and middle pharyngeal constrictor
   c) Middle and superior pharyngeal constrictor
   d) Superior pharyngeal constrictor and buccinator
      on ↓ post.

7. Which structure attaches to the lingula of the mandible?
   a) Temperomandibular ligament
   b) Stylomandibular ligament
   c) Sphenomandibular ligament
   d) Masseter muscle
   e) Temporalis muscle

8. The articular disc of the TMJ is moved forward primarily by the (↑ meniscus)
   a) Temporalis
   b) Stylomandibular ligament
   c) Capsular ligament
   d) Medial pterygoid muscle
   e) Lateral pterygoid muscle – sup. or lat.

9. The nonworking condyle usually moves in which directions?
   a) Upward, forward, medial
   b) Downward, forward, lateral
   c) Downward, forward, medial
   d) Upward, backward, medial
   e) Directly lateral

left w mov't on ↓ left
has a rt nw side (nw condyle)
moves medially & ↓

10. Which cranial nerve carries pain sensation from the posterior third of the tongue?

a) Trigeminal – sensation
b) Facial – taste
c) Hypoglossal
✓ d) Glossopharyngeal
e) Vagus

11. A patient had surgery performed that damaged the right hypoglossal nerve. The tongue will move in which direction when protruded?

a) Downward
b) Upward
c) Directly forward
✓ d) To the right – protrude on side of damage
e) To the left

12 Which salivary gland cells have folded cell membranes at their base, which are filled with large numbers of mitochondria?

a) Intercalated duct cells
✓ b) Striated duct cells – changes in ionic compositions of saliva
c) Serous secretory cells
d) Mucous secretory cells
e) Myoepithelial (basket) cells

13. Which structures are NOT seen in microscopic examination of the parotid gland? – # 100% Serou

a) Intercalated ducts
✓ b) Serous demilunes – mixed of.
c) Striated ducts
d) Serous secretory cells

14. Which cranial nerves pass through the jugular foramen?

a) VII, IX, X
✓ b) IX, X, XI
c) VIII, IX, X
d) VII, X, XI
e) None of the above

15. Food and oxygen can reach the osteocytes of compact bone through:
    a) Osseous matrix — can't pass
    b) Canaliculi — microscopic pores / canals
    c) Capillaries — veins, art.
    d) Cartilagenous matrix — can't pass
    e) Volkman's canals — branch of HC
    1) a, b, c
    2) a, c, e
    3) b, c, d
    4) a, c, d
    ✓ 5) b, c, e

16. Which muscle is the chief mover of the mandible TOWARD the left?
    a) Left medial pterygoid
    b) Left lateral pterygoid
    c) Right medial pterygoid
    ✓ d) Right lateral pterygoid — causes left lat. pte.

17. Which of the following is secreted by the neurohypophysis?
    a) FSH — ↳ post. pituitary
    b) TSH
    ✓ c) ADH
    d) LH
    e) STH

    a. ADH / vasopressin
    b. oxitocin
    - uterine contraction
    - Stim. ♀.

18. Which glandular area secretes hormones that are products of tyrosine metabolism? — ↳ prod. of epinephrine & norepinephrine (w/ or w/o adrenalin)
    a) Alpha cells of pancreas
    b) Beta cells of pancreas
    c) Adrenal cortex — stim. by ACTH, prod aldosterone & cortisol
    ✓ d) Adrenal medulla — prod. epineph.
    e) Testes

19. The number and location of the parathyroid glands is usually

a) Single, superior to thyroid

b) Multiple, superior to thyroid

c) Single, imbedded in thyroid tissue

d) Multiple, imbedded in thyroid tissue

e) Multiple, inferior to thyroid

20. A patient is involved in an accident that completely tears the left lateral pterygoid muscle. On attempting to open, the patient's mandible will move:

a) Left

b) Right

c) In an elevating direction

d) In a direct protruding direction