USMLE Step 1 Secrets

Your Key to USMLE Success

From the desk of Tom Paulson, Director of Test-Taking Strategy at USMLE Step 1 Secrets, January 20, 2004-

Dear future USMLE Success Story:

Congratulations on your purchase of the most advanced test-taking manual for the USMLE Step 1 licensure test. Notice I did not say study guide- there are plenty of decent study guides on the market, but that was not our objective in writing this manual. Our goal is to seek and exploit specific weaknesses in the USMLE Step 1 assessment, and then share those secrets with our customers.

Let's be perfectly honest here- you've worked hard enough in medical school, and if you want to spend hours in a study guide to boost your score, that's a great thing to do. In fact, we recommend at least a brief review of some of the better study guides on the market. But that's simply not enough to do well in the high-pressure high-stakes environment of the test day. How well you do on this test will have a significant impact on your future- and we have the research and practical advice to help you execute on test day.

The product you're reading now is much more than a study guide- it is a tactical weapon designed to exploit weaknesses in the test itself, and help you avoid the most common errors students make when taking the USMLE Step 1 licensure test.

How to use this manual

We don't want to waste your time. This manual is fast-paced and fluff-free. We suggest going through it a number of times, trying out its methods on a number of practice tests.

First, read through the manual completely to get a feel for the content and organization. Read the general success strategies first, and then proceed to the individual test sections. Each tip has been carefully selected for its effectiveness.

Second, read through the manual again, and take notes in the margins and highlight those sections where you may have a particular weakness (we strongly suggest printing the manual out on a high-quality printer).

Third, go through at least one practice test with the manual at your side and apply the strategies. We believe two practice tests to be the maximum benefit, the first time with all strategies except time (take as much time as you need), the second time without the benefit of the open manual to refer to during the test. See the appendix for the exclusive list of practice test sources we believe to be valuable.

Finally, bring the manual with you on test day and study it before the exam begins.

Your success is our success

We would be delighted to hear your USMLE Step 1 Success Story. Drop us a line at support@mo-media.com and tell us your story. Thanks for your business and we wish you continued success-

Sincerely,

The USMLE Step 1 Secrets Team

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Secret Key #1 – Guessing is not guesswork.

Even if you have no idea about a question, you still have a variable percentage chance of getting it right. Most students do not understand the impact that proper guessing can have on their score. Proper guessing can easily be the difference between success and failure.

Success Strategy #1

Let me introduce one of the most valuable ideas of this course- the $5 challenge:

You only mark your "best guess" if you are willing to bet $5 on it.
You only eliminate choices from guessing if you are willing to bet $5 on it.

Why $5? Five dollars is an amount of money that is small yet not insignificant, and can really add up fast (20 questions could cost you $100). Likewise, each answer choice on one question of the USMLE step 1 test will have a small impact on your overall score, but it can really add up to a lot of points in the end.

The process of elimination IS valuable. The following shows your chance of guessing it right:

If you eliminate this many choices:	0	1	2	3
Chance of getting it correct	25%	33%	50%	100%

However, if you accidentally eliminate the right answer or go on a hunch for an incorrect answer, your chances drop dramatically: to 0%. By guessing among all the answer choices, you are GUARANTEED to have a shot at the right answer.

That's why the $5 test is so valuable- if you give up the advantage and safety of a pure guess, it had better be worth the risk.

What we still haven't covered is how to be sure that whatever guess you make is truly random. Here's the easiest way:

Always pick the first answer choice among those remaining.

Such a technique means that you have decided, **before you see a single test question**, exactly how you are going to guess- and since the order of choices tells you nothing about which one is correct, this guessing technique is perfectly random.

Let's try an example-

A student encounters the following problem:

Which of the following characteristics match an arterial wound assessment done by a physician?
A: Painful, pain at rest
B: Medial aspect of lower leg
C: Increased temperature
D: Red, purple color

The student has a small idea about this question- he is pretty sure that the characteristic is "increased temperature," choice C, but he wouldn't bet $5 on it. He knows that the characteristic is either "painful, pain at rest" or "increased temperature," so he is willing to bet $5 on both choices B and D not being correct. Now he is down to A and C. At this point, he guesses A, since A is the first choice remaining.

The student is correct by choosing A, since the characteristic match would be "painful, pain at rest". He only eliminated those choices he was willing to bet money on, AND he did not let his stale memories (often things not known

definitely will get mixed up in the exact opposite arrangement in one's head). He blindly chose the first remaining choice, and was rewarded with the fruits of a random guess.

This section is not meant to scare you away from making educated guesses or eliminating choices- you just need to define when a choice is worth eliminating. The $5 test, along with a pre-defined random guessing strategy, is the best way to make sure you reap all of the benefits of guessing.

Similar Answer Choices

When you have two answer choices that are direct opposites, one of them is usually the correct answer.

Example:

A. Secretes cholesterol
B. Synthesizes cholesterol

These two answer choices are very similar and fall into the same family of answer choices. A family of answer choices is when two or three answer choices are very similar.

Summary of Guessing Techniques

1. Eliminate as many choices as you can by using the $5 test. Use the common guessing strategies to help in the elimination process, but only eliminate choices that fail the $5 test.
2. Among the remaining choices, only pick your "best guess" if it passes the $5 test.
3. Otherwise, guess randomly by picking the first remaining choice that was not eliminated.

Secret Key #2 – Practice Smarter, Not Harder

Many students delay the test preparation process because they dread the awful amounts of practice time they think necessary to succeed on the test. We have refined an effective method that will take you only a fraction of the time.

There are a number of "obstacles" in your way on the USMLE test. Among these are answering questions, finishing in time, and mastering test-taking strategies. All must be executed on the day of the test at peak performance, or your score will suffer. The USMLE is a mental marathon that has a large impact on your future.

Just like a marathon runner, it is important to work your way up to the full challenge. So first you just worry about questions, and then time, and finally strategy:

Success Strategy #2

1. Find a good source for USMLE Step 1 practice tests. One is included at the end of this guide for your convenience, but another good source for these are the links included and the end of this guide. You will need at least 2 practice tests.
2. If you are willing to make a larger time investment (or if you want to really "learn" the material, a time consuming but ultimately valuable endeavor), consider buying one of the better study guides on the market.
3. Take a practice test with no time constraints, with all study helps "open book." Take your time with questions and focus on applying the strategies.
4. Take a final practice test with no open material and time limits.

If you have time to take more practice tests, just repeat step 5. By gradually exposing yourself to the full rigors of the test environment, you will condition your mind to the stress of test day and maximize your success.

Secret Key #3 – Prepare, Don't Procrastinate

Let me state an obvious fact: if you take the USMLE step 1 licensure test three times, you will get three different scores. This is due to the way you feel on test day, the level of preparedness you have, and, despite claims to the contrary, some tests WILL be easier for you than others.

Since your passing is so crucial, you should maximize your chances of success. In order to maximize the likelihood of success, you've got to prepare in advance. This means taking practice tests and spending time learning the information and test taking strategies you will need to succeed.

General Strategies

The most important thing you can do is to ignore your fears and jump into the test immediately- do not be overwhelmed by any strange-sounding terms. You have to jump into the test like jumping into a pool- all at once is the easiest way.

Make Predictions

As you read and understand the question, try to guess what the answer will be. Remember that several of the answer choices are wrong, and once you begin reading them, your mind will immediately become cluttered with answer choices designed to throw you off. Your mind is typically the most focused immediately after you have read the passage and question and digested its contents. If you can, try to predict what the correct answer will be. You may be surprised at what you can predict.

Quickly scan the choices and see if your prediction is in the listed answer choices. If it is, then you can be quite confident that you have the right answer. It still won't hurt to check the other answer choices, but most of the time, you've got it!

Answer the Question

It may seem obvious to only pick answer choices that answer the question, but USMLE can create some excellent answer choices that are wrong. Don't pick an answer just because it sounds right, or you believe it to be true. It MUST answer the question. Once you've made your selection, always go back and check it against the question and make sure that you didn't misread the question, and the answer choice does answer the question posed.

Benchmark

After you read the first answer choice, decide if you think it sounds correct or not. If it doesn't, move on to the next answer choice. If it does, tentatively check that

answer choice. This doesn't mean that you've definitely selected it as your answer choice, it just means that it's the best you've seen thus far. Go ahead and read the next choice. If the next choice is worse than the one you've already selected, keep going to the next answer choice. If the next choice is better than the choice you've already selected, check the new answer choice as your best guess.

The first answer choice that you select becomes your standard. Every other answer choice must be benchmarked against that standard. That choice is correct until proven otherwise by another answer choice beating it out. Once you've decided that no other answer choice seems as good, do one final check to ensure that your answer choice answers the question posed.

Valid Information

Don't discount any of the information provided in the question. Every piece of information may be necessary to determine the correct answer. None of the information in the question is there to throw you off (while the answer choices will certainly have information to throw you off). If two seemingly unrelated topics are discussed, don't ignore either. You can be confident there is a relationship, or it wouldn't be included in the question, and you are probably going to have to determine what is that relationship for the answer.

Avoid "Fact Traps"

Don't get distracted by a choice that is factually true. Your search is for the answer that answers the question. Stay focused and don't fall for an answer that is true but incorrect. Always go back to the question and make sure you're choosing an answer that actually answers the question and is not just a true statement.

Milk the Question

Some of the questions may throw you completely off. They might deal with a subject you have not been exposed to, or one that you haven't reviewed in years.

While your lack of knowledge about the subject will be a hindrance, the question itself can give you many clues that will help you find the correct answer. Read the question carefully, and look for clues. Watch particularly for adjectives and nouns describing difficult terms or words that you don't recognize. Regardless of if you understand a word or not, replacing it with the synonyms used for it in the question may help you to understand what the questions are asking.
Example: A bacteriophage is a virus that infects bacteria….

While you may not know much information concerning the characteristics of a bacteriophage, the fifth word into the question told you that a bacteriophage is a virus. Whenever a question asks about a bacteriophage, you can mentally replace the word "bacteriophage" with the word "virus". Your more general knowledge of viruses will enable you to answer the question intelligibly.

Look carefully for these descriptive synonyms (nouns) and adjectives and use them to help you understand the difficult terms. Rather than wracking your mind about specific detail information concerning a difficult term in the question, use the more general description or synonym provided to make it easier for you.

Keys to Taking the Examination

1. A good night's sleep is better than reading the following material the night before the test.
2. Try out a set of ear plugs the day before because you may be in room full of people taking multiple tests, and it can be noisy.
3. Know the exact physical location of the testing site and drive the route to the site prior to test taking day.
4. Bring your identification required at the testing center including a marriage certificate for women who have changed their names.
5. Bring a light jacket or sweater because the inside of the testing center may be cold.

6. Take the Test.
7. Attempt to remember your own name and location of your car when leaving the testing facility.

Be Aware of the Following Hints

1. Most of the questions will focus on application of your knowledge of Anatomy, Physiology, Pathology, Immunology, Genetics, Pharmacology, Microbiology, NeuroAnatomy and Behavioral Scieces. However, a large number of questions will still focus on just basic knowledge of these subject areas.
2. 350 questions offered given on the USMLE Step 1 test. These questions are presented in seven block formats of 50 questions within each block.
3. Each area of basic knowledge is not included with a specific block. All of the material is random. You will be required to “switch gears” between each of the above content areas.
4. Each block should be considered a separate mini-test. You have 1 hour to complete each of the seven blocks.
5. You are allowed 45-60 minutes of time for breaks. Your breaks should not be taken during a block, but following a completed mini-test.
6. The USMLE is offered on the computer.

Registering for the USMLE Step 1 Licensure Test

1. Contact the National Board of Medical Examiners. Foreign applicants must apply to the ECFMG.

2. Send in complted application with a specified testing period. You must select a testing period (3 month window). Moreover, your application must be completely process before the start date of your testing "window."

3. Receive scheduling permit, candidate idendification number, and scheduling number. You will also receive validation of your testing "window" (3 month period).

4. Contact Slyvan Prometric to set-up a testing date.

5. Take the Test

Contact Information

National Board of Medical Examiners
http://www.nbme.org

Education Commision for Foreign Medical Graduates (ECFMG)

http://www.ecfmg.org

USMLE Step 1 Testing Tips

1. Wear loose fitting clothing to the testing center.

2. Bring at least 2 forms of ID to the testing center.

3. Study during the time of day you are most alert.

4. Allow yourself some flexibility in your study schedule if something unusual comes up and requires your immediate attention.

5. Make sure that your photo IDs match your current appearance.

6. Get a good night's sleep before the exam.

7. Don't attempt to cram the details the night before the test.

8. Set-up a study schedule at least 3-4 weeks before test day.

9. Maximize your learning style. If you are a visual learner use visual study aids, if you are an auditory learner, convert information into an auditory format.

10. Relax and limit your stress level before the exam.

11. Focus on your weakest knowledge base.

12. Find a study partner to review with and help clarify questions.

13. Eliminate the answer choices that you know are wrong and then guess.

14. Continue to maintain a positive attitude and not a defeatist position even if you feel the test is going poorly.

15. Only change your first answer is you are absolutely positive it is not correct.

16. Don't attempt to scan the question and then find the correct answer. You have the time to read each question.

USMLE Step 1 Score Reporting

The reported minimum score are as follows:

182 3-point scale

75 2-point scale

Generally, test scores are repored back to the student withing a 2-4 week time period. All scores are compared to a test group selected by USMLE. A passing score on the Step 1 test is around 60-65% correct answers. The key testing score is a pass/fail analysis. Basically, you either pass or fail.

Nervous System Review

Brain

Frontal lobe-controls emotions, judgments, controls motor aspects of speech, primary motor cortex for voluntary muscle activation

Parietal lobe-receives fibers with sensory information about touch, proprioception, temperature, and pain from the other side of the body

Temporal lobe-responsible for auditory information, and language comprehension

Occipital lobe- center for visual information
Cerebellum- coordination of muscle function
Brainstem - (midbrain, pons, and medulla)-respiratory and cardiac center, nerve pathways to the brain

Diencephalon – (thalamus, subthalamus, and hypothalamus)

Thalamus – Integrate and relay sensory information from the face, retina, cochlea, and taste receptors. (Interprets sensation of touch, pain and temperature).
Hypothalamus

1. Controls the autonomic nervous system and the neuroendocrine systems.
2. Maintains body homeostasis
3. Helps regulate body temperature
4. Helps regulate appetite control
5. Thirst Center
6. Sleeping Cycle
7. Control of Hormone secretion

Glascow Coma Scale

+Eye Opening

+Best Motor Response

+Best Verbal Response

Total (3-15 Score Range) A score of 1 in each category indicates no performance of skill.

Autonomic Nervous System

Sympathetic (Fight or Flight):

1. Dilated pupils
2. Elevates heart rate and respiratory rate
3. Sweating
4. Epinephrine and norepinephrine secreted
5. Increased blood pressure
6. Constriction of skin and abdominal arterioles

Parasympathetic:

1. Constricted pupils
2. Lowers heart rate and respiratory rate
3. Increased peristalsis
4. Acetylcholine secreted
5. Decreases blood pressure
6. Relaxation of skin and abdominal arterioles

Cranial Nerves

I-Olfactory-Smell

II-Optic-Vision acuity

III-Oculomotor – Eye function

IV-Trochlear – Eye function

V-Trigeminal – Sensory of the face,chewing

VI-Abducens – Eye function

VII-Facial – Facial expression, wrinkle forehead, taste anterior tongue
VIII-Vestibulocochlear – Auditory acuity, balance and postural responses
IX-Glossopharyngeal – taste on posterior 33% of the scale
X-Vagus – Cardiac, respiratory reflexes
XI-Spinal Accessory - Strength of trapezius and Sternocleidomastoid muscles
XII-Hypoglossal – Motor function of the tongue

Decorticate vs. Decerebrate Rigidity
Decorticate posturing-Upper limbs in flexion and the lower limbs in extension
Decerebrate posturing- Increased tone with all limbs in a position of extension

Circle of Willis Arteries

1. Lateral striate
2. PCA- posterior communicating artery
3. Anterior communicating artery
4. MCA-middle cerebral artery
5. Anterior cerebral artery

Key Terms

Apraxia-Inability to perform purposeful movements
Agnosia-Inability to recognize familiar objects by the various senses
Spasticity-increased tone, hyperactive reflexes, clonus,+Babinski
Ataxia-general term used to describe uncoordinated movement; may influence gait, posture, and patterns of movements
Chorea-involuntary, rapid, irregular, jerky movements, clinical feature of Huntington disease
Flaccidity-absent tone
Hypotonia-decreased tone
Expressive Aphasia- inability to speak or difficulty speaking
Receptive Aphasia-inability to understand verbal speech, inability to receive information

CVA, Stroke

1. Anterior cerebral stroke: lower extremity more involved than upper extremity, contralateral hemiparesis and sensory deficits
2. Posterior cerebral stroke: contralateral sensory loss, transient contralateral hemiparesis
3. Middle cerebral artery stroke: upper extremity more involved than the lower extremity, contralateral sensory loss

Risk Factors

1. Diabetes
2. Atherosclerosis
3. Hypertension
4. Cardiac disease
5. Transient ischemic attacks

Aneurysm Precautions

1. Avoid rectal temperatures
2. Limit visitors
3. Avoid Valsalva's maneuver
4. Head of bed should be between 30-45 degrees

Valsalva's maneuver – occurs when attempting to forcibly exhale with the glottis, mouth and nose closed. It causes an increase in intrathoracic pressure with an accompanying collapse of the vein of the chest wall. The following may result:

1. Slowing of the pulse
2. Decreased return of blood to the heart
3. Increased intrathoracic pressure

Elevated Intracranial Pressure

In most cases you should do the following:

1. Maintain proper fluid volumes

2. Set-up quiet environment for minimal sensory stimulation
3. Elevate HOB (head of bed) to approximately 30 degrees
4. Limit suctioning performed

Horner's Syndrome- Sympathetic innervation to the face is interrupted by a lesion in the brain stem resulting in pupillary constriction, dry and red face with no sweat, ptosis-Mueller's muscle, problem located in sympathetic ascending fibers

Autonomic Dysreflexia- caused by a lesion in the high thoracic or cervical cord. Severe hypertension, sweating and headaches noted. May occur with a blockage in a urine catheter

Signs/Symptoms

1. Bradycardia
2. Headache
3. Increased parasympathetic activity
4. Excessive perspiration
5. Excessive sympathetic response
6. Elevated blood pressure
7. Stimulation of baroreceptors in aortic arch and caroticd sinus

Parkinson's Disease-a degenerative disease with primary involvement of the basal ganglia; characterized by the following:

Signs/Symptoms

1. Bradykinesia
2. Resting tremor
3. Impaired postural reflexes
4. Rigidity
5. Loss of inhibitory dopamine
6. Mask like affect
7. Emotional lability

Multiple Sclerosis–progressive demyelinating disease of the central nervous system affecting mostly young adults

Cause unknown, most likely viral.

1. Fluctuating exacerbations
2. Demyelinating lesions limit neural transmission
3. Confirmed with lumbar puncture, elevated gamma globulin, CT/MRI, myelogram, EEG.
4. Mild to moderate impaired cognition common
5. Sensory Deficits
6. Bowel and Bladder Deficits
7. Spasticity common
8. Ataxic gait

Myasthenia gravis- neuromuscular disease characterized by fatigue of skeletal muscles and muscular weakness.

***Key point*-Review the differentiation between MG and a cholinergic crisis, using the Tensilon Test. A cholinergic crisis may have hypotension, bradycardia vs. myasthenia gravis.

Signs/Symptoms

1. Progressive involvement
2. Decreased muscle membrane acetylcholine receptors
3. Severe weakness (proximal more than distal muscles)
4. Facial, ocular and bulbar weakness
5. Possible life-threatening respiratory muscle weakness
6. Probable use of anticholinesterase drugs for treatment

Guillain-Barre' Syndrome-polyneuropathy with progressive muscular weakness

Signs/Symptoms

1. Demyelination of peripheral and cranial nerves

2. Motor paralysis in an ascending pattern
3. 3% Mortality – respiratory failure
4. Autonomic dysfunction-arrhythmias, blood pressure changes, tachycardia

Amyotrophic lateral sclerosis (Lou Gehrig's disease) – degenerative disease affecting upper and lower motor neurons

Signs/Symptoms

1. Death typically in 2-5 yrs.
2. Spasticity, hyperreflexia
3. Dysarthria, Dysphagia
4. Autonomic Dysfunction in approximately 1/3 of patients
5. Cognition is normal

Post-polio Syndrome- slowly progressive muscle weakness that occurs in patients with a history of acute poliomyelitis, after a stable period

Sign/Symptoms

1. New Weakness
2. Pain/Myalgia
3. Abnormal fatigue

Seizures

Epilepsy-recurrent seizures due to excessive and sudden discharge of cerebral cortical neurons.

Tonic-clonic (Grand Mal) –Pt. confused and drowsy about the seizures, 2-5 min generally

Absence seizures (Petit Mal)- Brief, no convulsive contractions, may be up to 100X day

Simple Seizures- no loss of consciousness

Complex Seizures, brief loss of consciousness with psychomotor changes

**_Key Point_- When a patient has a seizure during most interventions, do not use a tongue blade and allow free movement in a safe environment

Meningitis-inflammation of the meninges of the spinal cord and brain caused by bacteria.
The most common bacteria are the following: *Neisseria meningitidis, Diplococcus pneumoniae,* and *Haemophilus influenzae*
Signs/Symptoms

1. Brudzinski's sign
2. Kernig's sign
3. Stiff/Tight neck
4. Fever
5. Confused

Anterior Cord Syndrome – damage is mainly in anterior cord resulting in loss of motor function and pain and temperature with preservation of light touch, proprioception and position sense
Brown-Sequard Syndrome – hemisection of SC resulting in ipsilateral weakness and loss of position and vibration sense below the level of lesion

Define each of the following:
Decending Tracts:
Vestibulospinal
Corticospinal
Rubrospinal

Ascending Tracts:
Dorsal Column/Medial Leminiscal
Spinothalamic
Dorsal Spinocerebellar
Ventral Spinocerebellar

Upper Motor Neuron Lesion

A. Disuse atrophy
B. +Babinski
C. Hypertonia (Spasticity)
D. Weakness or paralysis of movement not individual muscles
E. Hyperreflexia

Lower Motor Neuron Lesion

A. True Atrophy
B. Weakness of individual muscles
C. Fibrillations
D. Hyporeflexia

APGAR score: (Appearance, Pulse, Grimace, Activity, Respiration) (0-2) each category.

1. Color
2. Heart Rate
3. Reflex irritiability
4. Muscle tone
5. Respiratory effort

Reflex Arc

The typical pathway of a reflex may be outlined as follows: sensory receptor on dendrite of dorsal root ganglion cell --------→ ganglion cell ----------→ axon cell ----------→ dorsal root --------→dorsal horn of spinal cord--------→ either directly to motor cell in ventral horn or via internuncial (association) neuron to ventral horn motor cell-------→ axon via ventral root ------→ spinal nerve-------→ effector organ (e.g., muscle).

Respiratory/Cardiac Review

Tidal volume - amount of air that is inhaled and exhaled during normal resting ventilation

Residual volume – the amount of air remaining in the lungs following a maximal expiration

ERV-Expiratory reserve volume- the volume of air that can be forcefully expelled following a normal expiration

IRV-Inspiratory reserve volume- the volume of air that can be forcefully breathed in following a normal inspiration

FVC –Forced vital capacity = IRV +TV +ERV

FEV1- Forced expiratory volume—the volume of air that can be forcefully expelled in one second following a full inspiration.

Total lung capacity-sum of the residual volume and the vital capacity

Functional residual capacity- the volume of air remaining in the lungs following a normal expiration or ERV + RV

Metabolic Equivalent (MET)- A rating of energy expenditure for a given activity based on oxygen consumption. One MET equals 3.5 ml of oxygen used per kilogram of body weight per minute.

CO = SV x HR

(Cardiac Output) = (Stroke Volume) x (Heart Rate)

$$EF = \frac{SV}{EDV} \times 100\%$$

$$\text{(Ejection fracture)} = \frac{\text{(Stroke volume)}}{\text{(End diastolic volume)}}$$

Breath Sounds

1. Friction rub- caused by the rubbing of pleural surfaces against one another, usually as the result of inflammation processes.
2. Rales (crackles) – Adventitious breath sounds associated with pathology. Rales could be the result of air bubbles in secretions or movement of fibrotic tissue during breathing. Basilar rales are often accompanied with left ventricular congestive heart failure. (Atelectasis, fibrosis, and pulmonary edema), Related to the opening of previously closed small airways and alveoli.
3. Rhonchi – Continuous low pitched, sonorous breath sounds that are most prominent during expiration and could be a result of air passing through airways narrowd by inflammation, bronchospasm or secretions. Heard during expiration
4. Stridor- Continuous adventitious sound of inspiration associated with upper airway obstruction
5. Wheezes – Continuous breath sounds that are high-pitched, and musical often associated with asthma, COPD, and foreign body aspiration

Acid/Base Balance	*pH*	*Causes*
Respiratory Alkalosis	Up	Alveolar hyperventilation
Respiratory Acidosis	Down	Alveolar hypoventilation
Metabolic Alkalosis	Up	(Steroids, adrenal disease)
Metabolic Acidosis	Down	(Diabetic, prolonged diarrhea)

Key Point - Hyperventilation may result in Respiratory Alkalosis

Normative Values for Infants/Adults

Term	Infant	Adult
HR	120bpm	60-100bpm
BP	75/50 mmHg	120/80 mmHg
RR	40	12-18

pH	7.26-7.41	7.35-7.45
Tidal Volume	20 ml	500 ml

COPD-Chronic Bronchitis/Emphysema-abnormal expiratory flow rates.

Chronic Bronchitis

Signs and Symptoms

1. Smoking History
2. Cor pulmonale
3. Decreased expiratory flow rates
4. Crackles and wheezes
5. Hypoxemia

Emphysema

Signs and Symptoms

1. Barralled chest
2. Dyspnea
3. Cyanosis
4. Clubbing
5. Accessory muscles of ventilation

Term	*Obstructive Disease*	*Restrictive Disease*
Total lung capacity	increases	decreases
Functional residual capacity	increases	decreases
Residual volume	increases	decreases
Vital capacity	decreases	decreases
PaCO2	increases	decreases
FEV1	sharp decrease	normal

Tuberculosis-infectious respiratory process caused by tubercle bacilli.

Test-PPD-Purified Protein Derivative- Negative 0-4mm after 48 hours

Positive >10mm after 48 hrs.

Sputum + for *Mycobacterium tuberculosis* within 2-3 weeks of onset. Later (-) in the latent phase.

Drugs of choice in most cases Isoniazid and Rifampin.

Medications for Lung Respiration

1. Anticoagulants-Coumadin and Heparin limit ability to tolerate percussion.
2. Atropine- use for severe asthma, to help with spasms of the involuntary muscles and inhibit secretions
3. Bronchodilators- Epinephrine, Alupent, Ventolin, Proventil- Relax smooth muscle and open airway lumen
4. Corticosteroids- Prednisone and Cortisol used to decrease edema and inflammation associated with COPD

Terminology

A. Orthopnea-difficulty breathing in positions other than upright sitting and standing

B. Orthostatic hypotension- decrease in blood pressure upon assuming an erect posture. This is normal, but may be excessive resulting in fainting.

C. Atelectasis-alveolar collapse involving part or all of the lung due to the complete absorption of gas or the inability of the alveoli to expand

D. Apnea- absence of respirations, usually temporary in duration

E. Bradycardia-Abnormally slow (low) pulse rate; below approximately 50 beats per minute.

F. Cor pulmonale-Right ventricular enlargement from a primary pulmonary cause

G. Cheyne-Strokes respiration-breathing pattern characterized by a gradual increase in rate and depth followed by a gradual decrease; periods of apnea occur between cycles.

H. Tachycardia-Abnormally rapid (high) pulse rate; over approximately 100 beats per minute.

I. Beta-adrenergic blocking agents (beta-blockers)-Propranolol, Metoprolol, nadolol, Atenolol, Timolol

J. Calcium channel blocking agent-Verapamil, Nifedipine, Diltiazem- A substance that inhibits the flow of calcium ions across membranes in smooth muscle. These drugs cause vasodilation and relieve angina pain and coronary artery spasm.

K. Ejection fraction-difference between left ventricular end diastolic volume and left ventricular end systolic volume.

L. Digitalis- a drug that strengthens the contraction of the heart muscle, slows the rate of contraction of the heart, and promotes the elimination of fluid from body tissues.

M. Antiarrhythmics-Lidocaine, Quinidine, Procainamide, Disopyramide, Phenytoin (Dilantin)- Agents used to treat cardiac arrhythmias.

N. Catecholamines-circulating compounds (epinephrine and norepinephrine) that are secreted by the sympathetic nervous system and the adrenal medulla; they act to increase cardiac rate, contractility, automaticity, and excitability.

Circulatory System

Functions

The circulatory system serves:

(1) to conduct nutrients and oxygen to the tissues;
(2) to remove waste materials by transporting nitrogenous compounds to the kidneys and carbon dioxide to the lungs;
(3) to transport chemical messengers (hormones) to target organs and modulate and integrate the internal milieu of the body;
(4) to transport agents which serve the body in allergic, immune, and infectious responses;
(5) to initiate clotting and thereby prevent blood loss;
(6) to maintain body temperature;
(7) to produce, carry and contain blood;
(8) to transfer body reserves, specifically mineral salts, to areas of need.

General Components and Structure

The circulatory system consists of the heart, blood vessels, blood and lymphatics. It is a network of tubular structures through which blood travels to and from all the parts of the body. In vertebrates this is a completely closed circuit system, as William Harvey (1628) once demonstrated. The heart is a modified, specialized, powerful pumping blood vessel. Arteries, eventually becoming arterioles, conduct blood to capillaries (essentially endothelial tubes), and venules, eventually becoming veins, return blood from the capillary bed to the heart.

Course of Circulation

Systemic Route:

a. *Arterial system*. Blood is delivered by the pulmonary veins (two from each lung) to the left atrium, passes through the bicuspid (mitral) valve into the left ventricle and then is pumped into the ascending aorta; backflow here is prevented by the aortic semilunar valves. The aortic arch toward the right side gives rise to the brachiocephalic (innominate) artery which divides into the right subclavian and right common carotid arteries. Next, arising from the arch is the common carotid artery, then the left subclavian artery.

The subclavians supply the upper limbs. As the subclavian arteries leave the axilla (armpit) and enter the arm (brachium), they are called brachial arteries. Below the elbow these main trunk lines divide into ulnar and radial arteries, which supply the forearm and eventually form a set of arterial arches in the hand which give rise to common and proper digital arteries. The descending (dorsal) aorta continues along the posterior aspect of the thorax giving rise to the segmental intercostals arteries. After passage “through” (behind) the diaphragm it is called the abdominal aorta.

At the pelvic rim the abdominal aorta divides into the right and left common iliac arteries. These divide into the internal iliacs, which supply the pelvic organs, and the external iliacs, which supply the lower limb.

b. *Venous system*. Veins are frequently multiple and variations are common. They return blood originating in the capillaries of peripheral and distal body parts to the heart.

Hepatic Portal System: Blood draining the alimentary tract (intestines), pancreas, spleen and gall bladder does not return directly to the systemic

circulation, but is relayed by the hepatic portal system of veins to and through the liver. In the liver, absorbed foodstuffs and wastes are processed. After processing, the liver returns the blood via hepatic veins to the inferior vena cava and from there to the heart.

Pulmonary Circuit: Blood is oxygenated and depleted of metabolic products such as carbon dioxide in the lungs.

Lymphatic Drainage: A network of lymphatic capillaries permeates the body tissues. Lymph is a fluid similar in composition to blood plasma, and tissue fluids not reabsorbed into blood capillaries are transported via the lymphatic system eventually to join the venous system at the junction of the left internal jugular and subclavian veins.

The Heart

The heart is a highly specialized blood vessel which pumps 72 times per minute and propels about 4,000 gallons (about 15,000 liters) of blood daily to the tissues. It is composed of:

Endocardium (lining coat; epithelium)
Myocardium (middle coat; cardiac muscle)
Epicardium (external coat or visceral layer of pericardium; epithelium and mostly connective tissue)
Impulse conducting system

Cardiac Nerves: Modification of the intrinsic rhythmicity of the heart muscle is produced by cardiac nerves of the sympathetic and parasympathetic nervous system. Stimulation of the sympathetic system increases the rate and force of the heartbeat and dilates the coronary arteries. Stimulation of the parasympathetic (vagus nerve) reduces the rate and force of the heartbeat and constricts the

coronary circulation. Visceral afferent (sensory) fibers from the heart end almost wholly in the first four segments of the thoracic spinal cord.

Cardiac Cycle: Alternating contraction and relaxation is repeated about 75 times per minute; the duration of one cycle is about 0.8 second. Three phases succeed one another during the cycle:

a) atrial systole: 0.1 second,
b) ventricular systole: 0.3 second,
c) diastole: 0.4 second

The actual period of rest for each chamber is 0.7 second for the atria and 0.5 second for the ventricles, so in spite of its activity, the heart is at rest longer than at work.

Blood

Blood is composed of cells (corpuscles) and a liquid intercellular ground substance called plasma. The average blood volume is 5 or 6 liters (7% of body weight). Plasma constitutes about 55% of blood volume, cellular elements about 45%.

Plasma: Over 90% of plasma is water; the balance is made up of plasma proteins and dissolved electrolytes, hormones, antibodies, nutrients, and waste products. Plasma is isotonic (0.85% sodium chloride). Plasma plays a vital role in respiration, circulation, coagulation, temperature regulation, buffer activities and overall fluid balance.

Define the following cardiovascular conditions:

Deep vein thrombosis:
Buerger's disease:

Endocarditis:

Kawasaki’s disease:

Pericarditis:

Takayasu’s arteritis:

Wegener’s granulomatosis:

Heart Sounds:

S1- tricuspid and mitral valve close

S2- pulmonary and aortic valve close

S3- ventricular filling complete

S4-elevated atrial pressure (atrial kick)

Wave Review

ST segment:	ventricles depolarized
P wave:	atrial depolarization
PR segment:	AV node conduction
QRS complex:	ventricular depolarization
U wave:	hypokalemia creates a U wave
T wave:	ventricular repolarization

Maternal Responses to Pregnancy

Placenta-secretion of estrogen, progesterone, gonadotropin, inhibin, placental lactogen and other hormones

Anterior Pituitary-increased secretion of prolactin and ACTH, secretes very little FSH and LH

Adrenal Cortex-increased secretion of aldosterone and cortisol

Posterior pituitary-increased secretion of vasopressin

Parathyroids-increased secretion of parathyroid hormone

Kidneys-increased secretion of renin, erythropoietin, and 1,25 dihydroxyvitam D3

Breasts-enlarge and develop mature grandular structure. cause: Estrogen, progesterone, prolactin, and placental lactogen

Blood Volume-increases cause: total erythrocyte volume is increased by erythropoietin and plasma volume by salt and water retention

Calcium balance- Positive. Cause: increased parathyroid hormone and 1,25 dihydroxyvitamin D3

Body weight- increases by an average of 12.5 kg, 60 percent of which is water

Circulation-Cardiac output increases, total peripheral resistance decreases (vasodilation in uterus, skin, breasts, GI tract, and kidneys), mean arterial pressure stays constant

Respiration-hyperventilation (arterial PCO_2 decreases)

Organic metabolism-Metabolic rate increases. Plasma glucose, gluconeogenesis, fatty acid mobilization all increase. Cause: hyporesponsiveness to insulin due to insulin antagonism by placental lactogen and cortisol.

Appetite and thirst-increase

Nutritional RDA's-increase

Microbiology Review

Characteristics of Bacteria Types

Rickettsias- gram-negative bacteria, small
Rickettsia rickettsii

Spirochetes- spiral shape, no flagella, slender
Lyme disease, Treponema pallidum-syphilis

Gram positive cocci- Hold color with Gram stain, ovoid or spherical shape
Staphlyococcus aureus, Streptococcus pneumoniae

Gram negative cocci- Loose color with Gram stain, spherical or oval shape
Neisseria meningidis (meningococcus*), Neisseria gonorrhoeae* (gonococcus)

Mycoplasmas- *Mycoplasma pneumoniae*

Acid-fast bacilli- Hold color with staining even when stained with acid in most cases. *Mycobacterium leprae, Mycobacterium tuberculosis*

Acitinomycetes- Stained positive with a gram stain, narrow filaments
Nocardia, Actinomyces israelii

Gram positive- Rod shaped, hold color with gram stain
Clostridium tetani, Bacillus anthracis

Gram negative- Do not hold color with gram stain, also rod shaped.
Pseudomonas aeruginosa, Escherichia coli, Klebsiella pneumoniae

Diseases and Acid Fast Bacilli Review

Disease	Bacteria	Primary Medication
Tuberculosis, renal and meningeal infections	*Mycobacterium tuberculosis*	Isoniazid + rifampin + pyrazinamide
Leprosy	*Mycobacterium leprae*	Dapsone + rifampin

Diseases and Spirochetes Review

Disease	Bacteria	Primary Medication
Lyme Disease	*Borrelia burgdorferi*	Tetracycline
Meningitis	*Leptospira*	Penicillin G
Syphilis	*Treponema pallidum*	Penicillin G

Diseases and Actinomycetes Review

Disease	Bacteria	Primary Medication
Cervicofacial, and other lesions	*Actinomyces israelii*	Penicillin G

Diseases and Gram-Negative Bacilli Review

Disease	Bacteria	Primary Medication
Meningitis	*Flavobacterium meningosepticum*	Vancomycin
UTI's Bacteremia	*Escherichia coli*	Ampicillin+/- aminoglycoside
Gingivitis, Genital	*Fusobacterium*	Penicillin G

infections, ulcerative pharyngitis	*nucleatum*	
Abscesses	*Bacteroides species*	Clindamycin/Penicillin G
Hospital acquired infections	*Acinetobacter*	Aminoglycoside
Abscesses, Endocarditis	*Bacteroides fragilis*	Clindamycin, metronidazole
Legionnaires' Disease	*Legionella pneumonphila*	Erythromycin
UTI's	*Proteus mirabilis*	Ampicillin/Amoxicillin
Pneumonia, UTI's, Bacteremia	*Pseudomonas aeruginosa*	Penicillin-Broad
Bacteremia, Endocarditis	*Streptobacillus moniliformis*	Penicillin G
Pneumonia, UTI	*Klebsiella pneumoniae*	Cephalosporin
Bacteremia, Wound infections	*Pasteurella multocida*	Penicillin G

Diseases and Gram-Positive Bacilli Review

Disease	Bacteria	Primary Medication
Gas Gangrene	*Clostridium*	Penicillin G
Tetanus	*Clostridium tetani*	Penicillin G
Pharyngitis	*Corynebacterium diphtheriae*	Penicillin G
Meningitis, Bacteremia	*Listeria monocytogenes*	Ampicillin
Anthrax / pneumonia	*Bacillus anthracis*	Penicillin G
Endocarditis	*Corynebacterium species*	Penicillin G/Vancomycin

Diseases and Cocci Review

Disease	Bacteria	Primary Medication
Genital infections, arthritis-dermatitis syndrome	*Neisseria gonorrhoeae*	Ampicillin, Amoxicillin
Meningitis, Bacteremia	*Neisseria meningitidis*	Penicillin G
Endocarditis, Bacteremia	*Streptococcus (viridans group)*	Gentamicin
Bacteremia, brain and other absesses	*Streptococcus (anaerobic species)*	Penicillin G
Endocarditis, Bacteremia	*Streptococcus agalactiae*	Ampicillin
Pneumonia, Osteomyelitis, abscesses	*Staphyloccus aureus*	Penicillin G/Vancomycin
UTI's, Endocarditis	*Streptococcus faecalis*	Ampicillin, Penicillin G
Pneumonia, sinusitis, otitis, Arthritis	*Streptococcus pneumoniae*	Penicillin G or V
Cellulitis, Scarlet fever, bacteremia	*Streptococcus pyogenes*	Penicillin G or V
Bacteremia, endocarditis	*Streptococcus bovis*	Penicillin G

DNA Virus Review

DNA Virus	*Infection*
Adenovirus	Eye and Respiratory infections
Hepatitis B	Hepatitis B
Cytomegalovirus	Cytomegalic inclusion disease
Epstein-Barr	Infectious mononucleosis
Herpes Types 1 and 2	Local infections oral and genital
Varicella-zoster	Chickenpox, herpes zoster

Smallpox	Smallpox

RNA Virus Review

RNA Virus	*Infection*
Human respiratory virus	Respiratory tract infection
Hepatitis A virus	Hepatitis A
Influenza virus A-C	Influenza
Measles virus	Measles
Mumps virus	Mumps
Respiratory syncytial virus	Respiratory tract infection in children
Poliovirus	Poliomyelitis
Rhinovirus types 1-89	Cold
Human immunodeficiency virus	AIDS
Rabies virus	Rabies
Alphavirus	Encephalitis
Rubella virus	Rubella

Immunoglobulin isotypes

IgA– can be located in secretions and prevents viral and bacterial attachment to membranes.

IgD- can be located on B cells

IgE-main mediator of mast cells with allergen exposure.

IgG- primarily found in secondary responses. Does cross placenta and destroys viruses/bacteria.

IgM- primarily found in first response. Located on B cells

Cytokines Review

IL-1 Primarily stimulate of fever response. Helps activate B and T cells. Produced by macrophages.

IL-2 Aids in the development of Cytotoxic T cells and helper cells. Produced by helper T cells.

IL-3 Aids in the development of bone marrow stem cells. Produced by T-cells.

IL-4 Aids in the growth of B cells. Produced by helper T-cells. Aids in the production of IgG and IgE

IL-5 Promotes the growth of eosinophils. Produced by helper T-cells. Also promotes IgA production.

IL-8 Neutrophil factor

TNF-α Promotes the activation of neutrophils and is produced by macrophages.

TNF-β Produced by T lymphocytes and encourages the activation of neutrophils

γ-interferon (Activates macrophages and is produced by helper T cells.)

Disorder	Autoantibody
Celiac disease	Anti-gliadin
Goodpasture's syndrome	Anti-basement membrane
Hashimoto's thyroiditis	Anti-microsomal
Pemphigus vulgaris	Anti-epithelial
Rhematoid arthritis	Anti-IgG
Scleroderma (CREST)	Anti-centromere
Systemic lupus	Antinuclear antibodies

Pharmacology Review

Drug Nomenclature

1. generic name – acetominophen
2. trade name – TYLENOL, PANADOL

Routes of Drug Entry

Enteral

1. ORAL – easiest, safe, have 1st pass effect, large surface area for absoption, some medications irritate the GI, some medications may be degraded by the stomach.
2. SUB-LINGUAL – absorption through the oral mucosa with no 1st pass effect.
3. RECTAL- normally no 1st pass effect, usually used if patients are vomiting

Parenteral

1. INHALATION – absorbed in the lungs, quick action, may cause inflammation in the lungs.
2. INJECTION (types):
    A. Intra-muscular – easy access, may treat muscle or prolonged release into circulation.
    B. Subcutaneous – Injection just below the skin, causes a localized response. TB skin test.
    C. Intra-arterial – used most commonly in chemotherapy also diagnostic procedures, drug introduced directly into the artery
    D. Intravenous – can use an IV line, useful in emergencies, side effects appear quickly

E. Intrathecal – used with narcotic analgesics and local anesthetics. Drugs can reach the CNS and by-pass the blood brain barrier.

Parasympathetic Action	Sympathetic Action
Discrete Response	Diffuse Response
Cranial/ Sacral origination	thoraco-lumbar origination
Presynaptic neurons release Ach	Presynaptic neurons – Ach
Postsynaptic neurons release Ach	Postsynaptic neurons –NE
Conserves Fuel, maintains GI	Fight or Flight Response

Cholinergic nerves release Ach
Adrenergic nerves release NE

I. Cholinomimetrics

1. Muscarinic Agonists
    A. Bethanecol (URECHOLINE) – increase GI motility
    B. Carbachol (ISOPTO, MIOSTAT, CARBACHOL) – various types of glaucoma
    C. Methacholine (PROVOCHOLINE) – test hyperactivity of airways
    D. Pilocarpine – used for glaucoma

2. Anticholinesterases
    A. Pysostigmine (ANTILIRIUM) – treat glaucoma, crosses BBB, reverse anticholinergic toxicity.
    B. Neostigmine (PROSTIGMIN) – synthetic form of Pysostigmine

(Anticholinesterases) – used for Myasthenia gravis, glaucoma, and to increase tone in bladder

Symptoms of Anticholinesterase toxicity:

1. Miosis
2. Rhinitis
3. Bradycardia
4. GI spasms
5. brochoconstriction
6. involuntary voiding of urine

II. Anticholinergics

1. Muscarinic Antagonists
    A. Atropine - anticholinergic effects
    B. Scopolamine – causes cycloplegic, impotence and used primarily in motion sickness preparations

(Muscarinic Antagonists) – used treat spastic GI, Parkinson's Disease, Asthma, Treatment of Peptic Ulcers

2. Ganglionic Blockers – Hexamethonium – blocks nicotinic receptors

Anticholinergics (Parasympatholytics) – used in the treatment of renal colic, allergic rhinitis, and peptic ulcers.

III. Adrenegic Agonists

1. Alpha-1 Selective agonists- Phenylephrine (NEO-SYNEPHRINE) – used to treat hypotension, tachycardia and nasal congestion.

2. Alpha-2 Selective agonists- Clonidine (CATAPRESS) – used as an antianxiety and analgesic drug. Also used to treat mild to moderate hypertension

3. Beta-1 Selective agonists
    A. Dobutamine (DOBUTREX) – short term management of cardiac decompensation following surgery
    B. Dopamine (DOPASTAT) – similar to Dobutamine

3. Beta-2 Selective agonists- Salbutamol (ALBUTEROL)- relaxes bronchial smooth muscle oral inhalant

4. Non-Selective Beta Agonists Isoproterenol- increases heart rate, vasodilation, bronchodilation, increased renin release

5. Mixed Alpha and Beta Agonists
    A. NE – (alpha 1 = alpha 2 > beta 1) – increased TPR, constriction of GI sphincters, elevates blood sugar
    B. Epinephrine – increased systolic BP, decreased diastolic BP, bronchodilation, and relaxation of GI smooth muscles, also elevates blood sugar
    C. Amphetamines- Methylphenidate (RITALIN)- used to treat hyperactive disorders
    D. Ephedrine (EFEDRON NASAL)- used to treat shock, nasal congestion, asthma, narcolepsy

Adrenegic Agonists (Sympathomimetics) - used to increase heart rate, and cause constriction of blood vessels. Used for shock treatment and cardiac decompensation.

IV. Adrenergic Antagonists

1. Alpha-1 Antagonists used to decrease vascular tone and treatment of pheochromocytoma
    A. Phenoxybenzamine (DIBENZALINE) used to treat Raynaud's disease
    B. Prazosin (MINIPRESS) used to treat hypertension
    C. Terazosin (HYTRIN) used to vasodilate and reduce serum lipid levels.

2. Non Selective Alpha antagonists
    A. Phentolamine (REGINTINE) control BP during pheochromocytoma
    B. Ergot Alkaloids (Ergotamine) used to treat migranes and relax constricted vessels.

3. Beta-1 Blockers
    A. Metoprolol (LOPRESSOR) used in the treatment of hypertension and blocks cardiac beta receptors
    B. Atenolol (TENORMIN) used in the treatment of hypertension, chronic stable angina, and myocardial infarct

4. Non-Selective Beta Blockers (B1 and B2)
    Propranolol (INDERAL) prototype beta blocker used for the treatment of hypertension, angina, migranes, and to prevent MI

Adrenergic Antagonists (Sympatholytics) – used in the treatment of migrane and vascular headaches.

V. Centrally Acting Agents

1. Baclofen (LIORESAL) – derivative of GABA, used with spasticity. Side effects of transient drowsiness, confusion and hallucinations usually oral administration.
2. Benzodiazepines – Diazepam (VALIUM) used with muscle spasms, some CP, cord lesions, side effects include sedation and physical addiction.

VI. Direct Acting Relaxants

Dantrolene (DANTRIUM) – only drug with direct action on muscle cell used for severe spasticity. Side effects include: hepatotoxic, and generalized muscle weakness.

VII. Neuromuscular Junction Blockers (NMJ)

1. Depolarizing agents – succinylcholine (ANECTINE) can paralyze muscle .
2. Non-Depolarizing agents – curare or tubocurare

(Neuromuscular Junction Blockers) used with orthopedic procedures, tetanus poisioning, tracheal intubation and adjuvant in surgical anesthesia.

Side effects of (NMJ)- histamine release, malignant hyperthermia, breaks bones, elevated temperature. (NMJ) drugs are used to allow mechanical ventilation and intubation. Other examples include: Mivacurium chloride (Mivacron) and Pancuronium bromide (Pavulon).

VIII. Other Muscle Relaxants

Botulinum toxin (BOTOX) and Transdermal Clonidine

IX. Local Anesthetics

1. Benzocaine (AMERICAINE) – not absorbed through the skin, no systemic affect.
2. Lidocaine (XYLOCAINE) – may cause drowsiness or tinnitis
3. Cocaine
4. Bupivicaine (MARCAINE) – Epidural
5. Procaine (NOVOCAINE) – Not used much

X. General Anesthetics

Categories:

1. Barbiturates (Thiopental / PENTOTHAL)- Rapid onset, short acting.
2. Benzodiazapines (Diazepam/ VALIUM)
3. Opiates (Meperidine/DEMEROL)

XI. Sedative Hypnotics

1. Barbiturates- (Phenobarbital/ (SOLFOTON) (NEMBUTAL) (SECONOL)- reversibly depress activity in excitable membranes, hypnotic, and rapid tolerance. May cause residual CNS depression and contraindicated in the presence of pain.
2. Benzodiazapines- used as a sedative, hypnotic, anti-anxiety, and anticonvulsant

XII. Antianxiety Agents

1. Benzodiazapines
2. Azapirones (BUSPAR)
3. Betablockers- Propranolol (INDERAL)
4. Alprazolam (XANAX)

5. Midazolam hydrochloride (VERSED)

XIII. Affective Disorders

Depression-

1. Tricyclics
    a. Amitriptyline (ELAVIL)
    b. Desipramine (PETOFRANE)
    c. Imipramine (JANIMINE)
    d. Doxepin (SINEQUAN)
    e. Clomipramine hydrochloride (Anafranil)
2. MAO Inhibitors – Phenelzine (NARDIL), Fluoxetine (PROZAC)
3. Second Generation Drugs
    a. Fluoxetine (PROZAC)
    b. Sertraline (ZOLOFT)

    Side effects: sedation and insomnia

Manic Depression-

Lithium: Side effects: slurred speech, increased muscle tone, hand tremor, coma, confusion, nausea.

XIV. Antipsychotics

1. Phenothazines
    a. Chlorpromazine (THORAZINE)
    b. Thioridazine (MELLARIL)
2. Thioxanthines- high potency
3. Butyrophenones – Haloperidol (HALODOL) – Most common antipsychotic.
4. Dihydroindolones
5. Dibenzoxazipines
    a. Loxapine (LOXITANE)
    b. Chlozapine (CLOZARIL)

XV. Seizures

1. Partial
    a. Simple
        Carbamazepine
        Phenytoin
        Phenobarbital
        Valproate

    b. Complex
        Carbamazepine
        Phenytoin
        Phenobarbital
        Valproate

    c. Partial progressing to General
        Carbamazepine
        Phenytoin
        Phenobarbital
        Valproate

2. Generalized
    a. Absence (petit mal)
        Clonazepam
        Ethosuximide
        Valproate

    b. Myolclonic
        Valproate

    c. Tonic/ Clonic

Carbamazepine
Phenytoin
Phenobarbital
Valproate

d. Atonic
Clonazepam

3. Status Epilepticus
Diazepam
Phenytoin
Phenobarb
Halothane

XVI. Opioids

1. Strong Agonists – Morphine, Meperidine (DEMEROL), Methadone (DOLOPHINE).
2. Mild to moderate Agonists Codeine (CODEINE SULFATE)
3. Mixed Agonists and Antagonists-Butorphanol (STADOL)
4. Antagonists – Naloxone (NARCAN)

Side Effects of Opioids:

1. Euphoria
2. Sedation
3. OH
4. Respiratory depression

XVII. Non-Opioid Analgesics

1. General – (NSAIDs) non steroidal anti-inflammatory drugs

2. Salicylates –Aspirin- used to treat fever, prevent DVT, prevent coronary artery thrombus, treat mild to moderate pain including headache, and muscle aches
   Side Effects: GI damage, hepatotoxicity, renal toxicity, salicylate overdose, Reye's Syndrome, Aspirin allergy

Other NSAIDs- Ibuprofen (ADVIL, MOTRIN), Indomethacin (INDAMETH, INDOCIN).

3. Acetominophen (Tylenol) – not an NSAID

XVIII. Anti-Inflammatory Drugs

1. Steroids- Cortisol- side effects immuosupression, cataract formation, alters fluid and electrolyte balance, myopathy.
   Steroid Drugs
   a. Prednisolone (PRELONE)
   b. Prenisone (DELTASONE)
   c. Dexamethasone (DEXASONE)
   Steroids commonly used with Spinal cord injury, organ transplants, asthma, COPD, and rheumatic disorders (RA, Lupus).

2. Histamine Antagonists
   1st Generation Drugs
   a. "amine" suffix
      Diphenhydramine (BENADRYL)
      Chlorpheniramine (CHLOR-TRIMETON)
      Pyrilamine (NISAVAL)
      Carbinoxamine (CARDEC)
   b. "izine" suffix
      Hydroxyzine (ATARAX)
      Cyclizine (MAREZINE)

Promethazine (PHENERGAN)

2nd Generation Drugs- do not cross blood brain barrier

"adine" suffix

Loratadine (CLARITIN)

Terfenadine (SELDANE)

(Histamine Antagonists)- decrease bronchospams, decrease edema and itching. Decrease capillary permeability, decrease vasoconstriction.

XIX. Respiratory Pharmacology

1. Antitussives- suppress cough may contain NSAIDS
    a. Benzonatate (TESSALON)
    b. Dextromethorphan (various trade names)
    c. Hydrocodone (HYCODAN), TRIAMINIC)
    d. Codeine (various trade names)

    Side effects: sedation, GI distress and dizziness

2. Decongestants- Most commonly alpha agonists.
    a. Ephedrine (PRIMATENE tabs)
    b. Epinephrine (PRIMATENE MIST)
    c. Oxymetazoline (AFRIN)
    d. Phenylephrine (NEO SYNEPHRINE)
    e. Pseudoephedrine (ACTIFED, SUDAFED)

    Side effects: headache, dizziness, nervousness and nausea

3. Antihistamines – adjunct in asthma, not real effective if used alone, decreased nasal congestion. Used for the treatment of rhinitis, motion sickness and idiopathic urticaria.

a. Chlorpheniramine (CHLOR-TRIMETON)
b. Clemastine (TAVIST)
c. Loratidine (CLARATIN)
d. Terfenadine (SELDANE)
e. Doxylamine (UNISOM NIGHT TIME SLEEP AID)
f. Dimenhydrinate (DRAMMAMINE)
g. Diphenhydramine hydrochloride (BENADRYL)
h. Cetirizine hydrochloride (ZYRTEC)

Side effects: sedation, dizziness, blurred vision, and incoordination

4. Mucolytics – decrease mucous viscosity used to treat the common cold to pneumonia.

   Acetylcysteine (MUCOMYST, MUCOSIL) primary drug

   Side effects: GI distress and inflammation of oral mucosa

5. Expectorants- increase respiratory secretions, increase ejection of mucous.

   Guaifenesin (ROBITUSSIN) primary medication

   Side effects: GI distress

6. Obstructive Pulmonary Disease

   Drugs used for treatment:

   a. Beta-agonists

   Side Effects: bronchial irritation with prolonged use.

   b. Xanthines- Theophlline, Theobromine

   Side Effects: nausea, confusion, seizures, irritable

   c. Anti-cholinergics

   Side Effects: dry mouth, tachycardia, blurred vision, confusion

d. Anti-inflammatory

   Corticosteroids

   Side Effects: osteporosis, muscle wasting, cataracts and hypertension

   Cromolyn Sodium- blocks histamine from mast cells

   Side Effects: nasal and resp. irritant

   Leukotriene Antagonists – Montelukast (SINGULAR)

   Side Effects: fatique, fever, GI, dizziness and headache

XX. GI Pharmacology

1. Antacids (TUMS, ROLAIDS, MILK of MAGNESIA)- attempt t neutralize acids. Used in the treatment of hyperacidity, indigestion, hyperphosphatemia, esophageal reflux, peptic ulcers and gastric ulcers.
2. H2 Blockers (TAGAMENT, PEPCID, AXID, ZANTAC) – block histamine reactions on GI, used for ulcers
3. Antidiarrheal medications
   a. Opioids (PAREGORIC) – decrease GI motility
   b. Absorbents (KAOPECTATE) – sequester the toxic product causing the diarrhea. Holds the harmful bacteria and toxins.
   c. Bismuth salicylate (PEPTO-BISMOL)- decreases GI secretions, stimulate water absorption in the large intestine.
4. Emetics (Apomorphine, Ipecac)

   Induce vomiting by stimulating the medullary emetic center
5. Antiemetics – antihistamines, phenothiazines (anti-psychotics), anticholinergics (Scopalamine). Antiemetics are used to decrease inner ear sensitivity and stimulate vomiting.
6. Cholelitholytics- used to dissolve gallstones

7. Electrolytes- (Mg2+), (Ca2+), (HCO_3), (K+), (Na+)- used in the treatment of hyponatremia, hypokalemia, hypocalcemia and metabolic acidosis.
8. Acid/Base Modifiers
    a. Alkalinizers-increase alkalinity and used in the treatment of metabolic acidosis. Examples include: Sodium lactate, Sodium bicarbonate, and Tromethamine
    b. Acidifiers-increase acid levels and used in the treatment of metabolic alkalosis. Example: ammonium chloride
9. Laxatives- used for constipation. Laxatives may include: stimulants, fecal softeners, or saline substances.

XXI. Cardiovascular Pharmacology

1. BP = CO x TPR
2. Classes of Antihypertensives

    a. Presynaptic agents: centrally acting, peripherally acting
    b. Dieuretics
    c. Beta Blockers
    d. Alpha Blockers
    e. Vasodilators
    f. Calcium Entry Blockers
    g. Angiotensin Converting Enzyme (ACE) Inhibitors

3. Types of Diuretics

    a. Thiazide diuretics
    Chlorthiazide (DIURIL)
    Hydrochlorothiazide (ESIDRIX)

Benzthiazide (HYDREX, EXNA)

b. Loop Diuretics
   Bumetadine (BUMEX)
   Ethacrynic Acid (EDECRIN)
   Furosemide (LASIX, FUROSIDE)
c. K sparing Diuretics – block K secretion at distal tubule
   Amiloride (MIDAMOR)
   Spironolactone (ALDACTONE)
   Triamterene (DYRENIUM)

Side effects of Diuretics: metabolic disorders, reflex tachycardia, vasoconstriction, orthostatic hypotension, decreased cardiac contractility.

Antidieuretics- used in the treatment of postoperative distention and diabetes insipidus.
Diuretics- used in the treatment of kidney disease, heart failure and endocrine disorders.

4. Beta blockers- decrease HR, force contraction

   a. Non selective – Propranolol (INDERAL)
   b. B1 selective – Atenolol (TENORMAN)
   c. Mixed antagonist/agonist Labetalol (NORMODYNE)

5. Alpha Blockers- used only in sever hypertension, now used more frequently in mild to moderate hypertension.

   a. Doxazosin (CARDURA)
   b. Phenoxybenzamine (DIBENZYLINE)
   c. Proazosin (MINIPRESS)
   d. Terazosin (HYTRIN)

Side effects: reflex tachycardia and orthostatic hypotension

6. Presynaptic Inhibitors

    a. Reserpine (SERPALAN)
    b. Guanethidine (ISMELIN
    Side effects: orthostatic hypotensin, and GI distress

7. Centrally Acting Agents – alpha 2 agonists, decrease SNS outflow from CNS.

    a. Clonidine (CATAPRES)
    b. Guanabenz (WYTENSIN)
    c. Methyldopa (ALDOMET)
    Side effects: dizzy, drowsy, dry mouth

8. Vasodilators

    a. Hydralazine (APRESOLINE)
    b. Minoxidil (LONITEN)
    c. Diazoxide (HYPERSTAST)
    d. Nitroprusside (NITROPRESS)
    Side effects: reflex tachycardia, dizziness, postural hypotension, weakness, GI distress, fluid retention, hirsutism

9. ACE inhibitors

    a. Captopril (CAPOTEN)
    b. Benazepril (LOTENSIN)
    Side effects: allergy, GI distress, dizziness, chest pain, and non productive cough

10. Calcium Entry Blockers- block entry of Ca into VSM and/or cardiac muscle.

    a. Nifedipine (PROCARDIA)
    b. Verapamil (CALAN, ISOPTIN)
    c. Diltiazam (CARDIZEM)

    Side effects: excessive vasodilation, nausea, dizziness, abnormal HR, orthostatic hypotension

11. Angina Pectoris

        a. Organic Nitrates- vasodilators- decrease cardiac preload, and afterload.
        b. Examples: Nitroglycerin (NITRO-BID, NITROSTAT) and Amyl Nitrate

        Side Effects: headache, dizziness, orthostatic hypotension, nausea.

        c. Beta Blockers- decrease H.R., force of contraction
        d. Examples: Atenolol (TENORMIN), Propranolol (INDERAL)

        Side Effects: cardiac depression, asthmatics beware

        e. Calcium Entry Blockers (CEBs)-vasodilate coronaries, general vasodilation
        f. Examples: Diltiazam (CARDIZEM), Nifedipine (PROCARDIA)

        Side Effects: headache, edema, dizziness, disturbances of cardiac rhythm, orthostatic hypotension, fatigue

12. Cardiac Arrhythmias- used in the treatment of paroxysmal atrial tachycardia, ventricular tachycardia, PVC's, and atrial fibrillation.

a. Class I Drugs

Class 1A- Quinidine (CARDIOQUIN)

Procainamide (PROMINE)

Class 1B- Lidocaine (XYLOCAINE)- severe ventricular arrhythmias

Class 1C- Ecainide (ENKAID)

Side Effects: aggravation of rhythm disturbances, dizziness, nausea, visual disturbances

b. Class II Drugs- Beta Blockers – decrease cardiac contractility and prolong refractory period, best for supraventricular arrhythmias (AV node), and some ventricular arrhythmias

c. Class III Drugs- used for ventricular arrhythmias

Bretylium (BRETYLOL)

Side Effects: transient increase in arrhythmias, orthostatic hypotension.

c. Class IV Drugs – Calcium Entry Blockers

Verapamil- most effective

Diltiazam- somewhat

Side Effects: excessive bradycardia, peripheral vasodilation

13. CHF- excessive fluid accumulation, blood backs up into capillaries

Left Heart Failure	Right Heart Failure
L Heart doesn't pump adequately	R Ht. Doesn't pump adeq.
Fluid backs up in lungs	Peripheral back up (blood)
Pulmonary Edema	Peripheral Edema
Shortness of Breath	

a. Cardiac Glycosides- increase intracellular calcium, stabilizes heart rate and slows impulse conduction.
   Side Effects: GI distress, drowsiness, fatigue, confusion, ventricular fib.

b. Diuretics – decrease fluid volume and therefore edema
   Side Effects: fatigue, confusion, nausea

c. ACE Inhibitors

d. Other- Amrinone and Milrinone- increase myocardial contractility

e. Dopamine/Dobutamine- sometimes used in acute heart failure- not used often, only in advanced cases or non-responsives

f. Vasodilators- used for severe heart failure- will cause hypotension, may include alpha blockers and direct vasodilators

14. Inotropics – Used in the treatment of atrial flutter, CHF, Paroxysmal atrial tachycardia, and atrial fibrillation.

XXII. Coagulation/Blood Disorders

1. Anticoagulants-prevent excessive clot formation in the VENOUS system. Used in the treatment of pulmonary embolism, cerebral accident, and malabsorption syndrome.
   a. Heparin- must give parenterally (IV or SubQ), set indwelling need (heparin lock) for IV
   b. Warfarin – impairs livers ability to synthesize clotting factors
      Given Orally- has a lag time of 2 days

2. Antithrombotics- used in the prevention of MI, and to prevent thromboembolism following arterial surgery like coronary bypass and arterial grafts.

a. Dipyridamole (DIPRIDACOT)
b. Sulfinpyrazone (ANTUVANE)

3. Thrombolytics – used to Breakdown existing clots, used with pulmonary embolism and to open clogged bypass shunts, also used with acute MI if given within 3-6 hours.
    a. Streptokinase and Urokinase
    b. Tissue Plasminogen Activator
    c. Antistreplase (EMINASE)

    Side Effects: Hemorrhage, back or joint pain, GI Distress, Hypersensitivity, Fever

4. Hematics – used in the treatment of pernicious anemia and megaloblastic anemia to increase the number of RBC's.

XXIII. Hyperlipidemia

1. HMG-CoA Reducatase Inhibitors- inhibit the enzyme used in early step of cholesterol synthesis.
    a. Lovastatin (MEVACOR)
    b. Prevastatin (PREVACHOL)

2. Fibric Acids- breakdown of LD
    a. Clofibrate (ABITRATE)
    b. Genfibrozil (LOPID)

3. Others
    a. Cholestyramine (QUESTRAN) – increases excretion of bile acids, cholesterol
    b. Niacin (VIT B3) – inhibits production of VLDL

c. Probucol (LORELCO) – breaks down LDL and inhibits deposition into arterial wall

XXIV. Diabetes Mellitus

1. Insulin - all type I, some type II, have rapid, short acting preps (for uncontrolled diabetes), have intermediate and long acting preps for better controlled. All injections, cannot take orally- all protein digested in GI

2. Oral hypoglycemics (Sulfonylureas)- give orally to decrease blood glucose in type II not type I, increases release insulin, increases sensitivity of cells to insulin.
   Adverse effects: hypoglycemia, heartburn, GI distress, headache

3. Glucagon- given to treat hypoglycemia
   Adverse effects: nausea, vomiting, and allergic reaction.

4. Cyclosporine (SANDIMMUNE) – immunosuppresant- may help protect against beta cell destruction if given soon after onset of symptoms (type 1). Long term success not known.

5. Aldose Reductase Inhibitors

6. Biquanides- decrease production of gluocose, used with Type II Diabetes

7. Meglitinide Insulin- used with Type II Diabetes, (glucose dependant)

Key signs of Hypoglycemia:

a. Confusion
b. Fatigue

c. Inappropriate sweating
d. Nausea
e. Hunger
f. Anxiety
g. Tachycardia

XXV. Anti-Infectives Drugs

1. Amebicides – kill amebas. (Entamoeba histolytica)-parasite. Used in the treatment of: Amebic hepatitis, and Amebic dysentery

2. Aminoglycosides –(gram negative bacteria). Used in the treatment of septicemia, UTI's and wounds.

3. Anthelmintics – (worm infections – helminthes) Used in the treatment of tapeworms, pin worms, round worms and hook worms. Tapeworms caused by (Echinococcus granulosus). Pinworms caused by (Enterobius vermicularis)

4. Antileprotics – used in the treatment of leprosy (Mycobacterium leprae)

5. Antivirals – used in the treatment of Herpes simplex, AIDS, Retinitis and Influenza A.

6. Cephalosporins – 1st , 2nd and 3rd generations. Used in the treatment of septicemia, osteomyelitis, UTI's and meningitis.

   A. 1st generation-(gram+ organisms)
   B. 2nd generation-(gram+ organisms) and (Haemophilus influenzae)
   C. 3rd generation- (gram- organisms)

7. Macrolides – Used in the treatment of Haemophilus influenzae and Streptococcus pneumonia

8. Penicillins – Used in the treatment of Rheumatic fever, gonorrhea, meningitis, otitis media, UTI's and pneumonia.

9. Quinolones- Used in the treatment of conjunctivitis, skin diseases, gonorrhea and UTI's.

10. Sulfonamides – Used in the treatment of Otitis media, Streptococcal infections and UTI's.

11. Tetracyclines - Used in the treatment of meningitis, pneumonia, UTI's and Venereal diseases.

XXVI. Corticosteroids

1. Androgens- female and male hormones that give the secondary sex characteristics.
2. Mineralocorticoids- mineral salts- maintain salt/water levels
3. Glucocorticoids- anti-inflammatory agents- work on metabolism of fats, proteins, and sugars.

Corticosteroids are used in the treatment of Adrenal insufficiency, Addison's disease, Rheumatoid arthritis and Hypopituitarism.

XXVII. Antineoplastic Drugs

1. Alkylating Drugs- used in the treatment of Multiple myelomas, lymphosarcomal leukemias and hodgin's disease.
2. Antimetabolites- used in the treatment of hodgin's disease, lymphosarcoma, acute lymphocytic leukemia, and reproductive carcinomas.
3. Antitumor antibiotic agents- used in the treatment of adenocarcinoma, Ewing's sarcoma, choriocarcinoma, and solid tumors.
4. Other agents
    a. Azathioprine (Imuran)- used in the treatment of kidney transplants
    b. Procarbazine hydrochloride (Matulane)- used in the treatment of Hodgkin's disease.
    c. Mitotane (Lysodren) used in the treatment of adrenocortical carcinoma
    d. Vincristine sulfate (Oncovin) used in the treatment of acute leukemia
    e. Vinblastine sulfate (Velban) used in the treatment of Hodgkin's disease and lyphosarcoma

XXVIII. Hormone Drugs

1. Hypothroidism- treated with Liotrix (Euthroid) and Liothyronine sodium (Cytomel). Also used with cretinism, nontoxic goiter and myxedema.
2. Hyperthyroidism- treated with Methimazole (Tapazole), Potassium iodine saturated solution (SSKI) and Radioactive iodine (sodium iodide). Also used with thyroid cancer, and thyrotoxic crisis.
3. Anterior pituitary – manages the adrenal cortex, bone growth, and thyroid gland.
4. Posterior pituitary – manages BP, milk production and water reabsoption.

XXVIX. Anti-Parkinsons

Anti-Parkinsons- used in the treatment of treatment of tremors, muscle weakness and other Parkinson's disease symptoms. Examples include: Cardibopa (LODOSYN) and Levodopa (LARODOPA).

XXX. Opthalmic/Nasal/Ear Drugs

1. Miotics- cause constriction of the pupils, used in surgery and with primary open angle glaucoma. Examples include: Carbachol (MIOSTAT), and Pilocarpine (PILOPTIC).
2. Mydriatics- cause dilation fo the pupils, used with open angle glaucoma and cycloplegia. Examples include: Atropine sulfate (ATROPINE-1), and Epinephrine hydrochloride (GLAUCON)
3. Nasal drugs- used in the treatment of rhinitis and congestion. Examples include:
    a. Fluticasone propionate (FLONASE)
    b. Oxymetazoline hydrochloride (AFRIN)
    c. Phenylephrine hydrochloride (NEO-SYNEPHRINE)
    d. Beclomethasone diproprionate (BECONASE)

4. Optic Anti-Inflammatory agents- used in the treatment of inflammation and allergic conditions also corneal injury. Examples include:

   a. Dexamethasone (MAXIDEX)
   b. Diclofenac sodium (VOLTAREN OPTHALMIC)
   c. Fluorometholone (FLAREX)

5. Optic Vasoconstrictors- used in the treatment of eye inflammation and allergies. Examples include:

   a. Tetrahydrozoline hydrochloride (COLLYRIUM)
   b. Oxymetazoline hydrochloride (VISINE)
   c. Naphazoline hydrochloride (ALLEREST)

6. Otics-used with ear infections and excessive earwax. Examples include:

   a. Carbamide peroxide (MURINE EAR)
   b. Boric acid solution (EAR-DRY)

XXXI. Topical Drugs

1. Scabicides- used to kill mites and in the treatment of people with scabies.

Example: Lindane (KWELL)

2. Pediculicides- used to kill lice.

Example: Permethrin (NIX)

3. Anti-infectives- Examples:

   a. Gentamicin sulfate (GARAMYCIN)
   b. Butoconazole nitrate (FEMSTAT)

4. Local anesthetics- Examples:

   a. Lidocaine (PRILOCAINE)
   b. Benzocaine (AMERICAINE)

5. Topical Corticosteroids- Examples:

   a. Hydrocortisone acetate (CORTAID)
   b. Hydrocortisone (CORTIZONE)

XXXII. Assorted Drugs

1. Gold Salts- used in the treatment of RA. Examples:
    a. Auranofin (RIDAURA)
    b. Gold sodium thiomalate (AUROLATE)
2. Spasmolytics- used in the treatment of a neurogenic bladder. Examples:
    a. Oxybutynin chloride (DITROPAN)
    b. Flavoxate hydrochloride (URISPAS)
3. Gout drugs- used in the treatment of gouty arthritis.
    a. Probenecid (BENEMID)
    b. Colchicine (COLGOUT)
    c. Allopurinol (ZYLOPRIM)
4. Uterine drugs- either stimulant, abortifacients, or relaxant:
    a. Stimulants
        1. Oxytocin (PITOCIN)
        2. Methylergonovine maleate (METHERGINE)
    b. Abortifacients
        1. RU 486
        2. Prostaglandin gel
    c. Relaxants
        1. Magnesium sulfate
        2. Terbutaline sulfate (BRETHINE)

Controlled Substance Categories

Schedule I	Highest potential abuse, used mostly for research. (heroin, peyote, marijuana)
Schedule II	High potential abuse, but used for therapeutic purposes (opioids, amphetamines and barbiturates)
Schedule III	Mild to moderate physical dependence or strong psychological dependence on both. (opioids such as codeine, hydrocodone that are combined with other non-opoid drugs)
Schedule IV	Limited potential for abuse and physical and/or psychological dependence (benzodiazepines, and some low potency opioids)
Schedule V	Lowest abuse potential of controlled substances. Used in cough medications and anti-diarrheal preps.

Dose Response- the relationship between dose and the body's response is called a dose-response curve (DRC).

Potency- relates to the dosage required to produce a certain response. A more potent drug requires a lower dosage than does a less potent drug to produce a given effect.

Efficacy- usually refers to maximum efficacy. Maximum efficacy is plateau (or maximum response), but may not be achievable clinically due to undesirable side

effects. In general, the steepness of the curve dictates the range of doses that are useful therapeutically.

LD_{50}/ED_{50} -- Quantal dose response curve is the relationship between the dose of the drug and the occurrence of a certain response.

Therapeutic index (TI)- the ratio of the median effective dose (ED_{50}) and the toxic dose (TD_{50}) is a predictor of the safety of a drug. This ratio is called the therapeutic index. Note: Acetominophin has TI of 27. Meperidine (DEMEROL) has a TI of 8.

Drug Distribution

Bioavailability dependant on several things:

1. Route of administration
2. The drug's ability to cross membranes
3. The drug's binding to plasma proteins and intracellular components

Membrane Review:

1. Membranes separate the body in components
2. The ability of membranes to act as barriers is related to its structure
3. Lipid Soluable compounds (many drugs) pass through by becoming dissolved in the lipid bylayer.
4. Glucose, H20, electrolytes can't pass on their own. They use pores.
5. In excitable tissues, the pores open and close.
6. Movement occurs by:
    a. passive diffusion
    b. active transport
    c. facilitated diffusion
    d. endocytosis

Passive Diffusion Review:

1. No energy expended.
2. Weak acids and bases need to be in non-ionized form (no net charge).
3. Drugs can also move between cell junctions. BBB is exception.
4. Must be lipid soluable to pass through pores.
5. Osmosis is a special case of diffusion
    a. A drug dissolved in H2O will move with the water by "bulk flow"
    b. Usually limited to movement through gap junctions because size too large for pores.

Active Transport Review:

1. Requires energy and requires a transport protein
2. Drugs must be similar to some endogenous substance.
3. Can carry substances against a gradient
4. Some drugs may exert their effect by increasing or decreasing transport proteins.

Facilitated Diffusion Review:

1. Requires transport protein
2. Does not require energy
3. Very few drugs move this way

Endocytosis:

1. Drug gets engulfed by cell via invagination
2. Very few drugs move this way and only in certain cells.

Regulation of distribution determined by:

1. Lipid permeability
2. Blood flow
3. Binding to plasma proteins
4. Binding to subcellular components

Volume of Distribution (V_d) - is a calculation of where the drug is distributed.

$$V_d = \frac{\text{amount of drug given (mg)}}{\text{concentration in plasma (mg/ml)}}$$

Calculate the V_d and compare to the total amount of body H20 in a person.

-if V_d = total amount of body (approx. 42) is uniformly distributed

-if V_d is less than 42 – retained in plasma and probably bound to plasma proteins

-if V_d is more than 42 – concentrated in tissues

This is not a “real value” but tells you where the drug is being distributed.

Placental Transfer of Drugs

1. Some drugs cause congenital anomalies
2. Cross placenta by simple diffusion
3. Must be polar or lipid-insoluable Not to Enter
4. Must assume the fetus is subjected to all drugs taken by the mother to some extent.

Biotransformation of Drugs

Biotransformation refers to chemically altering the original drug structure. "Metabolite" refers to the altered version. Biotransformation metabolites are generally more polar than the original drug. The kidney will excrete polar compounds, but reabsorb non-polar compounds.

Enzymatic reactions are either Phase I or Phase II reactions:
Phase I include:

1. hydrolysis rxns – split the original compound into separate parts
2. reduction rxns – either remove O2 or add H
3. oxidation rxns- adds an O2 molecule and removes a H molecule.
   These are the most predominant reactions for biotransforming drugs

Phase I reactions are generally more polar and usually inactive-some exceptions.

Phase II reactions are called conjugation rxns.

1. Lead to the formation of a covalent bond between the drug and another compound such as glucaronic acid, amino acids or acetate.
2. Products are highly polar and generally inactive- morphine is exception.
3. Products are rapidly excreted in urine and feces because poorly reabsorbed by kidney and intestine.
4. There is also a phenomenon known as entrohepatic recirculation – can result in re-entry of the parent drug back into the circulation and leads to delayed elimination and prolonged effect of the drug.

Most metabolism takes place in the liver- 1st pass significant. Kidney, skin, GI, and lugs have significant metabolic capacity. Phase I reactions take place mostly in endoplasmic reticulum (ER). Phase II reactions take place mostly in cytosol.

Cytochrome P450 mono-oxygenase enzymes are the major catalyst in Phase I. The Cyt 450 system is a series of enzymes that are heme containing proteins. The catalyze oxidation/reduction reactions- which make compounds more + or -. These metabolites are subjected to conjugation reactions and then excreted.

Biotransformation Factors:

1. Induction- certain drugs induce synthesis of addition Cyt 450 enzymes
2. Inhibition- certain drugs inhibit Cyt 450 enzymes
3. Genetic Polymorphism-slow vs. fast metabolizers
4. Disease- impaired liver function, decreased hepatic blood flow
5. Age/Gender-rate of phase I/II reactions slow in infants, females may have reduced ability to metabolize certain compounds?

Drug Elimination

1. Renal elimination
    a. Drugs get filtered and if not reabsorbed, gets excreted in urine
    b. Renal excretion involves: glomerular filtration, active tubular secretion, and passive tubular reabsorption.

2. Elimination by other routes.
    a. Lungs mostly volatile compounds
    b. Bile/fecal excretion
    c. Saliva, sweat, tears, breast milk
    d. Hair, skin

General Pharmacokinetics Review

Clinical Pharmacokinetics attempts to quantify the relationship between dose and effect. Primary parameters that dictate dosage include:

1. Clearance
2. Volume of Distribution
3. Bioavailability

Clearance-measure of the body's ability to eliminate a drug. Clearance is an expression of the volume of plasma which is cleared of the drug per unit time (ml/hr) not the concentration of the drug cleared.

$$\text{Clearance} = \text{flow (ml/min)} \times \frac{\text{amount of drug removed from the blood (mg/ml)}}{\text{Amount of drug going in to kidney (mg/ml)}}$$

Or

$$Cl = \text{flow} \times \frac{[C]in - [C]out \text{ (amount removed)}}{[C] \text{ in (amount in blood)}}$$

The systems of drug elimination are not usually saturated so drug elimination is dependent on the concentration of drug in the plasma. This means the higher the concentration of the drug, the faster the blood is cleared. When this is true this is called 1st order kinetics. In 1st order kinetics a constant faction of the drug is eliminated/unit time. The time required to remove half of the drug is called t ½. T1/2 is constant in 1st order kinetics.

In 1st order kinetics the:

Rate of elimination = concentration of drug in plasma (mg/ml) x Cl (ml/hr). When the systems for drug elimination become saturated, now have zero order elimination. Zero order elimination means that the elimination rate is constant over time, regardless of the concentration of drug in the system.

The aim is to maintain a steady-state concentration of a drug within a known therapeutic range. Steady state is achieved when the rate of elimination = rate of availability.

$$\text{Availability} = \frac{\text{amount of drug in plasma}}{\text{amount of drug given}}$$

Rate of Elimination = Cl x concentration in plasma

Time to reach steady state depends on dosing interval and elimination t ½ . If you want to achieve steady state more rapidly, a loading dose can be given followed by a maintenance dose.

Loading dose (mg) = target concentration (mg/ml) x V_d (ml)

Maintenance dose = amount given must equal amount eliminated within dosing time.

If given at intervals shorter than elimination time = toxicity.
If given at intervals longer than elimination time = ineffective dose.

Pharmacodynamic Terms

1. Agonist – has affinity and efficacy
2. Partial agonist – has affinity and partial efficacy
3. Antagonist – has affinity, no efficacy
4. Additive effects- !+1 = 2
5. Synergistic effects- 1+1 = 3
6. Affinity – attraction between drug and (X)
7. Specificity- attraction between drug and specific (X)
8. Potentiation- one drug enhances the effect of another drug
   Ex. Aspirin bumps T3/T4 off plasma proteins- more free T3/T4

Autonomic Nervous System Receptors

1. Cholinergic Receptors – Ach binds both – prefers Muscarinic

    a. Nicotinic-preferentially binds nicotine. Found at ganglion on post synaptic fiber. Found in both SNS and PNS. Drugs that bind to nicotinic receptors affect both systems.
    b. Muscarinic- preferentially binds muscarine. Found on target tissue in PNS and located on sweat gland in SNS.

2. Adrenergic Receptors:

    Alpha- found NE excited target tissue and also inhibited further release of NE from nerve. (constricted VSM)
    Beta- found that NE and EPI equally potent in heart but EPI 50x more potent

Behavioral Science Developmental Milestones

One Month

Fine Motor-Holds both hands in fists. Grasps object with palm reflexively.
Gross Motor-Moves extremities symmetrically. Drops head forward if held sitting. Lifts and turns head side to side when in prone.
Language-Responds to sound with startle. Responds to voice with decreased activity. Turns to localize, usually finds face or object and brightens.
Social/Play-Stares at brightly colored or patterned objects. Regards toys only when in front of eyes. Follows dangling toy to midline and vertically.

Second Month

Fine Motor-Holds ring placed in hand briefly. Brings hand to mouth. Looks at hands (3 months). Holds hands open instead of clenched and brings to midline (3 months).
Gross Motor- Lifts head 45 degrees in prone position. Rolls stomach to back (2-4) months. Holds head erect in sitting position with some bobbing.
Language-Cries differently when hungry, uncomfortable or bored. Coos. Smiles when some talks. Responds to loud noises and alerts to familiar voices.
Social/Play-Follows moving person with eyes. Follows dangling toy past midline (3 months).

Fourth Month

Fine Motor-Reaches for and grasps toy (eye-hand coordination at 5 months).
Gross Motor-Supports head when pulled to sit. Holds head steady when sitting. Sits with mid-to-lower truck support. Holds head 90 degrees when prone. Pushes up on arms and looks directly ahead. Rolls stomach to back.
Language-Laughs out loud. Squeals.
Social/Play-Initiates smile. Smiles and talks to self in mirror, pats image when close to mirror. Takes toy to mouth while on back.

Sixth Month

Fine Motor-Transfers toy hand to hand. Uses raking grasp or small object. Holds 1-inch cube with opposed grasp. Reaches for and secures toy with either hand, supine or sitting. Uses toys to make noise by banging and shaking.
Gross Motor-Rolls stomach to back and back to stomach. Sits briefly leaning on hands (tripod position). Bears weight on feet and bounces when standing.
Language-Makes tongue/lip sounds (raspberries, clicks, smacks).
Social/Play-Grasps feet when lying on back. Enjoys vigorous frolic play. Notices mother especially; conscious of strangers.

Nineth Month

Fine Motor-Takes objects out of open container. Holds bottle. Feeds self-cracker. Uses pincer grasp on small objects.
Gross Motor-Sits erect well. Gets from lying to sitting. Creeps/crawls. Pulls self to full standing position. Cruises
Language-Babbles with repeated consonant-vowel sounds. Imitates syllables. Responds to name.
Social/Play-Plays peek-a-cake and waves bye-bye. Looks for hidden or dropped toy.

Twelfth Month

Fine motor-Holds cup to drink. Releases object purposefully. Uses pincer grasp well. Imitates actions/uses of objects
Gross Motor-Cruises, walks independently or with one hand held (9-12 months). Crawls on all fours. Lets self down from furniture with control. Stands alone at least momentarily.
Language-Follows simple commands. Jabbers with sequences of mixed syllables used to communicate.
Social/Play-Plays simple ball game. Imitates favorite games. Shows interest in picture books and turns pages. Is affectionate toward familiar people.

Fifteen Month

Fine Motor-Places pegs and round puzzle pieces randomly. Dumps pellet from bottle on request. Stacks 2-3 cubes. Scribbles spontaneously when given crayon.

Gross Motor-Rarely falls when walking. Runs stiff-legged. Climbs on and off of chairs. Gets to standing position unaided.

Language-Uses vocabulary of 2-5 words. Points to common objects on request. Imitates easy words. Shakes head appropriately for yes and no.

Social/Play-Pulls person to show things. Uses spoon, spills good amount. Helps pull off clothes. Exhibits early tantrums.

Eighteenth Month

Fine Motor-Stacks 3-4 cubes. Imitates drawing straight line. Finishes small pegboard. Uses trial and error to place puzzle pieces.

Gross Motor-Walks upstairs and downstairs holding on. Kicks ball forward.

Language-Combines 2 ideas (car go, get down) (21 months) Uses jargon; 6-20 recognizable words. Points to pictures in book. Points to 4-8 body parts on request.

Social/Play-Imitates household tasks like sweeping, dusting. etc.. Takes off socks, shoes. Throws ball overhand.

Twenty-fourth Month

Fine Motor-Stacks 6-8 cubes. Opens door. Imitates construction of simple block train. Uses visual matching of a few shapes to place puzzle pieces.

Gross Motor-Jumps both feet of floor. Walks up and down stairs alone. Runs well. Catches large ball.

Language-Uses I, you, no, mine. Uses short sentences: 3-4 words. Has 50 or more words in vocabulary. Follows 2-step directions with early prepositions.

Social/Play-Feeds self, spills little. Pulls on simple garment. Parallel play. May demonstrate readiness for toilet training. Exhibits early imaginative play, exhibits limit testing, negativity.

Psychological Terms

1. Empathy-capacity to understand what your patient is experiencing from that patient's perspective.
2. Defense mechanisms:

   A: Compensation - covering up a weakness by stressing a desirable or strong trait

   B: Denial stage– the second reaction stage of psychologic adjustment to physical disablement or loss; an unconscious defense mechanism in which existence of unpleasant realities is blocked from conscious awareness

   C: Displacement – transferring of an emotion, or actual loss of function as a result of illness or accident

   D: Projection – attributing of our own unwanted trait onto another person

   E: Rationalization – the justification of behaviors using reason other than the real reason

   F: Reaction Formation – a defensive reaction, in which a behavior is exactly the opposite of what is expected

   G: PTSD- Posttraumatic stress disorder- psychopathologic reaction to a traumatic event

   H: Lability: Emotional instability; manifested by alterations or fluctuations in emotional state.

   I: Dysphoria- Exaggerated feelings of depression; may be accompanied by anxiety

   J: Perservation – a patient continues to repeat a movement, word or expression, even though it is meaningless. Associated with TBI or brain damage

   K: Anxiety- feelings of apprehension associated with the following sympathetic reactions

      1. Increased heart rate
      2. Dyspnea
      3. Hyperventilation

4. Dry mouth
5. GI symptoms (nausea/vomiting)

Grief Process

Denial- patients insist they are fine, joke about themselves or are not motivated to participate in the treatment

Anger- patients may become disruptive, blame others and do not admit to any improvement. The defense mechanism of displacement may occur.

Bargaining – patients may turn to religion or others in charge and make promises to effect a return of function or any further loss of function

Depression – patients may withdraw, cry or lose interest in treatment. Motivation is low and needs to be monitored closely by the doctor. The patient has an overwhelming sense of loss.

Acceptance – patients have worked through other grief stages, accepted their condition, relate more to their treatment and make plans for the future.

Conditions

Alzheimer's Disease – chronic, progress, widespread deterioration of the cerebrum. There is intellectual decline, loss of memory, confusion, anxiety, depression, loss or reasoning, possible motor impairment, and gait problems as the disease progresses.

Bipolar disorder (manic-depressive) – disorder characterized by mood swings from depression to mania. In the manic phase, patients often present with intense outbursts, high energy and activity, excessive euphoria, decreased need for sleep, and unrealistic beliefs.

Conversion Disorder – response to severe emotion stress resulting in involuntary disturbance of physical functions

Depressive reaction – neurotic reaction to a personal loss or failure that is disproportionate in intensity and duration

Nutrition

I. Six Key Nutrients:

1. Water
2. Protein
3. Minerals
4. Vitamins
5. Carbohydrates
6. Fats

II. Water Key Points

1. Normal production of water in a human is around 2500-2700 ml per day.
2. The average adult is composed of about 55-60% water.
3. More water is required for children and during warm weather.
4. Water acts as the body's solvent.
5. Water can be found in intra and extra cellular tissues.
6. Adults should take in 2-3 L of fluid over the course of a normal day.
7. Doctor should monitor if excess loss of water is occurring following surgery.
8. Also monitor following burns, diarrhea, and hemorrhage.

III. Protein Key Points

1. Proteins are made up of amino acids.
2. Amino Acids can be broken down into essential and non-essential amino acids. At least 9 amino acids must be found in your diet and cannot be manufactured by your own body.
3. There are three types of proteins: Complete, Incomplete, and Complementary.

4. Complete proteins are found in meats, cheese and poultry. These contain all 8 essential amino acids.
5. Incomplete proteins are found in plants, nuts, grains and legumes
6. Complimentary proteins- foods that have to be combined to offer a complete protein presentation.
7. Digestion process of chymotrypsin, trypsin, carboxypeptidase, and pepsin act upon proteins.
8. Proteins help in the production of antibodies and tissue healing.
9. Proteins become an energy source if carbs/fat are not available.
10. Marasmus-starvation
11. Recommend 15% caloric intake to be protein.
12. Uric acid, Nitrogen, and Hydrogen are all byproducts of protein breakdown.
13. Amino acids are incorporated into various structural and functional proteins, including enzymes.
14. A starving person has a negative nitrogen balance, a growing child or pregnant woman has a positive nitrogen balance.

IV. Mineral Key Points

1. Minerals help maintain the function of the various acids and bases in the body.
2. About 75% of the minerals are found in bones and teeth as calcium and phosphorus.
3. Minerals may function as catalyst for cell reactions.
4. Minerals help create compounds in some cases.
5. Magnesium, Calcium, Phosphorus, Sodium and Potassium are all considered minerals
6. Minerals are usually incorporated into organic molecules, although some occur in inorganic compounds or as free ions.
7. Homeostatic mechanics regulate mineral concentration in the body.
8. Minerals are responsible for about 4% of body weight.

9. Minerals are found in all types of tissue.
10. Minerals do not create energy in the body.
11. Calcium and Phosphorus are key minerals in body development and maintenance.
12. Sodium and Potassium help trigger cell reaction potentials.
13. Minerals are found primarily in unprocessed foods.

V. Major Minerals

Calcium (Ca)

Sources: Milk, Cheese, Broccoli, Turnips
Function: Bones, Clotting, Cell wall integrity, Conduction of Nerve Impulses
Disorders: Deficient Clotting, Poor Bone Structure- Osteoporosis, Limited cell integrity.

Chlorine (Cl)

Sources: Salt
Function: Helps produce acid-base relationships that are balanced, helps with osmotic pressures and the production of hydrochloric acid, helps regulate pH.
Disorders: Excessive water loss may cause low levels of chlorine in the body.

Magnesium (Mg)

Sources: Leafy Vegetables, Whole grains, Legumes, Milk
Function: Bones, Teeth, Function as enzymes, Nerve conduction, functions in the production of ATP
Disorders: Nervous system dysfunction

Phosphorus (P)

Sources: Egg Yolk, Whole grains, Meat, Milk
Function: Helps with calcification, Maintains acid-base relationship, Works as an enzyme, occurs in the phospholipids of cell membranes
Disorders: Rickets, poor bone structure

Potassium (K)

Sources: Fruits, Whole grains, Fish and Poultry
Function: Nervous system conduction, acid-base relationship, regulation of pH
Disorders: Nausea, Weakness of muscles

Sodium (Na)

Sources: Salt, Fish, Poultry, Milk
Function: Acid-base relationship, Nerve system conduction, Uptake of glucose
Disorders: Nausea, weakness, Muscle spasms/cramping

Sulfur (S)

Sources: Egg, Cheese, Nuts, Meat
Function: Aids with B vitamin function and helps develop with development of connective tissue, found in Insulin, Biotin, and mucopolysaccharides
Disorders: None applicable.

Vitamin Key Points

1. Fat- Soluble vs. Water Soluble Vitamins

2. Fat Soluble- Vitamin A, D, E, K
3. Water Soluble – Vitamin C, B1, B2, B6, B12, Folic Acid and Niacin

VI. Water Soluble Vitamins

Vitamin C – Ascorbic Acid

Sources: Citrus, Strawberries, Potatoes, Tomatoes
Function: Helps with uptake of iron, and cell membranes, closely related chemically to monosaccharides
Disorders: Scurvy, Anemia, Pronounced bruising of tissue

Vitamin B1- Thiamine

Sources: Legumes, Wheat germ, Pork
Function: Helps with muscle and nerve function, active in the synthesis of essential sugars
Disorders: Anorexia, nerve dysfunction, Beriberi

Vitamin B2- Riboflavin

Sources: Enriched breads, Milk, Meats, Greens
Function: Lip color, metabolic process of nutrients, eyes, can function as a coenzyme
Disorders: Weight loss, eye dysfunction, and lips may become inflamed.

Vitamin B6 - Pyridoxine

Sources: Red Meats
Function: Hemoglobin production, synthesis of proteins
Disorders: CNS disorders, kidney stones, and nausea

Vitamin B12 – Cobalamin

Sources: **Animals products only**
Function: RBC production, protein breakdown
Disorders: Pernicious anemia

Folic Acid - Folacin

Sources: Most foods.
Function: RBC production and protein breakdown, coenzyme in the synthesis of DNA
Disorders: Anemia, Stomatitis

Niacin – Nicotinic Acid

Sources: Meats, Peanut Butter
Function: Growth, Nervous System and Digestive System
Disorders: Pellagra, Dermatitis

VII. Fat Soluble Vitamins

Vitamin A – Retinol

Sources: Whole milk, Fish, Leafy Vegetables and Yellow Vegetables
Function: Vision, Skin, Teeth, - stored in the Liver
Disorders: Poor Vision, Xerophthalmia, Bad Skin

Vitamin D – Calciferol

Sources: Milk, Fish oils

Function: Bones. Also synthesized in the skin.
Disorders: Teeth, Bad bone structure, Rickets

Vitamin E – Tocopherol

Sources: Leafy Vegetables, Wheat germ
Function: Antioxidant, Stabilizes RBC's, stored in muscles and adipose tissue.
Disorders: Anemia, RBC's are broken down

Vitamin K – Menadione

Sources: Pork liver, Leafy Vegetables
Function: Helps with prothrombin for blood clotting
Disorders: Hemorrhagic conditions

VIII. Carbohydrates Key Points

1. Three types of carbohydrates: polysaccharides, disaccharides, monosaccharides.
2. Polysaccharides- Glycogen, dietary fiber, and starch found in cereal, rice, corn and pasta.
3. Disaccharides- (double sugars) – maltose, lactose, sucrose, found in molasses, table sugar
4. Monosaccharides – (simple sugars) - Fructose, glucose, galactose found in fruit and honey
5. Energy is released from glucose by oxidation.
6. If inadequate amounts of glucose are available, amino acids may be converted to glucose.
7. Carbohydrates provide energy and help in the breakdown of fat.
8. Carbohydrates can only be used the form of simple sugars by the body.

9. Primary processing and uptake of carbohydrates occurs in the small intestine by the enzymes maltase, sucrase, and lactase.
10. Glucose is the simple sugar used by the CNS and glucose can be stored as glycogen (polysaccharide) until being used later.
11. High levels of carbohydrates can lead to weight gain, and poor nutritional status.
12. Studies indicate that approximately 55% of an adults intake is carbohydrates.
13. Carbohydrates are absorbed as monosaccharides.
14. Dietary fiber can be broken down into soluble and insoluble dietary fiber.
15. Glucose is regulated by Insulin and Glucagon (horomone).
16. Educate patients to reduce simple sugars and encourage patients to eat more complex carbohydrates.

IX. Fat Key Points

1. Excessive fats can lead to weight gain, stroke, and heart disease.
2. There are two primary types of fat: saturated fats and unsaturated fats.
3. Saturated fats- completely maximized number of Hydrogen present. Examples: eggs, chocolate, dairy, coconut oil, meats, usually solid at room temperature.
4. Unsaturated fats- usually liquid at room temperature, do not have maximum number of Hydrogen atoms present. Examples: soybean and corn oil.
5. Fats provide insulation to the body.
6. Linoleic acid is an essential fatty acid.
7. Cholesterol is obtained in foods of animal origin only.
8. Fats help with the transportation of fat soluable vitamins.
9. Fats act as an energy source when carbohydrates are unavailable.
10. Fats help create linoleic acid which is an essential component not created in the human body.

11. Primary fat breakdown occurs in the small intestine, however, some is performed in the stomach by gastric lipase.
12. Fats can also be classified as visible or invisible.
13. Visible fats: Shortening, Meats, Margarine, Butter
14. Invisible fats: Cheese, Milk, Avocado
15. Recommend to your patients total intake of fat to be less than 30% of caloric intake.
16. Cholesterol is a fatty type complex and is found in healthy adults.
17. Cholesterol is divided into (HDL) and (LDL) cholesterol.
18. HDL- High density lipoprotein
19. LDL- Low density lipoprotein
20. High Cholesterol is noted as above 240mg/dl
21. Borderline – 200-240 mg/dl
22. <200 mg/dl Recommended
23. Recommend polyunsaturated fats to lower cholesterol levels to your patients.

X. Nutritional Considerations for Various Age Ranges

Infant/Toddler

1. Recommend breastfeeding to your patients. Breastfeed babies have lower level of allergies and have antibodies from the mother. Breast milk also provides more vitamin C.
2. If breastfeeding is not desired, bottle feeding can be used. Cow's milk should not be used with bottle feeding due to an infant's intolerance of cow's milk. Enfamil and Isomil are adequate formulas.
3. Infants should receive higher levels of protein due to brain and body development.
4. Infants usually start on semi-solid food around 5-7 months with rice cereal being the first transition in many cases.

5. It is best to introduce a new food type and wait a few days to determine if the infant has allergies due to the new food.
6. Iron supplements are recommended in many cases after 4 months with infants.
7. The infant should be observed at all time while eating to observe for choking type behavior.
8. Egg whites, honey and cow's milk should not be given until at least 1 year.

3.5 - 5 Year Age Range

1. Children may be "picky" eaters at this stage.
2. Do not attempt to force feed.
3. Children will demonstrate preferences with food.
4. Encourage healthy snack foods and limit processed sugars.

5-12 Year Age Range

1. Food preferences become more stable.
2. Encourage proper nutrition. Limiting simple sugars, and adequate protein uptake levels.

Teenager

1. Growth spurt with puberty, normally earlier in girls.
2. Girls start to develop more fatty tissue.
3. Boys start to develop more muscle.
4. Normally, increased uptake of sugars at this stage.

Adults

1. Should follow the Food Pyramid.

2. Vitamin supplement not recommend during this stage of life unless indicated due to deficiency.

Geriatrics

1. Aging process creates a situation were the body's nutritional requirements decrease.
2. Older adults may have deficiencies in some minerals and vitamins.
3. Also limited uptake of these vitamins and minerals may be occurring in the intestines.
4. Decreased use of senses may cause food to seem stale and encourage older adults to use excessive salt in their diet.
5. May be presence of decreased drive to eat healthy foods and older adults may not seek out eating with others.
6. Recommend eating with other adults, encouraged continued consumption of protein over softer foods like starches when applicable.
7. Monitor older adults for difficult swallowing especially if there is a history of a stroke.

Nursing and Pregnancy Considerations

1. Higher levels of protein are recommended during nursing and pregnancy.
2. Mothers will have to increase their caloric intake by at least 500 calories per day to provide nutrition to the infant.
3. Mothers that are nursing should also take in extra fluids. Recommend milk to nursing mothers.
4. During pregnancy increased calories are needed. A weight gain of 25-30 lbs is normal.

5. If vomiting becomes a problem during pregnancy recommend separating food and fluids at mealtime and smaller portions.
6. Limiting caffeine, and taking a prenatal vitamin are also recommended.

Pathological Conditions

1. AIDS- caused by a retrovirus in which viral RNA becomes part of the host cell DNA. Reduction in T-cells (<250) and a high viral load can cause HIV to progress to AIDS. Low immunity can lead to opportunistic infections like pneumoncystsis carinnii, secondary cancers, salmonella, neuropathies, and meningitis. Use of protease inhibitors in combination with other drugs seems to be a major step in the management of HIV.
2. Budd-Chiari syndrome- leads to congestive liver disease. Caused by an occlusion of the hepatic veins or IVC.
3. Cellulitis- inflammation of the connective tissue, tends to be widespread and is poorly defined. It is frequently accompanied by infection. The skin over the are is often hot, red, and edematous, and resembles the skin of an orange.
4. CHF- may result in tachycardia, decreased stroke volume, LE swelling and decreased cardiac output.
5. Cri-du-chat syndrome – Noted severe mental deficits and chromosome 5 short arm.
6. Cystic fibrosis – thickening of secretions of all exocrine glands, leading to obstruction. Probable multiple frequent respiratory infections especially Staph. Aureus and Pseudomonas Aeruginosa
7. Dermatitis- superficial inflammation of the skin, characterized by vesicles (when acute), redness, edema, oozing, crusting, scaling and usually itching
8. Deep vein thrombosis – formation of an abnormal blood clot in a deep vein. If the clot breaks free it may become a pulmonary embolus. Symptoms include a +Homan's sign, positive doppler. Anticoagulant therapy is indicated in most cases.
9. Diabetes Mellitus-Insulin dependent is due to the absolute insulin deficiency and can lead to diabetic ketoacidosis
10. Diabetes mellitus-non-insulin-dependent diabetes is usually associated with obesity and is caused by a combination of insulin resistance and a defect in

beta-cell responsiveness to elevated plasma glucose concentration. Plasma insulin concentration is usually normal or elevated.

11. Fragile X syndrome- X-linked disease with appearance of enlarged testes, autism and enlarged jaw.
12. Down's syndrome- Trisomy 21-altered facial appearance, mental retardation, simian crease, congenital heart disease.
13. Duchenne's muscular dystrophy- X-linked recessive disease with noted pelvic weakness and calf hypertrophy.
14. Edward's syndrome- Trisomy 18- mental retardation, congenital heart disease, life span < 1 yr.
15. Eisenmenger's syndrome- Late cynosis due to increasing pulmonary hypertension.
16. Gout – metabolic disease marked by elevated level of serum uric acid and deposition of urate crystals in the joints, soft tissue and kidneys. Treatment often involves anti-inflammatory medications, daily use of colchicine and lowering of urate concentration in body fluids with diet.
17. Hemophilia – bleeding disorder that is inherited and has to do with clotting factor deficiency.
18. Hepatitis – inflammation of the liver and may be caused by viral or bacterial infections or chemical agents. Transmission is from blood, body fluids, or body tissues, through oral or sexual contact or contaminated needles. Signs/Symptoms include elevated lab values of hepatic transaminases and bilirubin, enlarged liver with tenderness, fever and juandice. Treatment-IV fluids, analgesics, interferon and vaccines
19. Herpes zoster – acute nervous system viral infection involving the dorsal root ganglia and characterized by vesicular eruption and neuralgic pain I the cutaneous areas supplied by peripheral sensory nerves arising at the infected dermatome or myotome. Treatment involves corticosteroids for pain relief in many cases.
20. Intermittent claudication – arterial insufficiency that results in ischemia to the exercising muscle. Relief of pain is achieved by resting.

21. Kartagener's syndrome-linked to situs inversus, causes sterility.
22. Lyme disease – inflammatory disease caused by a spirochete transmitted to humans by a tick bit and is common in the northeastern U. S. Treatment often involves antibiotic, medications for pain relief.
23. Paget's disease – slowly progressive metabolic bone disease characterized by an initial phase of excessive bone re-absorption followed by a reactive phase of excessive abnormal bone formation. The disease can be fatal when associated with CHF, bone sarcoma or giant cell tumors
24. Psoriasis – chronic disease of the skin with erythematous plaques covered with a silvery scale. Common on the scalp, elbows, knees, and genitalia. Treatment involves long-wave UV light, combination UV light with oral photosensitizing drug (Psoralen).
25. Pulmonary emboli- a thrombus from the peripheral venous circulation lodges in the pulmonary artery with the subsequent obstruction of blood flow to the lungs. Treatment often involves a low-dose heparin, analgesis, and pulmonary vasodilators.
26. Rhematoid arthritis – Complaints of fatigue, weight loss, weakness and general diffuse musculoskeletal pain are often the initial presentations. Pain is localized to specific joints with symmetrical bilateral presentation. Deformities of the fingers are common.
27. Reye's syndrome- (hepatoencephalophathy), sometimes fatal with children related to viruses and acetaminophen.
28. Systemic lupus erythematosus – chronic, systemic rheumatic, inflammatory disorder of the connective tissues which affects multiple organs including skin and joints.
29. Turner syndrome- Noted webbing of the neck and ovarian dysgenesis. (X0)
30. Tuberculosis – infection spread by droplets from the untreated infected host. Treatment involves medications to eliminate infection.
31. Wilson's Disease- (hepatolenticular degeneration) copper does not enter circulation and builds up in the brain, liver and eye.

Online Pathology Slide Review

http://www.mo-media.com/pathology/

Major Hormones

Growth hormone- major stimulus of postnatal growth: Induces precursor cells to differentiate and secrete insulin-like growth factor I which stimulates cell division, stimulates protein synthesis

Insulin-stimulates fetal growth, stimulates postnatal growth by stimulating secretion of IGF-1, stimulates protein synthesis

Thyroid hormones-permissive for growth hormone's secretion and actions, permissive for development of the central nervous system

Testosterone-stimulates growth at puberty, in large part by stimulating the secretion of growth hormone, causes eventual epiphyseal closure, stimulates protein synthesis

Estrogen-stimulates the secretion of growth hormone at puberty, causes eventual epiphyseal closure

Cortisol-inhibits growth, stimulates protein catabolism

Various Blood and Urine Values

1. Creatinine- increased in blood and urine with kidney disease
2. Albumin – protein that if elevated in the urine indicative of renal disorder. This is sometimes called "proteinuria". Note-Albumin levels decrease after a burn injury
3. Gamma globulin – is a blood protein that helps in resisting infection. Elevated in patients with MS.
4. Hematocrit – percent of red blood cells in the blood. Normal values range from 35-55%.

5. Erythrocyte sedimentation rate – speed at which red blood cells settle after an anticoagulant has been added to a blood sample.

Tumor Review

Primary Tumors

Neuromas-80-90% of brain tumors, named for what part of nerve cell affected.

Meningiomas- outside of arachnoidal tissue, usually benign and slow growing

Glioblastoma Multiform-50% of all primary tumors, linked to specific genetic mutations

Secondary Tumors

Metastatic carcinomas

Scale –degree of anaplasia: differentiation of mature (good) vs. immature cells (bad)

Grade I: up to 25% anaplasia

Grade II: 26-50% anaplasia

Grade III: 51-75% anaplasia

Grade IV: 76-100% anaplasia

Primary Tumor Effect:

1. Headaches
2. Vomiting
3. Seizures
4. Neurological problems
5. Dementia
6. Drowsiness

Secondary Tumor Effect:

1. Direct compression/necrosis

2. Herniation of brain tissue
3. Increase ICP

Noteworthy Tumor Markers

1. AFP
2. Alkaline phosphatase
3. β-hCG
4. CA-125
5. PSA

Define the following terms:

Basal cell carcinoma:
Chondrosarcoma:
Ewing's sarcoma:
Giant cell tumor:
Melaonoma:
Meningioma:
Oligodendroglioma:
Pituitary ademona:
Schwannoma:
Squamous cell carcinoma:

Leukemia Review

Know the following four types of leukemias. Be able to differentiate between the four types.

ALL- acute lymphocytic leukemia
AML- acute myelocytic leukemia
CLL- chronic lymphocytic leukemia
CML- chronic myeloid leukemia

Genetics and Cell Biology

Molecular genetics. DNA: double-helix structure, its roles as template in nucleic acid synthesis.

Nucleotides: Types and three structural components of DNA and RNA; base-pairing.

Protein Synthesis. Sequence of events from transcription to translation; the roles of mRNA, tRNA, amino acid and growing peptide chain, and the ribosome. Diversity and protein functions.

Enzymes. Catalytic function and universality of. General principles of enzyme action: active site:, specificity. Regulatory enzymes and feedback inhibition. Knowledge of Michaelis-Menten kinetics (e.g., K_m) is *not* required

Metabolism. ATP as universal energy source. Glycolysis, Krebs cycle, and electron-transport chain: important steps, intracellular location, sites and amounts of ATP and CO^2 production, O^2 consumption.

Prokaryotes. Defining characteristics. Viruses: protein-DNA structure; life cycle (lytic and lysogenic); as obligate intracellular parasites; bacteriophage. Bacteria: classification by shape (e.g., cocci, bacilli, spirochetes, rickettsians). Importance of mutation, transformation, transduction.

Eucaryotes. Defining characteristics. Function and essential structure of important organelles and inclusions, such as mitochondria, ribosomes, nucleus, nuclear and cell membranes. Mitosis: stages of, principles of, associates structures. The only thing that should be known about fungi is their characteristic life cycle.

Organismal Biology

Embryology and Reproduction. Meiosis and principles of sexual reproduction. Crude understanding of male and female sexual anatomy and physiology. Fertilization of egg and subsequent developmental stages (zygote, morula, blastula, gastula, neurula). The three primary germ layers and the organs each gives rise to. Basic anatomy of the early embryo. Induction and differentiation: prototypical example – development of the vertebrate eye.

Respiration and Renal Function. Lungs as gas exchangers (of O^2, CO^2). The kidneys as excretory organs (of urea, bicarbonate, drugs, etc.) and as reabsorbing organs (e.g., of glucose, water, sodium). The glomerulus, nephron, loop of Henle.

Circulation. Basic anatomy of the heart and great vessels. Functions of arteries, arterioles, capillaries, venules, and veins. Lymphatic system: function; drainage. Thermoregulation: counter-current heat exchange mechanism; importance of increased or decreased blood flow to the skin.

Muscle and Bone. Principles of muscle action: actinmyosin contraction, role of O^2 and lactic acid production, utilization of glucose and creatine phosphate. Characteristics of smooth, striated (voluntary), and cardiac muscle. Bone: cellular components and inorganic matrix; cartilage and organic matrix. Haversian canals. Tendons and ligaments.

Nervous System. The neuron: dendrites, cell body, axon, resting potential, impulse propagation, sodium potassium transfers. Autonomic nervous system, central vs. peripheral nervous systems, afferent vs. efferent nerves vs. interneurons. The reflex arc. Basic functions of the medulla, cerebellum, and cerebrum. The neuromuscular junction.

Endocrine System. The major glands and their hormones. The feedback loop. Special emphasis is on the sex hormones, insulin, epinephrine, antidiuretic hormone (ADH), thyroid hormone. Connection between the hypothalamus and the pituitary gland.

Digestion. Major digestive events occurring in the mouth, stomach, small intestine, and large intestine. The portal vein, liver, bile, and gall bladder. Pancreatic digestive enzymes. Villi and microvilli.

The Gene, Alleles, and Mandelian Principles. Genetic crosses, pedigree analysis. Dominance, co-dominance, sex-linkage, heterozygosity, pleitropy. Mechanism and significance of crossovers. Assumptions necessary for the Hardy-Weinberg equilibrium
(but not the Hardy-Weinberg formula)

Animal and Human behavior. Imprinting, reflex, ritual, conditioned behavior, learning, habit, insight, etc. Territoriality, competition, dominance, aggression, courtship. Predation, symbiosis, mutualism, commensalisms, parasitism, saprophytism.

Evolution. Darwinian principles (survival of the fittest); definition of fitness. Lamarckian inheritance. Evolutionary mechanisms such as speciation, radiation, extinction, convergence, divergence. Nomenclature of taxonomy (kingdom, phylum, class, order, family, genus, species) and Linnaean nomenclature. Basic comparative anatomy and general evolutionary trends in body structure. Homology and analogy (with regard to organs).

The Cell- Its Structures and Function

The cell is the basic unit of structure and function and basis of all life; all cells come from preexisting cells.

Size

Most cells are between 10 and 100μ (microns) in diameter. Measurements are made utilizing the following units:

1 cm= 10mm

1 mm= 1000μ

1μ= 10,000Å (angstrom units)

Average sizes of structures may be listed as follows:

Cells about 10μ	(100,000 Å)
Mitochondria about 1μ	(10,000 Å)
Bacteria about 1μ	(10,000 Å)
Viruses about 0. 1μ	(1,000 Å)
Macromolecules about 0.01μ	(100 Å)
Molecules about 0.001μ	(10Å)
Hydrogen ion about 0.0001μ	(1 Å)

Resolution is commonly defined as the ability to discriminate two points and visualize them as two points, even though they are extremely close together. With the unaided eye these two points might appear as one point. The resolution is dependent on the wavelength of the light source and can be calculated to be about one-half the wavelength.

Examples of resolving power are:

Human eye about 0.1 mm (100μ)

Light microscope about 0.2μ (2000 Å)

Electron microscope about 2-5 Å

Composition of Protoplasm

Protoplasm is made up mainly of proteins, carbohydrates, fats, salts and water; its average elemental composition is:

Oxygen 75 + %
Carbon 10+%
Hydrogen 10+%
Nitrogen 2+%
Sulfur about 0.2%
Phosphorus about 0.3%
Potassium 0.3%
Chlorine about 0.1%
Less than 0.1% - Sodium, calcium,
magnesium, iron, etc.

Properties of the Cell and Protoplasm

Irritability

1. Conductivity
2. Respiration
3. Absorption
4. Secretion
5. Excretion
6. Growth
7. Reproduction
8. Metabolism

Components of a typical Cell

Cells are commonly recognized as having two major compartments: ***Cytoplasm*** which includes all components within the cell membrane but outside of the nucleus and ***nucleoplasm*** which includes everything within the nuclear membrane.

Cell Membrane: The cell membrane, or unit membrane, usually is about 75-100 Å thick; it is a trilaminar structure. As described by Danielli and Davson (1935), two protein layers sandwich a bimolecular lipid layer.
The cell membrane:
Provides for a boundary resulting in a controlled environment.
It is a relatively watertight barrier.
Maintains a constant composition and environment resulting in homeostasis.
Is semipermiable; only certain types of molecules are allowed to pass.
Is composed mainly of proteins, lipids, and carbohydrates; the major types of lipids found in nature are fats, phospholipids, and steroids.

Structure. Electron microscopy suggests that the central region of the membrane consists of two layers of lipid molecules, mainly phospholipids and steroids. Each layer is thought to be one molecule thick. The phospholipids molecules are fairly long and have two functional poles: one exhibits lipid properties (it exhibits hydrophobic properties, repelling water); the other exhibits polar properties(it has a tendency to dissolve water, and exhibits hydrophilic properties). The hydrophobic ends of both layers of lipid molecules associate with each other since they have affinity for one another. The hydrophilic portions face toward the protein layers; parts of proteins associate readily with water. Electron microscopy substantiates that there is a light central layer surrounded by two denser layers. The two denser layers are thought to represent the proteins and hydrophilic portions of the lipid molecules.

Activities. The plasma membrane is semi-permeable. It controls the passage of materials into and out of the cell. The movement of materials into and out of the cell is called *transport.*

There are two types of transport—passive, or transport that does not require the cells energy, and active, which does require the energy expenditure.
There are two types of passive transport—diffusion and osmosis.
In *diffusion* molecules pass from an area of higher concentration to that of lower concentration until the concentrations are equal on both sides of the membrane. Diffusion, in other words, follows the concentration gradient.

Osmosis is the movement of water across the semi-permeable membrane. Water will pass into a more concentrated solution and this passage of water will equalize the concentration of dissolved substances on each side of the membrane so that equilibrium is theoretically achieved.
Equilibrium implies an equal number of molecules of all dissolved material per unit volume on each side of the membrane compartment; the same applies to the concentration of each individual diffusible component.

Gases pass through the cell membrane with ease. Water and small molecules pass more readily than large molecules and lipid soluble materials enter the cell easier than non lipid soluble substances.
Active transport requires the cell to expand energy to allow materials to pass through the membrane. (Also called uphill transport, energy dependant transport can operate against concentration gradients.) Electrical charge has also to be considered. The inside of the cell is usually electrically negative in comparison to the outside environment.
In active transport, materials enter the cell in membrane-bound vesicles, formed by the membrane. This process is known collectively as *endocytosis.* When it involves solid material we speak of *phagocytosis;* liquid materials enters via *pinocytosis.* The process of expulsion of material is known as *exocytosis.*

Special Sites. To amplify the complexities of the cell membrane some general statements are in order at this point.

Cells must be held together and specialized structures are required. Adjacent cell membranes interdigitate and intercellular cement is utilized.

A *desmosome* is a specialized area of connection between adjacent cellular membranes (macula adherens).

A terminal bar is a dense area surrounding the apical cellular surface. It includes the tight junction (zona occludens) and the loose junction (zona adherens).

Layers of material (probably mucopolysaccharide) secreted by the cell are found on the surface of the cell. The most prominent layer is the *basement membrane,* or *basal lamina.*

The thick cellulose cell wall of plants falls within the above category. These structures are boundaries and must be traversed by material entering and leaving the cell.

Intercellular Space

Cells are usually separated by a space of about 100-200 Å. Only at specialized contact points do cells appose each other. The space is filled mainly by a matrix of proteins and polysaccharides which function in cementing cells to one another. Some cells possess special extracellular polysaccharide substances: cartilage is rich in chrondroitin sulfate; joints have large amounts of hyaluronic acid; and cell walls of plants are composed largely of cellulose.

Cytoplasmic matrix

The cytoplasm of a cell appears homogeneous, translucent, and structureless; the homogeneous mass, which is also called cell-sap or hyaloplasm, contains inorganic substances and organic compounds of varying molecular sizes. The more peripheral layer of this matrix is also known as ectoplasm (plasmagel). It appears more rigid and seems to lack granules completely.

Cellular Inclusions

These may be composed of proteins, fats, carbohydrates, granules, pigments, and crystals.

a) *Secretion granules (products of cell activity)*. These are usually membrane-bound products that await extrusion by the cell (exocrine secretion into ducts or endocrine secretion into the extracellular space and capillaries).Release of secretory product from the cells is via exocytosis. Under the general term endocytosis (taking into the cell), are the more specific terms, pinocytosis (taking in of fluid) and phagocytosis (taking in of solids).

b) *Lipid droplets*. These are globular accumulations synthesized by the cell. During periods of need they may serve as a source of energy.

c) *Glycogen granules*. These are small spherical units synthesized by the cell. They serve as storage reservoirs of carbohydrates.

d) *Pigment granules*. These may be of two types: endogenous pigments derived from cell metabolismor exogenous pigments taken in by the cell. Hemosiderin, is an example of an exogenous pigment, while the lipochromes and the melanins are endogenous in nature.

e) *Vacuoles*. Under this general term may be classified any membrane-bound globular structure.

f) *Plastids*. The plastids are composed of leucoplasts, chromoplasts and chloroplasts. Leucoplasts resemble chloroplasts but have no chlorophyll;

they manufacture starch, oil and protein. Chromoplasts possess pigments and are responsible for the color of flower petals. Chloroplastspossess chlorophyll, which is capable of capturing light energy to produce Glucose from CO^2 and H^2O.

Mitochondria

Mitochondria are the best known of the cellular organelles. They had been described during the 19th century, notably by Kollicker and Fleming. Altman, using Janus green, was able to stain them in 1890. Structually, the mitochondrion is composed of an outer trilaminar membrane and an inner trilaminar membrane; the inner one forms folds which are known as *cristae*. The space between the two membranes is about 6-10 nm wide.

Mitochondria as a whole and specifically the cristae vary in size, shape and number not only in different cells but also in the same cell depending on its functional state. Mitochondria are present in greater numbers in cells exhibiting high levels of activity and having more energy requirements. Muscle and grandular tissues fall in the above category.
DNA has been found in the mitochondria of animals and the chloroplasts of plants. Mitochondria are capable of division and are not generated *de novo.* Granules have been observed in the mitochondria Matrix. Their identity is in question, however; some believe they might be reservoirs of calcium and other divalent ions. Phosphate is taken up with Ca^{2+} and calcium phosphate deposit may be the end result.

Mitochondria are the biochemical power plants of the cell. They recover energy from food stuffs (via krebs cycle, or citric acid cycle; tricarboxylic acid cycle and the respiratory chain) and convert it via phosphorylation into adenosine triphosphate (ATP). In this manner they produce the energy necessary for the metabolic processes.

Enzymes*.* The organization of enzymes and coenzymes(especially enzymes involved in odidative phosphorylation) in the cristae appears to be highly specific facilitating an orderly and proper sequence of reactions.
Enzymes concerned with the Krebs cycle are presumed to be either free in the mitochondrial matrix (internal medium) or loosely bound to the membranes since they are readily recovered when mitochondria are disrupted. The electron transport and oxidative phosphorylation seem to be coupled.
Enzymes then are associated with the outer membrane, the inner membrane, the space between the outer and inner membranes, and the matrix.

DNA and protein Synthesis*.* Most extranuclear DNA, if not all, can be found in mitochondria (and in plants in the chloroplast). Thereis evidence that proteins are synthesized in mitochondria under direction of mitochondrial DNA. In biochemical preparations of mitochondria the synthesizing enzymes necessary for RNA and proteins
Have been isolated.However, there is also considerable documentation that the code for the enzymes involved in oxidative phosphorylation originates in nuclear DNA. Therefore, it must be assumed that mitochondrial DNA is involved only in the partial coding of the proteins manufactured in the organelle.

Krebs Cycle*.* Mitochondria are involved in the Krebs citric acid cycle in which organic acids are oxidized to CO^2. In each successive step oxidation of a single carbon of the chain takes place and each reaction requires a different enzyme. The ATP produced is a small molecule and can diffuse out of the mitochondrion into the cytoplasm and participate in the endothermic reactions of the cell.

Endoplasmic Reticulum (ER)

This cellular organelle was first described using phase microscopy by Porter, Claude and Fallam in 1945. It is an extensive network of interconnecting

channels. The endoplasmic reticular membranes are unit membranes (triminar). When ribosomes line the outer surface it is designated as *rough endoplasmic reticulum* (RER). The primary form of this organelle is the rough variety. The smooth is derived from the rough due to loss of ribosomes. The amount of each depends on the cell type and the cellular activity.

The RER is the synthetic machinery of the cell. It is mainly concerned with protein synthesis.

The Golgi Complex

This structure was discovered by Camillo Golgi in 1898. All eukaryotic cells, except for the red blood cell, possess a Golgi apparatus. Generally speaking the Golgi complex is prominent in glandular cells and is thought to function in the production, concentration packaging, and transportation of secretory material. IN summary one can link the Golgi complex to: secretion, membrane biogenesis, lysosome formation, membrane recycling, hormone modulation.

Lysosome

Lysosomes are described as containing proteolytic enzymes (hydrolases).Lysosomes contain acid phosphatase and other hydrolytic enzymes.. These enzymes are enclosed by a membrane and are released when needed into the cell or into phagocytic vesicles.

Lysosomal enzymes have the capacity to hydrolyze all classes of macromolecules.

A generalized list of substrates acted upon by respective enzymes is given bellow:

Lipids by lipases and phospholipases;

Proteins by proteases or peptidases;

Polysaccharides by glycosidases;

Nucleic acids by nucleases;

Phosphates (organic-linked) by phosphatases;

Sulphates (organic-linked) by sulfatases.

Peroxisomes

Peroxisomes are found in virtually all mammalian cell types and probably arise from swellings of the endoplasmic Reticulum. These structures are often smaller than lysosomes. These enzymes they possess are active in the production of hydrogen peroxide (urate oxidase, D-amino acid oxidase, α-hydroxyacid oxidase), and one functions in destroying hydrogen peroxide (catalase). The peroxisomes function in purine catabolism and in the degradation of nucleic acids.

Nucleus

The nucleus was first described by Robert Brown in 1831. The nucleus is surrounded by a double layer of the typical trilaminar membrane which is pierced by small pores. The pores measure about 50-80 nm in diameter.The pores allow and serve in the interchange of nuclear and cytoplasmic material.

Aproximate composition of the nucleus:
80% protein, 15% DNA, 5% RNA, 3% lipid.

Functions: Simply speaking, the nucleus controls the metabolic aspects of the cell and is responsible for its structural integrity, function, survival and passage of the hereditary material to the next generation.

DNA Structure*, DNA*-deoxyribonucleic acid – is a nucleic acid. A nucleic acid is a polymer of nucleotides. The combination of *purine* or *pyrimidine* base, a sugar, and phosphoric acid is called a *nucleotide. Deoxyrobose* is the sugar in DNA; ribose is the other nucleic acid, ribonucleic acid, or RNA.

DNA molecules are composed of two nucleotide strands coiled together in a double helix. Watson and Crick (1953) proposed a double helix model of DNA.

The two strands consist of sugar-phosphate backbones which are connected by pairs of bases.All DNA nucleotides consist of a 5-carbon sugar (deoxyribose) with a phosphate group attached at one end and a nitrogen-containing ring compound (the base) at the other. The nitrogenous bases are: adenine and guanine (*purines*) and thymine, cytosine, and uracil (*pyrimidines).* In DNA they pair specifically in the following manner:

Adenine and Thymine …….Guanine and Cytosine.

RNA pair as follows:
Adenine and Uracil ……Guanine and Cyrosine.
The paired bases are held together by hydrogen bonds.

Characteristics of DNA and RNA

DNA	RNA
Double stranded	Single stranded (mainly)
Sugar-deoxyribose	Sugar- ribose
Base- thymine	Base- uracil

DNA determines and acts as a template for RNA synthesis. With the help of a transcription enzyme (RNA polymerase) a complementary RNA strand is produced. The base pairings are as follows:
DNA T-thymine, C-cytosine
RNA A-adenine, G-guanine.

Once RNA has been manufactured in the nucleus it moves fairly quickly into the cytoplasm.

Messenger RNA (mRNA) from the nucleus brings the coded message for protein synthesis to ribosomal RNA (rRNA). Ribosomal RNA imparts the

message to *transfer RNA* (Trna), which carries the specific amino acids coded for to the ribosomes, where protein synthesis is carried out.

Chromatin. The survivor of the cell, organism, and species depends upon the chromatin material in the nucleus. Chromatin is DNA combined with protein, and stains with basic dyes. During the interphase of the cell cycle some chromosomes are visualized as tight coils and are referred to as *heterochromatin*.

Ribosomes and Polysomes: Ribosomes may be free or attached to the membranes of the endoplasmic Reticulum, which is then designated as rough ER. Ribosomes are the sites of protein synthesis in the cell. If ribosomes appear in clusters (rosettes) in the cytoplasm, they are commonly termed *polyribosomes* or *polysomes*.

Ribosomes possess RNA known as ribosomal RNA (rRNA) and both rRNA and messenger RNA (mRNA) are produced on DNA templates in the nucleus.

Microtubules: These structures are usually associated with centrioles and basal bodies. They are also present in the cytoplasm of various cells, in particular the axons of neurons. Microtubules apparently function in the maintenance of the structural integrity (shape and rigidity) of the cell. Transport of material and movement of cilia and flagella are also ascribed to these organelles.

Microfilaments: These structures are prominent in the microvilli of the absorptive cells of the intestines. They have been shown to be associated with the regions of the terminal web and the desmosome.

Centrioles, Cilia and Flagella: The centrioles are self-reproducing organelles that play an important role in the separation of the chromosomes during mitosis. Before division of the cell the centriole splits into two and the daughter centrioles

migrate to opposite sides of the nucleus. The form the center of the *spindle* and *aster* configuration during cell division.

Organelles almost identical in structure to the centriole are the basal bodies of cilia and flagella. The structure and function of cilia and flagella are similar. They, like the centriole, have nine (9) sets of tubules arranged in a peripheral cylinder; the sets, however, are doublets, not triplets. And unlike centrioles, cilia and flagella have an additional pair of central tubules. Therefore, we can summarize the arrangement in centrioles as 9 + 0-, and in cilia and flagella as 9 + 2.

Cell Division – Mitosis

For purposes of convenience, mitosis is divided into prophase, metaphase, anaphase, and telophase; the process, however, is a continuous one. The major events during the phases are:

1. *Prophase:* Chromosomes become distinct and nucleolus (nucleoli) disappear(s); centriole(s) and asters and spindle appear; nuclear membrane disappears.

2*. Metaphase*: Chromosomes move to the equator of the cell and duplicate.

3. Anaphase: The two chromatids split apart and start migration toward the poles of the spindle; the spindle loses its definition.

4. *Telophase:* Chromosomes lengthen and become less distinct; nucleoli reappear. The next period of growth and rest is known as *interphase*.

5. *Interphase:* Cell growth; protein synthesis; DNA synthesis; chromosome duplication.

Methods of Examining the Cell

1. Histological Methods:

a. *Microscopy*
b. *Stains*

2. Histochemical Methods: Tissues are composed of various chemicals such as proteins, carbohydrates, lipids, inorganic salts and miscellaneous substances, and various tests are used to detect these chemicals.

Examples:

Proteins (with tyrosine) – yellow color;

1) Enzymes – various tests for phosphatases, lipases, oxidases, exterases, and dehydrogenases;
2) Carbohydrates – glycogen by periodic acid Schiff (PAS) test results in a magenta or purple color; glycolproteins give a positive PAS magenta color. Basal laminae and reticular fibers are strongly PAS positive;
3) Lipids – Sudan dyes or osmic acid;
4) Nucleic acids – Feulgen reaction is specific for DNA, but not for RNA, which can be detected by ribonuclease. Both DNA and RNA are basophilic (because they are both acids).

3. Fixation: The fixative must modify the cell to resist further treatments and also to make further treatments possible. Fixatives may be classified as either coagulant or non-coagulant. Examples of each are:

1) *coagulant:* methanol, ethanol, acetone, nitric acid, hydrochloric acid, picric acid, trichloroacetic acid and mercuric chloride.

2) *non*-coagulant: formaldehyde, glutaraldehyde, osmium tetroxide, potassium dichromate, acetic acid, and potassium permanganate.

Fixatives can also be sub classified into two categories. The following are examples:

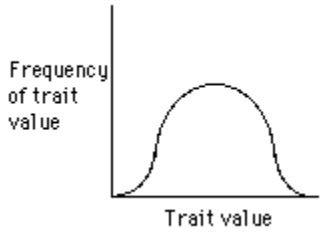
1) *additive:* osmium tetroxide, formaldehyde, and glutaraldehyde.
2) *Non-additive:* methanol, ethanol, and acetone.

4. Method of Preparation

1) *Fixation*
2) *Dehydration*
3) *Embedding*
4) *Sectioning*
5) *Staining*

Polygenic Traits

The distribution of individuals with different trait values for polygenic (quantitative) traits in a population is typically a bell-shaped curve, as shown here:



There are three main ways selection could act on a population, given a distribution of traits such as this. These are:

1. **Directional selection:** the situation in which one extreme form of the trait has highest fitness.

2. **Stabilizing selection:** the situation in which the average form of the trait has higher fitness than does either extreme.

3. **Disruptive selection:** the situation in which both extreme forms of the trait have higher fitness than does the average.

The results of selection on quantitative traits generally makes sense -- the forms that have highest fitness become most common. As shown, **directional selection** results in a change in the mean value of the trait toward the form that has highest fitness. **Stabilizing selection** results in the loss of the extreme forms of the trait; this means there is a decrease in genetic variation -- eventually, genetic variation may be lost, as all individuals will have the alleles for the highest fitness, average, trait value. At this point, any phenotypic variation would depend on direct environmental effects rather than on genetic differences among individuals, and the heritability of the trait would be zero, or at least very low. **Disruptive selection** results in an increase in both extremes and a loss of intermediate forms.

Over a long period of time **directional selection** will result in a shift in the frequency of individuals with different traits until the average form has highest fitness. At this point, the situation becomes one of stabilizing selection, and the extreme forms of the trait will be lost. So directional selection eventually will lead to a situation where genetic variation will be lost (heritability will become zero) and all individuals will have the alleles for the highest fitness form of the trait.

Probability

Probability - Events are possible outcomes of some random processes
Examples of events :
you pass 320
The genotype of a random individual is Bb
the weight of a random individual is less than 150 pounds

We can define the probability of a particular event, say A, as the fraction of outcomes in which event A occurs.

Denote Probability of A by Pr(A), or Prob(A)

For example, when flipping a coin once, the possible outcome is heads or tails. Pr(Head) = 0.75 means that chance is 75% that the coin will be a head and hence

Pr(Tail) = 1 - Pr(Head) = 0.25.

Useful Rules of Probability

Probabilities are between zero (never occur) and one (always occur)
Pr(A) lies between zero and one for all A.

Probabilities sum to one
The sum of probabilities of all mutually exclusive events is one.
For example, if there are n possible outcomes, Pr(1) + Pr(2) + .. + Pr(n) = 1

Hence, Pr(1) = 1 - (Pr(2) + .. + Pr(n))

The AND and OR Rules

AND rule: If A and B are independent events (knowledge of one event tells us nothing about the other event), then the probability that BOTH A and B occur is
Pr(A and B) = Pr(A) Pr(B)

Hence generally AND = multiply probabilities

OR rule: If A and B are exclusive events (non overlapping), then the probability that EITHER A or B occurs is
Pr(A or B) = Pr(A) + Pr(B)

Hence generally OR = add probabilities

Example:

Suppose we are rolling a fair dice and flipping a fair coin

What is the probability of rolling an even number on the dice?
A single roll of a fair dice has possible outcomes 1, 2, 3, 4, 5, 6 each with the same probability, 1/6. Rolling an even number means rolling 2 OR 4 OR 6. These three events (2, 4, 6) are non overlapping, and hence exclusive, so we can use the OR = add rule, giving
Pr(Roll even) = Pr(2) + Pr(4) + Pr(6) = 3/6 = 1/2

What is the probability of rolling a 5 and then getting a head in the coin flip?
The dice roll and coin flip are independent events as the outcome of one does not influence the outcome of the other. Hence,
Pr(Head AND roll 5) = Pr(Head) * Pr(5) = 1/2*1/6 = 1/12

Conditional Probability

How do we compute joint probabilities when A and B are NOT independent (i.e., knowing that A has occurred provides information on whether or not B has occurred).
The joint probability of A and B, Pr(A,B) , is the product of the probability of B, Pr(B), with the Probability of A given B, Pr(A | B).
Pr(A,B) = Pr(A | B) Pr(B)

Pr (A | B) is called the conditional probability of A given B
Pr (A | B)= Pr(A,B) / Pr(B)
A and B are said to be independent if Pr(A | B) = Pr(A), so that knowing event B occurred gives us no information about event A.

An important use for conditional probabilities is to compute the probability of some complex event by conditioning on other events. For example, suppose that event A occurs under one of three other (mutually exclusive) events, say B, C, and D. Then
Pr(A) = Pr(A|B)*Pr(B) + Pr(A|C)*Pr(C) + Pr(A|D)*Pr(D) For example, suppose there are three genotypes with different disease risks, where event A is having the disease, and B, C, and D are three different genotypes. Pr(A|D) is the risk of the disease for genotype D, and so forth. The overall risk of the disease is just the weighted risk over all genotypes.

Disease Relative Risks

What is the risk that you will have a disease given your sib (brother/sister) does?

This is quantified by the **disease relative risk**, RR, where

- RR = Prob(sib 1 affected | sib 2 is) / Prob(random individual affected)
- Thus, RR is the **increase in your risk over that for a random individual.**
- Note that RR = 1 if Prob(sib 1 affected | sib 2 is) = Prob(random individual affected), i.e. you have no increased risk given a relative has the disease.

Hence **the disease relative risk is the increase in the conditional probability for a sib (or other relative) vs. a random individual.**

As an example, consider diabetes. The probability that a random individual (from the US population) has type 1 diabetes is 0.4 percent. This is also referred to as the **population prevalence**, K. However, the frequency of diabetes in families with an affected sib is 6 percent. The resulting relative risk that an individual has diabetes, given that its sib does, is 6/0.4 = 15.

What is the probability that a pair of sibs both have diabetes?

- Pr(Both sibs affected) = Pr(2nd affected | 1st is) Pr(1st affected) = 0.06 * 0.004 = 0.00024
- Note that Pr(2nd affected | 1st is) = RR*K, as RR = Pr(2nd affected | 1st is) / K. Hence Pr(Both sibs affected) = (RR*K)*K = (K^2)* RR
- Hence, the population frequency of families with both sibs affected is 15 times more common than expected by chance (i.e., if the disease is independent of family membership, which is K^2).

Example : Rheumatoid Arthritis

Consider the following data for individuals with rheumatoid arthritis (from Del Junco et al, 1984)

	Disease	No disease	Total
Sibs of affected individuals	21	475	496
Spouses of affected individuals	12	661	673

- Prob(2nd sib affected | 1st sib affected) = 21 / 496 = 0.042
- Prob(random affected) = 12 / 673 = 0.018
- Relative Risk, RR = 0.042 / 0018 = 2.374

Key Genetic Definitions

Aerobe. A microorganism that grows in the presence of oxygen. See Anaerobe.

Agarose gel electrophoresis. A matrix composed of a highly purified form of agar that is used to separate larger DNA and RNA molecules ranging 20,000 nucleotides. (See Electrophoresis.)

Alleles. Alternate forms of a gene or DNA sequence, which occur on either of two homologous chromosomes in a diploid organism. (See DNA polymorphism.)

Alternative mRNA splicing. The inclusion or exclusion of different exons to form different mRNA transcripts. (See RNA.)

Amino acid. Any of 20 basic building blocks of proteins-- composed of a free amino (NH2) end, a free carboxyl (COOH) end, and a side group (R).

Ampicillin (beta-lactamase). An antibiotic derived from penicillin that prevents bacterial growth by interfering with cell wall synthesis.

Amplify. To increase the number of copies of a DNA sequence, in vivo by inserting into a cloning vector that replicates within a host cell, or in vitro by polymerase chain reaction (PCR).

Anaerobe. An organism that grows in the absence of oxygen. See Aerobe.

Antibody. An immunoglobulin protein produced by B- lymphocytes of the immune system that binds to a specific antigen molecule

Antigen. Any foreign substance, such as a virus, bacterium, or protein, that elicits an immune response by stimulating the production of antibodies.

Antigenic switching. The altering of a microorganism's surface antigens through genetic rearrangement, to elude detection by the host's immune system.

Asexual reproduction. Nonsexual means of reproduction which can include grafting and budding.

Bacillus. A rod-shaped bacterium.

Bacteriocide. A class of antibiotics that kills bacterial cells.

Bacteriophage (phage or phage particle). A virus that infects bacteria. Altered forms are used as vectors for cloning DNA.

Bacteriostat. A class of antibiotics that prevents growth of bacterial cells.

Bacterium. A single-celled, microscopic prokaryotic organism: a single cell organism without a distinct nucleus.

Base pair (bp). A pair of complementary nitrogenous bases in a DNA molecule--adenine-thymine and guanine-cytosine. Also, the unit of measurement for DNA sequences.

beta-DNA. The normal form of DNA found in biological systems, which exists as a right-handed helix.

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Carcinogen. A substance that induces Cancer.

Carcinoma. A malignant tumor derived from epithelial tissue, which forms the skin and outer cell layers of internal organs.

Catalyst. A substance that promotes a chemical reaction by lowering the activation energy of a chemical reaction, but which itself remains unaltered at the end of the reaction. (See Catalytic antibody, Catalytic RNA.)

Catalytic antibody (abzyme). An antibody selected for its ability to catalyze a chemical reaction by binding to and stabilizing the transition state intermediate.

Catalytic RNA (ribozyme). A natural or synthetic RNA molecule that cuts an RNA substrate.

Cation. A positively charged ion.

cDNA library. A library composed of complementary copies of cellular mRNAs.

cDNA. DNA synthesized from an RNA template using reverse transcriptase.

Cellular oncogene (proto-oncogene). A normal gene that when mutated or improperly expressed contributes to the development of Cancer.

Centrifugation. Separating molecules by size or density using centrifugal forces generated by a spinning rotor. G forces of several hundred thousand times gravity are generated in ultracentrifugation. (See Density gradient centrifugation.)

Chemotherapy. A treatment for Cancers that involves ad- ministering chemicals toxic to malignant cells.

Chloramphenicol. An antibiotic that interferes with protein synthesis.

Chromatid. Each of the two daughter strands of a duplicated chromosome joined at the centromere during mitosis and meiosis.

Chromosome. A single DNA molecule, a tightly coiled strand of DNA, condensed into a compact structure in vivo by complexing with accessory histones or histone-like proteins. Chromosomes exist in pairs in higher eukaryotes. (See Chromosome walking.)

Clone. An exact genetic replica of a specific gene or an entire organism. See Cloning.

Cloning. The mitotic division of a progenitor cell to give rise to a population of identical daughter cells or clones. (See Directional cloning, Megabase cloning, Molecular cloning, Subcloning.)

Coenzyme (cofactor). An organic molecule, such as a vitamin, that binds to an enzyme and is required for its catalytic activity.

Colony. A group of identical cells (clones) derived from a single progenitor cell.

Commensalism. The close association of two or more dissimilar organisms where the association is advantageous to one and doesn't affect the other(s). See Parasitism, Symbiosis.

Competency. An ephemeral state, induced by treatment with cold cations, during which bacterial cells are capable of uptaking foreign DNA.

Complementary DNA or RNA. The matching strand of a DNA or RNA molecule to which its bases pair. (See DNA, RNA.)

Complementary nucleotides. Members of the pairs adenine-thymine, adenine-uracil, and guaninecytosine that have the ability to hydrogen bond to one another. (See nucleotide.)

Conjugation. The joining of two bacteria cells when genetic material is transferred from one bacterium to another.

Contiguous (contig) map. The alignment of sequence data from large, adjacent regions of the genome to produce a continuous nucleotide sequence across a chromosomal region. (See Mapping.)

Cyclic AMP (cyclic adenosine monophosphate). A second messenger that regulates many intracellular reactions by transducing signals from extracellular growth factors to cellular metabolic pathways.

Cytogenetics. Study that relates the appearance and behavior of chromosomes to genetic phenomenon.

Dalton. A unit of measurement equal to the mass of a hydrogen atom, 1.67 x 10E-24 gram/L (Avogadro's number).

Death phase. The final growth phase, during which nutrients have been depleted and cell number decreases. (See Growth phase.

Denature. To induce structural alterations that disrupt the biological activity of a molecule. Often refers to breaking hydrogen bonds between base pairs in double-stranded nucleic acid molecules to produce in single-stranded polynucleotides or altering the secondary and tertiary structure of a protein, destroying its activity.

Density gradient centrifugation. High-speed centrifugation in which molecules "float" at a point where their density equals that in a gradient of cesium chloride or sucrose. (See Centrifugation.)

Dideoxynucleotide (DNA). A deoxynucleotide that lacks a 3' hydroxyl group, and is thus unable to form a 3'-5' phosphodiester bond necessary for chain elongation. Dideoxynucleotides are used in DNA sequencing and the treatment of viral diseases. (See Nucleotide.)

Diploid cell. A cell which contains two copies of each chromosome. See Haploid cell.

Directional cloning. DNA insert and vector molecules are digested with two different restriction enzymes to create noncomplementary sticky ends at either end of each restriction fragment. This allows the insert to be ligated to the vector in a specific orientation and prevents the vector from recircularizing. (See Cloning.)

DNA (Deoxyribonucleic acid). An organic acid and polymer composed of four nitrogenous bases--adenine, thymine, cytosine, and guanine linked via intervening units of phosphate and the pentose sugar deoxyribose. DNA is the genetic material of most organisms and usually exists as a double-stranded molecule in which two antiparallel strands are held together by hydrogen bonds between adeninethymine and cytosine-guanine. (See b-DNA, cDNA, Complementary DNA or RNA, DNA polymorphism, DNA sequencing, Double-stranded complementary DNA, Duplex DNA, Z-DNA.)

DNA diagnosis. The use of DNA polymorphisms to detect the presence of a disease gene.

DNA fingerprint. The unique pattern of DNA fragments identified by Southern hybridization (using a probe that binds to a polymorphic region of DNA) or by polymerase chain reaction (using primers flanking the polymorphic region).

DNA polymorphism. One of two or more alternate forms (alleles) of a chromosomal locus that differ in nucleotide sequence or have variable numbers of repeated nucleotide units. (See Allele.)

DNA sequencing. Procedures for determining the nucleotide sequence of a DNA fragment.

Dominant gene. A gene whose phenotype is when it is present in a single copy.

Dominant(-acting) oncogene. A gene that stimulates cell proliferation and contributes to oncogenesis when present in a single copy. (See Oncogene.)

Dominant. An allele is said to be dominant if it expresses its phenotype even in the presence of a recessive allele. See Allele, Phenotype, Recessive.

Double helix. Describes the coiling of the antiparallel strands of the DNA molecule, resembling a spiral staircase in which the paired bases form the steps and the sugar-phosphate backbones form the rails.

Double-stranded complementary DNA (dscDNA). A duplex DNA molecule copied from a cDNA template.

Downstream. The region extending in a 3' direction from a gene.

Electrophoresis. The technique of separating charged molecules in a matrix to which is applied an electrical field. (See Agarose gel electrophoresis, Polycrylamide gel electrophoresis.)

Electroporation. A method for transforming DNA, especially useful for plant cells, in which high voltage pulses of electricity are used to open pores in cell membranes, through which foreign DNA can pass.

Encapsidation. Process by which a virus' nucleic acid is enclosed in a capsid. See Coat protein.

Endophyte. An organism that lives inside another.

Enzymes. Proteins that control the various steps in all chemical reactions.

Escherichia coli. A commensal bacterium inhabiting the human colon that is widely used in biology, both as a simple model of cell biochemical function and as a host for molecular cloning experiments.

Eukaryote. An organism whose cells possess a nucleus and other membrane-bound vesicles, including all members of the protist, fungi, plant and animal kingdoms; and excluding viruses, bacteria, and blue-green algae. See Prokaryote.

Exon. A DNA sequence that is ultimately translated into protein.

Express. To translate a gene's message into a molecular product.

Fungus. A microorganism that lacks chlorophyll.

Gamete. A haploid sex cell, egg or sperm, which contains a single copy of each chromosome.

GEM. A genetically engineered microorganism.

Gene amplification. The presence of multiple genes. Amplification is one mechanism through which proto-oncogenes are activated in malignant cells.

Gene cloning. The process of synthesizing multiple copies of a particular DNA sequence using a bacteria cell or another organism as a host. See DNA, Host.

Gene expression. The process of producing a protein from its DNA- and mRNA-coding sequences.

Gene flow. The exchange of genes between different but (usually) related populations.

Gene frequency. The percentage of a given allele in a population of organisms. See Allele.

Gene insertion. The addition of one or more copies of a normal gene into a defective chromosome.

Gene linkage. The hereditary association of genes located on the same chromosome.

Gene modification. The chemical repair of a gene's defective DNA sequence. See DNA.

Gene pool. The totality of all alleles of all genes of all individuals in a particular population.

Gene splicing. Combining genes from different organisms into one organism. See recombinant DNA.

Gene translocation. The movement of a gene fragment from one chromosomal location to another, which often alters or abolishes expression.

Gene. A locus on a chromosome that encodes a specific protein or several related proteins. It is considered the functional unit of heredity. (See Dominant gene, Fusion gene, Gene amplification, Gene expression, Gene flow, Gene pool, Gene splicing, Gene translocation, Recessive gene, Regulatory gene.)

Genetic code. The three-letter code that translates nucleic acid sequence into protein sequence. The relationships between the nucleotide base-pair triplets of a messenger RNA molecule and the 20 amino acids that are the building blocks of proteins. See Base pair, Nucleic acid, Nucleotide.

Genetic disease. A disease that has its origin in changes to the genetic material, DNA. Usually refers to diseases that are inherited in a Mendelian fashion, although noninherited forms of Cancer also result from DNA mutation.

Genetic engineering. The manipulation of an organism's genetic endowment by introducing or eliminating specific genes through modern molecular biology techniques. A broad definition of genetic engineering also includes selective breeding and other means of artificial selection.

Genetic marker. A gene or group of genes used to "mark" or track the action of microbes.

Genome. The genetic complement contained in the chromosomes of a given organism, usually the haploid chromosome state.

Genotype. The structure of DNA that determines the expression of a trait. See Phenotype.

Genus. A category including closely related species. Interbreeding between organisms within the same category can occur.

Germ cell (germ line) gene therapy. The repair or re- placement of a defective gene within the gamete-forming tissues, which produces a heritable change in an organism's genetic constitution.

Green revolution. Advances in genetics, petrochemicals, and machinery that culminated in a dramatic increase in crop productivity during the third quarter of the 20th century.

Growth factor. A serum protein that stimulates cell division when it binds to its cell-surface receptor.

Growth phase (curve). The characteristic periods in the growth of a bacterial culture, as indicated by the shape of a graph of viable cell number versus time. (See Death phase, Lag phase, Logarithmic phase, Stationary phase.)

Haploid cell. A cell containing only one set, or half the usual (diploid) number, of chromosomes.

Hemophilia. An X-linked recessive genetic disease, caused by a mutation in the gene for clotting factor VIII (hemophilia A) or clotting factor IX (hemophilia B), which leads to abnormal blood clotting.

Heteroduplex. A double-stranded DNA molecule or DNA-RNA hybrid, where each strand is of a different origin.

Heterogeneous nuclear RNA (hnRNA). The name originally given to large RNA molecules found in the nucleus, which are now known to be unedited mRNA transcripts, or pre-mRNAs.

Homologous chromosomes. Chromosomes that have the same linear arrangement of genes--a pair of matching chromosomes in a diploid organism. See Chromosomes.

Homologous recombination. The exchange of DNA fragments between two DNA molecules or chromatids of paired chromosomes (during crossing over) at the site of identical nucleotide sequences.

Homozygote. An organism whose genotype is characterized by two identical alleles of a gene. See Allele, Genotype.

Host. An organism that contains another organism.

Human growth hormone (HGH, somatotrophin). A protein produced in the pituitary gland that stimulates the liver to produce somatomedins, which stimulate growth of bone and muscle.

Hybridization. The hydrogen bonding of complementary DNA and/or RNA sequences to form a duplex molecule. (See Northern hybridization, Southern hybridization.)

Hybridoma. A hybrid cell, composed of a B lymphocyte fused to a tumor cell, which grows indefinitely in tissue culture and is selected for the secretion of a specific antibody of interest.

Immortalizing oncogene. A gene that upon transfection enables a primary cell to grow indefinitely in culture. (See Oncogene.)

In situ. Refers to performing assays or manipulations with intact tissues.

In vivo. Refers to biological processes that take place within a living organism or cell.

Incomplete dominance. A condition where a heterozygous off- spring has a phenotype that is distinctly different from, and intermediate to, the parental phenotypes. See Heterozygote, Phenotype.

Insulin. A peptide hormone secreted by the islets of Langerhans of the pancreas that regulates the level of sugar in the blood.

Interferon. A family of small proteins that stimulate viral resistance in cells.

Intergenic regions. DNA sequences located between genes that comprise a large percentage of the human genome with no known function.

Intron. A noncoding DNA sequence within a gene that is initially transcribed into messenger RNA but is later snipped out. See Coding, DNA, Messenger RNA, Transcription.

Ion. A charged particle.

Isotope. One of two or more forms of an element that have the same number of protons (atomic number) but differing numbers of neutrons (mass numbers). Radioactive isotopes are commonly used to make DNA probes and metabolic tracers.

Kanamycin. An antibiotic of the aminoglycoside family that poisons translation by binding to the ribosomes. See Kanamycin.

kanr. Kanamycin resistance gene. (See Selectable marker.)

Karyotype. All of the chromosomes in a cell or an individual organism, visible through a microscope during cell division.

Lag phase. The initial growth phase, during which cell number remains relatively constant prior to rapid growth. See growth phase.

Lawn. A uniform and uninterrupted layer of bacterial growth, in which individual colonies Cannot be observed.

Library. A collection of cells, usually bacteria or yeast, which have been transformed with recombinant vectors carrying DNA inserts from a single species. (See cDNA library, Expression library, Genomic library.)

Ligase (DNA ligase). An enzyme that catalyzes a condensation reaction that links two DNA molecules via the formation of a phosphodiester bond between the 3' hydroxyl and 5' phosphate of adjacent nucleotides.

Lineage. A chart that traces the flow of genetic information from generation to generation.

Linkage map. See Genetic linkage map.

Linkage. The frequency of coinheritance of a pair of genes and/or genetic markers, which provides a measure of their physical proximity to one another on a chromosome.

Linked genes/markers. Genes and/or markers that are so closely associated on the chromosome that they are coinherited in 80% or more of cases.

Liposomes. Membrane-bound vesicles constructed in the laboratory to transport biological molecules.

Locus (plural = loci). A specific location or site on a chromosome.

Logarithmic phase (log or exponential growth phase). The steepest slope of the growth curve--the phase of vigorous growth during which cell number doubles every 20-30 minutes.

Lysis. The destruction of the cell membrane.

Lysogen. A bacterial cell whose chromosome contains integrated viral DNA.

Lysogenic. A type or phase of the virus life cycle during which the virus integrates into the host chromosome of the infected cell, often remaining essentially dormant for some period of time. See Lysogen.

Lytic. A phase of the virus life cycle during which the virus replicates within the host cell, releasing a new generation of viruses when the infected cell lysis.

Malignant. Having the properties of Cancerous growth.

Mapping. Determining the physical location of a gene or genetic marker on a chromosome. (See Continuous map, Genetic map, Physical map.)

Megabase cloning. The cloning of very large DNA fragments. (See Cloning.)

Messenger RNA (mRNA). The class of RNA molecules that copies the genetic information from DNA, in the nucleus, and carries it to ribosomes, in the cytoplasm, where it is translated into protein. (See RNA.)

Metabolism. The biochemical processes that sustain a living cell or organism.

Metallothionein. A protective protein that binds heavy metals, such as cadmium and lead.

Microbe. A microorganism.

Microbial mats (biofilms). Layered groups or communities of microbial populations.

Microinjection. A means to introduce a solution of DNA, protein, or other soluble material into a cell using a fine microcapillary pipet.

Mitosis. The replication of a cell to form two daughter cells with identical sets of chromosomes.

Molecular cloning. The biological amplification of a specific DNA sequence through mitotic division of a host cell into which it has been transformed or transfected. (See Cloning.)

Molecular genetics. The study of the flow and regulation of genetic information between DNA, RNA, and protein molecules.

Monoclonal antibodies. Immunoglobulin molecules of single- epitope specificity that are secreted by a clone of B cells.

Movable genetic element. (See Transposon.)

Mutagen. Any agent or process that can cause mutations. See Mutation.

Mutation. An alteration in DNA structure or sequence of a gene. (See Point mutation.)

Natural selection. The differential survival and reproduction of organisms with genetic characteristics that enable them to better utilize environmental resources.

Nicked circle (relaxed circle). During extraction of plasmid DNA from the bacterial cell, one strand of the DNA becomes nicked. This relaxes the torsional strain needed to maintain supercoiling, producing the familiar form of plasmid. (See Plasmid.)

Nitrocellulose. A membrane used to immobilize DNA, RNA, or protein, which can then be probed with a labeled sequence or antibody.

Nitrogen fixation. The conversion of atmospheric nitrogen to biologically usable nitrates.

Nontarget organism. An organism that is affected by an interaction for which it was not the intended recipient.

Northern hybridization. (Northern blotting). A procedure in which RNA fragments are transferred from an agarose gel to a nitrocellulose filter, where the RNA is then hybridized to a radioactive probe. (See Hybridization.)

Nuclease. A class of enzymes that degrades DNA and/or RNA molecules by cleaving the phosphodiester bonds that link adjacent nucleotides. In deoxyribonuclease (DNase), the substrate is DNA. In endonuclease, it cleaves at internal sites in the substrate molecule. Exonuclease progressively cleaves from the end of the substrate molecule. In ribonuclease (RNase), the substrate is RNA. In the S1 nuclease, the substrate is single-stranded DNA or RNA.

Nucleic acids. The two nucleic acids, deoxyribonucleic acid (DNA) and ribonucleic acid (RNA), are made up of long chains of molecules called nucleotides. See DNA, RNA, Nucleotides.

Nuclein. The term used by Friedrich Miescher to describe the nuclear material he discovered in 1869, which today is known as DNA.

Nucleoside analog. A synthetic molecule that resembles a naturally occuring nucleoside, but that lacks a bond site needed to link it to an adjacent nucleotide.

Nucleoside. A building block of DNA and RNA, consisting of a nitrogenous base linked to a five-carbon sugar.

Nucleotide. A building block of DNA and RNA, consisting of a nitrogenous base, a five-carbon sugar, and a phosphate group. Together, the nucleotides form codons, which when strung together form genes, which in turn link to form chromosomes. (See Chromosome, Codon, Complementary nucleotides, Dideoxynucleotide, DNA, Gene, Oligonucleotide, RNA.)

Nucleus. The membrane-bound region of a eukaryotic cell that contains the chromosomes.

Oligonucleotide. A DNA polymer composed of only a few nucleotides. (See Nucleotide.)

Oncogene. A gene that contributes to Cancer formation when mutated or inappropriately expressed. (See Cellular oncogene, Dominant oncogene, Immortalizing oncogene, Recessive oncogene.)

Oncogenesis. The progression of cytological, genetic, and cellular changes that culminate in a malignant tumor.

Open reading frame. A long DNA sequence that is uninterrupted by a stop codon and encodes part or all of a protein. (See Reading frame.)

Operator. A prokaryotic regulatory element that interacts with a repressor to control the transcription of adjacent structural genes.

Organelle. A cell structure that carries out a specialized function in the life of a cell.

Origin of replication. The nucleotide sequence at which DNA synthesis is initiated.

Overlapping reading frames. Start codons in different reading frames generate different polypeptides from the same DNA sequence. (See Reading frame.)

Ovum. A female gamete.

Palindromic sequence. A DNA locus whose 5'-to-3' sequence is identical on each DNA strand. The sequence is the same when one strand is read left to right and the other strand is read right to left. Recognition sites of many restriction enzymes are palindromic. See DNA.

pAMP. Ampicillin-resistant plasmid developed for this laboratory course. (See Plasmid.)

Parasitism. The close association of two or more dissimilar organisms where the association is harmful to at least one. See Commensalism, Parasitism, Symbiosis.

Pathogen. Organism which can cause disease in another organism.

Pedigree. A diagram mapping the genetic history of a particular family.

Persistence. Ability of an organism to remain in a particular setting for a period of time after it is introduced.

Phenotype. The observable characteristics of an organism, the expression of gene alleles (genotype) as an observable physical or biochemical trait. See Genotype.

Pheromone. A hormone-like substance that is secreted into the environment.

Phosphatase. An enzyme that hydrolyzes esters of phosphoric acid, removing a phosphate group.

Phospholipid. A class of lipid molecules in which a phosphate group is linked to glycerol and two fatty acyl groups. A chief component of biological membranes.

Physical map. A map showing physical locations on a DNA molecule, such as restriction sites, and sequence-tagged sites.

Plaque. A clear spot on a lawn of bacteria or cultured cells where cells have been lysed by viral infection.

Point mutation. A change in a single base pair of a DNA sequence in a gene.

Polyacrylamide gel electrophoresis. Electrophoresis through a matrix composed of a synthetic polymer, used to separate proteins, small DNA, or RNA molecules of up to 1000 nucleotides. Used in DNA sequencing.

Polyclonal antibodies. A mixture of immunoglobulin molecules secreted against a specific antigen, each recognizing a different epitope.

Polygenic. Controlled by or associated with more than one gene.

Polylinker. A short DNA sequence containing several restriction enzyme recognition sites that is contained in cloning vectors.

Polymer. A molecule composed of repeated submits.

Polymerase (DNA). Synthesizes a double-stranded DNA molecule using a primer and DNA as a template. (See Poly(A) polymerase, Polymerase chain reaction, RNA polymerase, Taq polymerase.)

polymerase chain reaction (PCR). A procedure that enzymatically amplifies a DNA polymerase. (See Polymerase.)

Polynucleotide. A DNA polymer composed of multiple nucleotides. (See Nucleotide.)

Polypeptide (protein). A polymer composed of multiple amino acid units linked by peptide bonds.

Polyploid. A multiple of the haploid chromosome number that results from chromosome replication without nuclear division.

Polysaccharide. A polymer composed of multiple units of monosaccharide (simple sugar).

Polyvalent vaccine. A recombinant organism into which has been cloned antigenic determinants from a number of different disease-causing organisms.

Primary cell. A cell or cell line taken directly from a living organism, which is not immortalized.

Primer. A short DNA or RNA fragment annealed to single-stranded DNA, from which DNA polymerase extends a new DNA strand to produce a duplex molecule.

Prokaryote. A bacterial cell lacking a true nucleus; its DNA is usually in one long strand. See Eukaryote.

Pronucleus. Either of the two haploid gamete nuclei just prior to their fusion in the fertilized ovum.

Protease. An enzyme that cleaves peptide bonds that link amino acids in protein molecules.

Protein kinase. An enzyme that adds phosphate groups to a protein molecule at serine, threonine, or tyrosine residues.

Protein. A polymer of amino acids linked via peptide bonds and which may be composed of two or more polypeptide chains.

Proteolytic. The ability to break down protein molecules.

Recessive gene. Characterized as having a phenotype expressed only when both copies of the gene are mutated or missing.

Recessive(-acting) oncogene, (anti-oncogene). A single copy of this gene is sufficient to suppress cell proliferation; the loss of both copies of the gene contributes to Cancer formation.

Recognition sequence (site). A nucleotide sequence--composed typically of 4, 6, or 8 nucleotides--that is recognized by a restriction endonuclease. Type II enzymes cut (and their corresponding modification enzymes methylate) within or very near the recognition sequence.

Recombinant DNA. The process of cutting and recombining DNA fragments from different sources as a means to isolate genes or to alter their structure and function.

Recombinant. A cell that results from recombination of genes.

Recombination frequency. The frequency at which crossing over occurs between two chromosomal loci--the probability that two loci will become unlinked during meiosis.

Regulatory gene. A gene whose protein controls the activity of other genes or metabolic pathways.

Relaxed plasmid. A plasmid that replicates independently of the main bacterial chromosome and is present in 10-500 copies per cell.

Renature. The reannealing (hydrogen bonding) of single- stranded DNA and/or RNA to form a duplex molecule.

Repressor. A DNA-binding protein in prokaryotes that blocks gene transcription by binding to the operator.

Restriction-fragment-length polymorphism (RFLP). Differences in nucleotide sequence between alleles at a chromosomal locus result in restriction fragments of varying lengths detected by Southern analysis.

Retrovirus. A member of a class of RNA viruses that utilizes the enzyme reverse transcriptase to reverse copy its genome into a DNA intermediate, which integrates into the host cell chromosome. Many naturally occurring Cancers of vertebrate animals are caused by retroviruses.

Reverse genetics. Using linkage analysis and polymorphic markers to isolate a disease gene in the absence of a known metabolic defect, then using the DNA sequence of the cloned gene to predict the amino acid sequence of its encoded protein.

Reverse transcriptase (RNA-dependent DNA polymerase). An enzyme isolated from retrovirus-infected cells that synthesizes a complementary (c)DNA strand from an RNA template.

Ribosomal RNA (rRNA). The RNA component of the ribosome

Ribosome. Cellular organelle that is the site of protein synthesis during translation..

Ribosome-binding site. The region of an mRNA molecule that binds the ribosome to initiate translation.

RNA (ribonucleic acid). An organic acid composed of repeating nucleotide units of adenine, guanine, cytosine, and uracil, whose ribose components are linked by phosphodiester bonds. (See Antisense RNA, Heterogeneous nuclear RNA, Messenger RNA, Ribosomal RNA, RNA polymerase, Small nuclear RNA, Transfer RNA.)

RNA polymerase. Transcribes RNA from a DNA template.

Salmonella. A genus of rod-shaped, gram-negative bacteria that are a common cause of food poisoning.

Sequence hypothesis. Francis Crick's seminal concept that genetic information exists as a linear DNA code; DNA and protein sequence are colinear.

Sequence-tagged site (STS). A unique (single-copy) DNA sequence used as a mapping landmark on a chromosome.

Signal transduction. The biochemical events that conduct the signal of a hormone or growth factor from the cell exterior, through the cell membrane, and into the cytoplasm. This involves a number of molecules, including receptors, proteins, and messengers.

Somatic cell gene therapy. The repair or replacement of a defective gene within somatic tissue.

Somatic cell. Any nongerm cell that composes the body of an organism and which possesses a set of multiploid chromosomes (diploid in most organisms).

Southern hybridization (Southern blotting). A procedure in which DNA restriction fragments are transferred from an agarose gel to a nitrocellulose filter, where the denatured DNA is then hybridized to a radioactive probe (blotting).

Spore. A form taken by certain microbes that enables them to exist in a dormant stage. It is an asexual reproductive cell. See Asexual reproduction, Dormant.

Stationary phase. The plateau of the growth curve after log growth, during which cell number remains constant. New cells are produced at the same rate as older cells die.

Stringent plasmid. A plasmid that only replicates along with the main bacterial chromosome and is present as a single copy, or at most several copies, per cell.

Structure-functionalism. The scientific tradition that stresses the relationship between a physical structure and its function, for example, the related disciplines of anatomy and physiology.

Subunit vaccine. A vaccine composed of a purified antigenic determinant that is separated from the virulent organism.

Supergene. A group of neighboring genes on a chromosome that tend to be inherited together and sometimes are functionally related.

Supernatant. The soluble liquid &action of a sample after centrifugation or precipitation of insoluble solids.

Symbiosis. The close association of two or more dissimilar organisms where both receive an advantage from the association. See Commensalism, Parasitism.

Synapsis. The pairing of homologous chromosome pairs during prophase of the first meiotic division, when crossing over occurs.

T-DNA (transfer DNA, tumor-DNA). The transforming region of DNA in the Ti plasmid of Agrobacterium tumefaciens.

Telomere. The end of a chromosome.

Template. An RNA or single-stranded DNA molecule upon which a complementary nucleotide strand is synthesized.

Terminator region. A DNA sequence that signals the end of transcription.

Tetracycline. An antibiotic that interferes with protein synthesis in prokaryotes.

Thymidine kinase (tk). An enzyme that allows a cell to utilize an alternate metabolic pathway for incorporating thymidine into DNA. Used as a selectable marker to identify transfected eukaryotic cells.

Transcapsidation. The partial of full coating of the nucleic acid of one virus with a coat protein of a differing virus. See Coat protein.

Transcription. The process of creating a complementary RNA copy of DNA.

Transduction. The transfer of DNA sequences from one bacterium to another via lysogenic infection by a bacteriophage

Transfection. The uptake and expression of a foreign DNA sequence by cultured eukaryotic cells.

Transformant. In prokaryotes, a cell that has been genetically altered through the uptake of foreign DNA. In higher eukaryotes, a cultured cell that has acquired a malignant phenotype.

Transforming oncogene. A gene that upon transfection converts a previously immortalized cell to the malignant phenotype.

Translation. The process of converting the genetic information of an mRNA on ribosomes into a polypeptide. Transfer RNA molecules carry the appropriate amino acids to the ribosome, where they are joined by peptide bonds.

Translocation. The movement or reciprocal exchange of large-chromosomal segments, typically between two different chromosomes.

Transposition. The movement of a DNA segment within the genome of an organism.

Transposon (transposable, or movable genetic element). A relatively small DNA segment that has the ability to move from one chromosomal position to another.

tRNA (transfer RNA). The class of small RNA molecules that transfer amino acids to the ribosome during protein synthesis. See Transfer RNA.

Trypsin. A proteolytic enzyme that hydrolyzes peptide bonds on the carboxyl side of the amino acids arginine and lysine.

Tumor virus. A virus capable of transforming a cell to a malignant phenotype. (See Virus.)

Vaccine. A preparation of dead or weakened pathogen, or of derived antigenic determinants, that is used to induce formation of antibodies or immunity against the pathogen.

Vaccinia. The cowpox virus used to vaccinate against smallpox and, experimentally, as a carrier of genes for antigenic determinants cloned from other disease organisms.

Variable surface glycoprotein (VSG). One of a battery of antigenic determinants expressed by a microorganism to elude immune detection.

Variation. Differences in the frequency of genes and traits among individual organisms within a population.

Vector. An autonomously replicating DNA molecule into which foreign DNA fragments are inserted and then propagated in a host cell. Also living carriers of genetic material (such as pollen) from plant to plant, such as insects.

Viral oncogene. A viral gene that contributes to malignancies in vertebrate hosts.

Virulence. The degree of ability of an organism to cause disease.

Virus. An infectious particle composed of a protein capsule and a nucleic acid core, which is dependent on a host organism for replication. A double-stranded DNA copy of an RNA virus genome that is integrated into the host chromosome during lysogenic infection. (See Coat protein, DNA, Genome, Host, Nucleic acid, RNA, Tumor virus.)

Wild type. An organism as found in nature; the organism before it is genetically engineered.

X-linked disease. A genetic disease caused by a mutation on the X chromosome. In X-linked recessive conditions, a normal female "carrier" passes on the mutated X chromosome to an affected son.

X-ray crystallography. The diffraction pattern of X-rays passing through a pure crystal of a substance.

Liver Function

A. Endocrine function

1. In response to growth hormone, the liver secretes insulin-like growth factor (IGF-I), which promotes growth by stimulating cell division in various tissues, including bone.
2. Contributes to the activation of vitamin D
3. Forms triiodothyronine T3 from thyroxine T4
4. Secretes angiotensinogen, which is acted upon by renin to form angiotensin I
5. Metabolizes hormones

B. Clotting functions

1. Produces many of the plasma clotting factors, including prothrombin and fibrinogen
2. Produces bile salts, which are essential for the gastrointestinal absorption of vitamin K, which is, in turn, needed for production of the clotting factors.

C. Plasma proteins

1. Synthesizes and secretes plasma albumin, acute phase proteins, binding proteins for steroid hormones and trace elements, lipoproteins, and other proteins

D. Exocrine functions

1. Synthesizes and secretes bile salts, which are necessary for adequate digestion and absorption of fats.
2. Secretes into the bile a bicarbonate-rich solution of inorganic ions, which helps neutralize acid in the duodenum.

E. Organic metabolism

1. Converts plasma glucose into glycogen and triacylglycerols during absorptive period
2. Converts plasma amino acids to fatty acids, which can be incorporated into triacylglycerols during absorptive period.
3. Synthesizes triacylglycerols and other sources during postabsorptive period and releases glucose into the blood.
4. Converts fatty acids into ketones during fasting.
5. Produces urea, the major end product of amino acid catabolism and releases it into the blood.

F. Cholesterol metabolism

1. Synthesizes cholesterol and releases it into the blood.
2. Secrets plasma cholesterol into the bile.
3. Converts plasma cholesterol into bile salts.

G. Excretory and degradative functions

1. Secretes bilirubin and other bile pigments into the bile.
2. Excretes, via the bile, many endogenous and foreign organic molecules as well as trace metals.
3. Biotransforms many endogenous and foreign organic molecules.
4. Destroys old erythrocytes.

Kidney and Urinary System

1. The kidneys regulate the water and ionic composition of the body, excrete waste products, excrete foreign chemicals, produce glucose during prolonged fasting, and secrete three hormones-renin, 1,25 dihydroxyvitamin D3, and erythropoietin. The first three functions are accomplished by continuous processing of the plasma.
2. Each renal corpuscle comprises a glomerulus, and a Bowman's capsule, into which the glomerulus protrudes.
3. The tubule extends out from Bowman's capsule and is subdivided into many segments, which can be combined for reference purposes into the proximal tubule, loop of Henley, distal convoluted tubule, and collecting duct. Beginning at the level of the collecting ducts, multiple tubules join and empty into the renal pelvis, from which urine flows through ureters to the bladder.
4. Each glomerulus is supplied by an afferent arteriole, and an efferent arteriole leaves the golmerulus to branch into peritubular capillaries, which supply the tubule.
5. The three basic renal processes are glomerular filtration, tubular reabsorption, and tubular secretion. In addition, the kidneys synthesize and/or catabolize certain substances. The excretion of a substance is equal to the amount filtered plus the amount secreted minus the amount reabsorbed.

Major Functions of Cells Mediating Immune Responses

Neutrophils-phagocytosis, release chemicals involved in inflammation (vasodilators, chemotaxins)

Basophils-have functions in blood similar to those of mast cells in tissues
Eosinophils- destroy multicellular parasites, participate in immediate hypersensitivity reactions
Monocytes- have functions in blood similar to those of macrophages in tissues, enter tissues and are transformed into macrophages
B cells-initiate antibody-mediated immune responses by binding specific antigens to their plasma-membrane receptors, which are immunoglobulins. During activation are transformed into plasma cells, which secrete antibodies, present antigen to helper T cells.
Cytotoxic T cells- bind to antigens on plasma membrane of target cells (virus-infected cells, cancer cells and tissue transplants) and directly destroy the cells
Helper T cells-secrete cytokines that help to activate B cells, cytotoxic T cells, NK cells, and macrophages
NK cells-bind directly and nonspecifically to virus-infected cells and cancer cells and kill them, function as killer cells in antibody-dependent cellular cytotoxicity
Plasma cells-secrete antibodies
Macrophages and macrophage-like cells-Phagocytosis and intracellular killing, extracellular killing via secretion of toxic chemicals, process and present antigens to helper T-cells, secrete cytokines involved in inflammation, activation and differentiation of helper T cells, and systemic responses to infection or injury (the acute phase response)
Mast cells- release histamine and other chemicals involved in inflammation

Four Basic Tissues

1. **Muscle Tissue:** Muscle tissue is contractile in nature and functions to move the skeletal system and body viscera.

TYPES OF MUSCLE

Type	Characteristics	Location
Skeletal	Striated, voluntary	Skeletal muscles of the body
Smooth	Non-striated, involuntary	Walls of digestive tract and blood vessels, uterus, urinary bladder
Cardiac	Striated, involuntary	heart

2. **Nervous Tissue:** Nervous tissue is composed of cells (*neurons*) that respond to external and internal stimuli and have the capability to transmit a message (*impulse*) from one area of the body to another. This tissue thus induces a response of distant muscles or glands, as well as regulating body processes such as respiration, circulation, and digestion.

3. **Epithelial Tissue:** Epithelial tissue covers the external surfaces of the body and lines the internal tubes and cavities. It also forms the glands of the body. Characteristics of epithelial tissue (epithelium) are that it
   (1) has compactly aggregated cells;
   (2) has limited intercellular spaces and substance;
   (3) is avascular (no blood vessels);
   (4) lies on a connective tissue layer—the basal lamina;

(5) has cells that form sheets and are polarized;

(6) is derived from all three germ layers.

TYPES OF EPITHELIUM

Classification	Location(s)	Function(s)
Simple squamous epithelium	Endothelium of blood and lymphatic vessels; Bowman's capsule and thin loop of Henle in kidney; mesothelium lining pericardial, peritoneal and pleural body cavities; lung alveoli; smallest excretory ducts of glands	Lubrication of body cavities (permits free movement of organs); pinocytotic transports across cells
Stratified squamous keratinized epithelium	Epidermis of skin	Prevents loss of water and protection
Stratified squamous nonkeratinized epithelium (moist)	Mucosa of oral cavity, esophagus, anal canal; vagina; cornea of eye and part of conjunctiva	Secretion; protection; prevents loss of water
Simple cuboidal epithelium	Kidney tubules; choroids plexus; thyroid gland; rete testis; surface of ovary	Secretion; absorption; lines surface
Stratified cuboidal epithelium	Ducts of sweat glands;	Secretion; protection

	developing follicles of ovary	
Simple columnar epithelium	Cells lining lumen of digestive tract (stomach to rectum); gall bladder; many glands (secretory units and ducts); uterus; uterine tube (ciliated)	Secretion; absorption; protection; lubrication
Pseudostratified columnar epithelium	Lines lumen of respiratory tract (nasal cavity, trachea and bronchi) (cliliated); ducts of epididymis (stereocilia); ductus deferens; male urethra	Secretion; protection; facilitates transport of substances on surface of cells
Stratified columnar epithelium	Male urethra; conjunctiva	Protection
Transitional epithelium	Urinary tract (renal calyces and pelvis, ureter and urinary bladder)	Protection

Epithelial cells may also have specializations at the cell surface. For example,

Microvilli—fingerlike projections of plasma membranes.

Cilia—motile organelles extending into the luman consisting of specifically arranged microtubules.
Flagella—similar to cilia. Primary examples are human spermatozoa.
Stereocilia—are actually very elongated Microvilli.

4. **Connective Tissue:** Connective tissue is the packing and supporting material of the body tissues and organs. It develops from mesoderm (mesenchyme). All connective tissues consist of three distinct components: ground substance, cells and fibers.

    a) *Ground substance*. Ground substance is located between the cells and fibers, both of which are embedded in it. It forms an amorphous intercellar material. In the fresh state, it appears as a transparent and homogenous gel. It acts as a route for the passage of nutrients and wastes to and from the cells within or adjacent to the connective tissue.

    b) *Fibers.* The fiber components of connective tissue add support and strength. Three types of fibers are present: *collagenous, elastic* and *reticular.*

Integumentary (Skin) System

The skin and the specialized organs derived from the skin (hair, nails and glands) form the integumentary system.

Functions: The skin functions by surfacing the body and thus protecting it from dehydration as well as from damage by the elements in the external environment. The skin also helps maintain normal body activities.

Structure: Skin consists of the *epidermis* and *dermis* (*corium*). Deep to the dermis and therefore, the skin, is the *hypodermis*, which is also known as the *subcutaneous* or superficial connective tissue of the body.

Epidermis: The epidermis is derived from the ectoderm and is composed of a keratinized stratified squamous epithelium. *Thick skin* denotes skin with a thicker epidermis which contains more cell layers when compared to *thin skin*. The epidermis ranges in thickness from 0.07 millimeter to 1.4 millimeters. The epidermis consists of specific cell layers:

1. stratum basale or germinativum
2. stratum spinosum
3. stratum granulosum
4. stratum lucidum
5. stratum corneum

Glands

Glands are specialized organs derived from skin. There are two basic types: sebaceous and sweat.

Sebaceous Glands: Sebaceous glands are *simple branched alveolar* (*acinar*) *glands* with a *holocrine* mode of secretion.

Sweat Glands: Sweat is a watery fluid containing ammonia , urea, uric acid and sodium chloride. There are two types of sweat glands: eccrine and apocrine.

Eccrine Sweat Glands: The *eccrine sweat glands* are simple, coiled tubular glands with a merocrine mode of secretion.

Apocrine Sweat Glands: the *apocrine sweat glands* are very large glands which are thought to have a merocrine mode of secretion.

Hair

Hairs are long, filamentous keratinized structures derived from the epidermis of skin.

Structure: A hair consists of a *shaft* and a *root*.

Hair Follicles: The *hair follicle* consists of two sheathes, the *epithelial root sheath* and the *connective tissue root sheath*.

Hair Growth: Growth of a hair depends on the viability of the epidermal cells of the hair matrix which lie adjacent to the dermal papilla in the hair bulb. The matrix cells abutting the dermal papilla proliferate and give rise to cells which move upward to become part of the specific layers of the hair root and the inner epithelial root sheath.

Hair Musculature: Hairs are oriented at a slight angle to the skin surface and are associated with *arrector pili muscles*. These smooth muscle bundles extend from the dermal root sheath to a dermal papilla. Contraction results in the standing up of the hairs and raising of the skin surrounding the hair.

Nails

Nails are translucent plates of keratinized epithelial cells on the dorsal surface of distal phalanges of fingers and toes.

Initial Assessment of Burns

1. ABC's

Airway- If inhalation injury is suspected, a bonchoscopy may be indicated to determine extent of injury. Endotracheal tube placement early in order to avoid tracheostomy and complications. Tracheostomy bypasses upper respiratory system.

Breathing-Caution if burn wound is circumferential partial to full thickness in the region of the chest. Escharotomy may be indicated to facilitate excursion of the chest wall. Escharotomy is a longitudinal incision through eschar and down to subcutaneous tissue.

Circulation- Control bleeding from internal trauma, fractures, etc. Caution if burn wound is circumferential, partial to full thickness involving an extremity as vascular occulsion may result. Escharotomy may be indicated in order to restore blood perfusion. Persistent edema involving an extremity may lead to compartment syndrome. Clinical presentation includes numbness, poor capillary refill, decreased pulse and temperature and paler. Fasciotomy wound be indicated.

2. Complete evaluation process to determine extent and depth of burn.
3. Shock-Shock is the most immediate life-threatening complication due to moderate-severe burn wound injury. Hypovolemia is a loss of circulatory fluids into interstitial spaces. Clinical presentation is decrease in BP, decreased urinary output, and an increase in hematocrit. Intravascular fluid is the first fluid to be depleted, followed by interstitial fluid while the most stable is intercellular fluid. Treatment includes hydration with IV fluids via two large-bore 16 gauge needles. Amount of fluid administered is based upon TBSA/body weight via Parkland/Baxter formula. Monitor urine output via Foley catheter. Adults should yield 30-50 ml of urine/hour, while children should yield .5-1 ml/kg/hr. Decrease in urine output indicates decreased

blood flow to the kidneys. Excessive hydration may result in cerebral, pulmonary edema.

Burn Wound Care-Burn wounds are quickly assessed and covered with silvadene ointment and gauze in ER by nursing. Wound care is important, but no a primary concern during the resuscitative phase. Hydrotherapy is usually deferred during this phase due to risk of infection, leaching of electrolytes, and risk of hypothermia.

Wound Care Terms

1. Maceration-process of becoming soft or separated into constituent elements or as if by steeping in fluid.
2. Eschar-scab formed after a burn; may be thick, leathery or thin appearing white to beize or green.
3. Necrosis-localized death of living tissue. Devitalized, avascular, dehydrated and may appear brown to black.
4. Slough-a mass of dead tissue separating from an ulceration; appears loose, stringy; usually white to beige often associated with infection.
5. Induration- to increase the fibrous element; to make hard as in the presence of cellulitis.
6. Rubor-red;erythema
7. Calor-heat
8. Dolor-pain
9. Tumor-hard or indurated
10. Erythema-abnormal redness of the skin due to capillary congestion
11. Pitting edema-an abnormal excess accumulation of serous fluid in connective tissue. Palpation of the area creates an indentation in the soft tissue.
12. Hypergranulation-excessive amount of granulation tissue which retards epithelialization; red beefy in color
13. Hypogranulation-excessive amount of epithelial tissue which grows down into the wound cavity and retards granulation; pink and shiny. Also known as proud flesh.

14. Dehiscence-to split the lines or borders of an incision
15. Transudate-water and electrolytes (clear)
16. Exudate-protein and leukocytes (cloudy)
17. Serous-clear fluid found within blisters. Formed following coagulation and contains immune bodies
18. Sanguineous- consisting of or relating to blood
19. Serosanguineous- combination of clear and bloody drainage
20. Lavage-therapeutic washing of an organ
21. Excoriation-to wear off the skin, abrade, denude.
22. Denude-to strip off all covering
23. Purulent-containing or consisting of pus; white blood cells.
24. Desiccated- to dry up; dehydrate
25. Undermining- a separation or space between the periwound skin and the sidewall of the wound bed.

Characteristics of Arterial, Venous and Diabetic Wounds for Assessment Purposes

Pain

Arterial-painful, pain at rest, increased with elevation

Venous-relatively painless, decreased with elevation

Diabetic-painless

Location

Arterial-distal lateral leg, toes, over phalangeal heads

Venous-medial aspect of lower leg and ankle, malleolus area

Diabetic-plantar aspect of foot, met heads, heel

Temperature

Arterial-decreased

Venous-increased
Diabetic-increased

Color
Arterial-pale base
Venous-red, purple
Diabetic-red unless coexisting PVD

Axial Skeleton

The axial skeleton consists of 80 bones forming the trunk (spine and thorax) and skull.

Vertebral Column: The main trunk of the body is supported by the spine, or vertebral column, which is composed of 26 bones, some of which are formed by the fusion of a few bones. The vertebral column from superior to inferior consists of 7 cervical (neck), 12 thoracic and 5 lumbar vertebrae, as well as a sacrum, formed by fusion of 5 sacral vertebrae, and a coccyx, formed by fusion of 4 coccygeal vertebrae.

Ribs and Sternum: The axial skeleton also contains 12 pairs of *ribs* attached posteriorly to the thoracic vertebrae and anteriorly either directly or via cartilage to the *sternum* (breastbone). The ribs and sternum form the *thoracic cage*, which protects the heart and lungs. Seven pairs of ribs articulate with the sternum (*fixed ribs*) directly, and three do so via cartilage; the two most inferior pairs do not attach anteriorly and are referred to as *floating ribs*.

Skull: The skull consists of 22 bones fused together to form a rigid structure which houses and protects organs such as the brain, auditory apparatus and eyes. The bones of the skull form the *face* and *cranium* (brain case) and consist of 6 single bones (*occipital, frontal, ethmoid, sphenoid, vomer* and *mandible*) and

8 paired bones (*parietal, temporal, maxillary, palatine, zygomatic, lacrimal, inferior concha* and *nasal*). The *lower jaw* or *mandible* is the only movable bone of the skull (head); it articulates with the temporal bones.

Other Parts: Other bones considered part of the axial skeleton are the *middle ear bones* (*ossicles*) and the small U-shaped *hyoid bone* that is suspended in a portion of the neck by muscles and ligaments.

Appendicular Skeleton

The *appendicular skeleton* forms the major internal support of the appendages—the *upper* and *lower extremities* (limbs).

Pectoral Girdle and Upper Extremities: The arms are attached to and suspended from the axial skeleton via the *shoulder* (*pectoral*) *girdle*. The latter is composed of two *clavicles* (*collarbones)* and two *scapulae* (*shoulder blades*). The clavicles articulate with the sternum; the two *sternoclavicular joints* are the only sites of articulation between the trunk and upper extremity.

Each upper limb from distal to proximal (closest to the body) consists

Each upper limb from distal to proximal (closest to the body) consists of hand, wrist, forearm and arm (upper arm). The *hand* consists of 5 *digits* (fingers) and 5 *metacarpal* bones. Each digit is composed of three bones called *phalanges*, except the thumb which has only two bones.

Pelvic Girdle and Lower Extremities: The lower *extremities*, or legs, are attached to the axial skeleton via the *pelvic* or *hip girdle*. Each of the two coxal, or *hip bones* comprising the pelvic girdle is formed by the fusion of three bones—*illium, pubis,* and *ischium*. The coxal bones attach the lower limbs to the trunk by articulating with the sacrum.

THE HUMAN SKELETAL SYSTEM	
Part of the Skeleton	**Number of Bones**
Axial Skeleton	**80**
Skull	22
Ossicles (malleus, incus and stapes)	6
Vertebral column	26
Ribs	24
Sternum	1
Hyoid	1
Appendicular Skeleton	**126**
Upper extremities	64
Lower extremities	62

Characteristics of Bone

Bone is a specialized type of connective tissue consisting of cells (*osteocytes*) embedded in a calcified matrix which gives bone its characteristic hard and rigid nature. Bones are encased by a *periosteum*, a connective tissue sheath. All bone has a central marrow cavity. *Bone marrow* fills the marrow cavity or smaller marrow spaces, depending on the type of bone.

Types of Bone: There are two types of bone in the skeleton: *compact bone* and *spongy* (cancellous) bone.

Compact Bone. Compact bone lies within the periosteum, forms the outer region of bones, and appears dense due to its compact organization. The living osteocytes and calcified matrix are arranged in layers, or *lamellae*. Lamellae may

be circularly arranged surrounding a central canal, the *Haversian canal*, which contains small blood vessels.

Spongy Bone. Spongy bone consists of *bars, spicules* or *trabeculae*, which forms a lattice meshwork. Spongy bone is found at the ends of long bones and the inner layer of flat, irregular and short bones. The trabeculae consist of osteocytes embedded in calcified matrix, which in definitive bone has a lamellar nature. The spaces between the trabeculae contain bone marrow.

Bone Cells: The cells of bone are osteocytes, osteoblasts, and osteoclasts. *Osteocytes* are found singly in *lacunae* (spaces) within the calcified matrix and communicate with each other via small canals in the bone known as *canaliculi*. The latter contain osteocyte cell processes. The osteocytes in compact and spongy bone are similar in structure and function.

Osteoblasts are cells which form bone matrix, surrounding themselves with it, and thus are transformed into osteocytes. They arise from undifferentiated cells, such as mesenchymal cells. They are cuboidal cells which line the trabeculae of immature or developing spongy bone.

Osteoclasts are cells found during bone development and remodeling. They are multinucleated cells lying in cavities, *Howship's lacunae*, on the surface of the bone tissue being resorbed. Osteoclasts remove the existing calcified matrix releasing the inorganic or organic components.

Bone Matrix: *Matrix* of compact and spongy bone consists of collagenous fibers and ground substance which constitute the organic component of bone. Matrix also consists of inorganic material which is about 65% of the dry weight of bone. Approximately 85% of the inorganic component consists of calcium phosphate in a crystalline form (hydroxyapatite crystals). Glycoproteins are the main components of the ground substance.

MAJOR TYPES OF HUMAN BONES

Type of Bone	Characteristics	Examples
Long bones	Width less than length	Humerus, radius, ulna, femur, tibia
Short bones	Length and width close to equal in size	Carpal and tarsal bones
Flat bones	Thin flat shape	Scapulae, ribs, sternum, bones of cranium (occipital, frontal, parietal)
Irregular bones	Multifaceted shape	Vertebrae, sphenoid, ethmoid
Sesamoid	Small bones located in tendons of muscles	---------

Joints

The bones of the skeoeton articulate with each other at *joints*, which are variable in structure and function. Some joints are immovable, such as the *sutures* between the bones of the cranium. Others are *slightly movable joints*; examples are the *intervertebral joints* and the *pubic symphysis* (joint between the two pubic bones of the coxal bones).

TYPES OF JOINTS

Joint Type	Characteristic	Example

Ball and socket	Permits all types of movement (abduction, adduction, flexion, extension, circumduction); it is considered a universal joint.	Hips and shoulder joints
Hinge (ginglymus)	Permits motion in one plane only	Elbow and knee, interphalangeal joints
Rotating or pivot	Rotation is only motion permitted	Radius and ulna, atlas and axis (first and second cervical vertebrae)
Plane or gliding	Permits sliding motion	Between tarsal bones and carpal bones
Condylar (condyloid)	Permits motion in two planes which are at right angles to each other (rotation is not possible)	Metacarop-phalangeal joints, temporomandibular

Adjacent bones at a joint are connected by fibrous connective tissue bands known as *ligaments*. They are strong bands which support the joint and may also act to limit the degree of motion occurring at a joint.

Muscular System

Classification

A muscle cell not only has the ability to propagate an action potential along its cell membrane, as does a nerve cell, but also has the internal machinery to give it the unique ability to contract.

Most muscles in the body can be classified as striated muscles in reference to the fact that when observed under a light microscope the muscular tissue has light and dark bands or striations running across it. Although both skeletal and cardiac muscles are striated and therefore have similar structural organizations, they do possess some characteristic functional differences.

In contrast to skeletal muscle, cardiac muscle is a functional syncytium. This means that although anatomically it consists of individual cells the entire mass normally responds as a unit and all of the cells contract together. In addition, cardiac muscle has the property of automaticity which means that the heart initiates its own contraction without the need for motor nerves.

Non-striated muscle consists of multi-unit and unitary (visceral) smooth muscle. Visceral smooth muscle has many of the properties of cardiac muscle. To some extent it acts as a functional syncytium (e.g., areas of intestinal smooth muscle will contract as a unit. Smooth muscle is part of the urinary bladder, uterus, spleen, gallbladder, and numerous other internal organs. It is also the muscle of blood vessels, respiratory tracts, and the iris of the eye.

Skeletal Muscles

In order for the human being to carry out the many intricate movements that must be performed, approximately 650 skeletal muscles of various lengths, shapes, and strength play a part. Each muscle consists of many muscle cells or fibers held together and surrounded by connective tissue that gives functional integrity to the system. Three definite units are commonly referred to:

(1) endomysium—connective tissue layer enveloping a single fiber;
(2) perimysium—connective tissue layer enveloping a bundle of fibers;
(3) epimysium—connective tissue layer enveloping the entire muscle

Muscle Attachment and Function

For coordinated movement to take place, the muscle must attach to either bone or cartilage or, as in the case of the muscles of facial expression, to skin. The portion of a muscle attaching to bone is the tendon. A muscle has two extremities, its origin and its insertion.

Terms to Describe Movement

Flexion is bending, most often ventrally to decrease the angle between two parts of the body; it is usually an action at an articulation or joint.

Extension is straightening, or increasing the angle between two parts of the body; a stretching out or making the flexed part straight.

Abduction is a movement away from the midsagittal plane (midline); to adduct is to move medially and bring a part back to the mid-axis.

Circumduction is a circular movement at a ball and socket (shoulder or hip) joint, utilizing the movements of flexion, extension, abduction, and adduction.

Rotation is a movement of a part of the body around its long axis.

Supination refers only to the movement of the radius around the ulna. In supination the palm of the hand is oriented anteriorly; turning the palm dorsally puts it into pronation. The body on its back is in the supine position.

Pronation refers to the palm of the hand being oriented posteriorly. The body on its belly is the prone position.

Inversion refers only to the lower extremity, specifically the ankle joint. When the foot (plantar surface) is turned inward, so that the sole is pointing and directed toward the midline of the body and is parallel with the median plane, we speak of inversion. Its opposite is eversion.

Eversion refers to the foot (plantar surface) being turned outward so that the sole is pointing laterally.

Opposition is one of the most critical movements in humans; it allows us to have pulp-to-pulp opposition, which gives us the great dexterity of our hands. In this movement the thumb pad is brought to a finger pad. A median nerve injury negates this action.

Structural Organization of a Muscle Fiber

A muscle fiber is a single muscle cell. If we look at a section of a fiber we see that it is complete with a cell membrane called the sarcolemma and has several nuclei located just under the sarcolemma—it is multinucleated. Each fiber is composed of numerous cylindrical fibrils running the entire length of the fiber.

Myofilaments

The thick and thin myofilaments form the contractile machinery of muscle and are made up of proteins. Approximately 54% of all the contractile proteins (by weight) is myosin. The thick myofilament is composed of many myosin molecules oriented tail-end to tail-end at the center with myosin molecules staggered from the center to the myofilament tip. The second major contractile protein is actin. Actin is a globular protein.

Sarcoplasm

The sarcoplasm (cytoplasm of the muscle cell) contains Golgi complexes near the nuclei. Mitochondria are found between the myogibrils and just below the sarcolemma. The myofibrils are surrounded by smooth endoplasmic reticulum (*sarcoplasmic reticulum*) composed of a longitudinally arranged tubular network (*sarcotubules*).

The complex (terminal cistern-T tubule-terminal cistern) formed at this position is known as a *triad*. The T tubules function to bring a wave of depolarization of the sarcolemma into the fiber and thus into intimate relationship with the terminal cisternae.

Excitation

Contraction in a skeletal muscle is triggered by the generation of an action potential in the muscle membrane. Each motor neuron upon entering a skeletal muscle loses its myelin sheath and divides into branches with each branch innervating a single muscle fiber, forming a *neuromuscular junction*. Each fiber normally has one neuromuscular junction which is located near the center of the fiber. A *motor unit* consists of a single motor neuron and all the muscle fibers innervated by it. The *motor end plate* is the specialized part of the muscle fiber's membrane lying under the neuron.

Contraction

According to the sliding filament theory (Huxley) the sacromere response to excitation involves the sliding of thin and thick myofilaments past one another making and breaking chemical bonds with each other as they go. Neither the thick nor thin myofilaments change in length. If we could imagine observing this

contraction under a light microscope we would see the narrowing of the “H” and “I” bands during contraction while the width of the “A” band would remain constant.

Muscle Twitch

A muscle’s response to a single maximal stimulus is a *muscle twitch*. The beginning of muscular activity is signaled by the record of the *electrical activity* in the sarcolemma. The *latent period* is the delay between imposition of the stimulus and the development of tension.

Tetanus

When a volley of stimuli is applied to a muscle, each succeeding stimulus may arrive before the muscle can completely relax from the contraction caused by the preceding stimulus. The result is *summation*, an increased strength of contraction. If the frequency of stimulation is very fast, individual contractions fuse and the muscle smoothly and fully contracts. This is a *tetanus*.

Energy Sources

In any phenomenon including muscular contraction the energy input to the system and the energy output from the system are equal. Let us consider first the energy sources for muscular contraction. The immediate energy source for contraction is ATP which can be hydrolyzed by actomyosin to give ADP, P_i , and the energy which is in some way associated with cross-bridge motion.

Types of Muscle Fibers

Skeletal muscle fibers can be described, on the bases of structure and function, as follows:

1. *White (fast) fibers* – contract rapidly; fatigue quickly; energy production is mainly via anaerobic glycolysis; contain relatively few mitochondria; examples are the muscles of the eye.
2. *Red (slow) fibers* – contract slowly; fatigue slowly; energy production is mainly via oxidative phosphorylation (aerobic); contain relatively many mitochondria; examples are postural muscles.
3. *Intermediate fibers* – have structural and functional qualities between those of white and of red fibers.

Special Report- USMLE Step 1 Sample Questions

Note: The length of the review material in this document indicates the broad scope of the USMLE Step 1 Test test content. These questions provide 4 answer choices for each question. On the actual USMLE Step 1 Licensure Test, the number of answer choices is greater and more distractors are found. Adding more distractors to a test decreases the odds a random guess will be accurate. Moreover, the actual USMLE questions are *Best Answer* questions. Some answers will be partially right, however, there is only one right answer.

1. A doctor is working in an outpatient orthopedic clinic. During the patient's history the patient reports, "I tore 3 of my 4 Rotator cuff muscles in the past." Which of the following muscles cannot be considered as possibly being torn?

A: Teres minor
B: Teres major
C: Supraspinatus
D: Infraspinatus

2. A doctor at outpatient clinic is determining the appropriate sequence to arrange patients in the afternoon. Which of the following calls should have the highest priority for medical intervention?

A: A home health patient reports, "I am starting to have breakdown of my heels."
B: A patient that received an upper extremity cast yesterday reports, "I can't feel my fingers in my right hand today."
C: A young female reports, "I think I sprained my ankle about 2 weeks ago."
D: A middle-aged patient reports, "My knee is still hurting from the TKR."

3. A doctor working a surgical unit, notices a patient is experiencing SOB, calf pain, and warmth over the posterior calf. All of these may indicate which of the following medical conditions?

A: Patient may have a DVT.
B: Patient may be exhibiting signs of dermatitis.
C: Patient may be in the late phases of CHF.
D: Patient may be experiencing anxiety after surgery.

4. A doctor is performing a screening on a patient that has been casted recently on the left lower extremity. Which of the following statements should the doctor be most concerned about?

A: The patient reports, “I didn’t keep my extremity elevated like the doctor asked me to.”
B: The patient reports, “I have been having pain in my left calf.”
C: The patient reports, “My left leg has really been itching.”
D: The patient reports, “The arthritis in my wrists is flaring up, when I put weight on my crutches.”

5. The bacteria *Neisseria gonorrhoeae* can be classified as a:

A: Gram-negative cocci
B: Spirochetes
C: Acid-fast bacilli
D: Gram-positive cocci

6. The bacteria *Staphylococcus aureus* can be classified as a:

A: Gram-negative cocci

B: Spirochetes
C: Acid-fast bacilli
D: Gram-positive cocci

7. A doctor has just started on the 7PM surgical shift rotation. Which of the following patients should the doctor check on first?

A: A 75 year-old female who is scheduled for an EGD in 10 hours.
B: A 34 year-old male who is complaining of low back pain following back surgery and has an onset of urinary incontinence in the last hour.
C: A 21 year-old male who had a lower extremity BKA yesterday, following a MVA and has phantom pain.
D: A 27 year-old female who has received 1.5 units of RBC's. via transfusion the previous day.

8. A 22 year-old patient in a mental health lock-down unit under suicide watch appears happy about being discharged. Which of the following is probably happening?

A: The patient is excited about being around family again.
B: The patient's suicide plan has probably progressed.
C: The patient's plans for the future have been clarified.
D: The patient's mood is improving.

9. Which of the following microorganisms has not been linked to Meningitis?

A: *Flavobacterium meningosepticum*
B: *Listeria monocytogenes*
C: *Pasteurella multocida*
D: *Streptobacillus moniliformis*

10. A 13 year old girl is admitted to the ER with lower right abdominal discomfort. The admitting physician should take which the following measures first?

A: Administer Loritab to the patient for pain relief.
B: Place the patient in right sidelying position for pressure relief.
C: Start a Central Line.
D: Provide pain reduction techniques without administering medication.

11. A patient that has TB can be taken off restrictions after which of the following parameters have been met?

A: Negative culture results.
B: After 30 days of isolation.
C: Normal body temperature for 48 hours.
D: Non-productive cough for 72 hours.

12. A doctor teaching a patient with COPD pulmonary exercises should do which of the following?

A: Teach purse-lip breathing techniques.
B: Encourage repetitive heavy lifting exercises that will increase strength.
C: Limit exercises based on respiratory acidosis.
D: Take breaks every 10-20 minutes with exercises.

13. A patient asks a doctor the following question. Exposure to TB can be identified best with which of the following procedures?

A: Chest x-ray
B: Mantoux test
C: Breath sounds examination
D: Sputum culture for gram-negative bacteria

14. A fifty-five year-old man suffered a left frontal lobe CVA. The patient's family is not present in the room. Which of the following should the doctor watch most closely for?

A: Changes in emotion and behavior
B: Monitor loss of hearing
C: Observe appetite and vision deficits
D: Changes in facial muscle control

15. A central venous pressure reading of 11cm/H(2)0 of an IV of normal saline is determined by the doctor caring for the patient. The patient has a diagnosis of pericarditis. Which of the following is the most applicable:

A: The patient has a condition of hypovolemia.
B: Not enough fluid has been given to the patient.
C: Pericarditis may cause pressures greater than 10cm/H(2)0 with testing of CVP.
D: The patient may have a condition of arteriosclerosis.

16. A physician is instructing a patient on the order of sensations with the application of an ice water bath for a swollen right ankle. Which of the following is the correct order of sensations experienced with an ice water bath?

A: cold, burning, aching, and numbness
B: burning, aching, cold, and numbness
C: aching, cold, burning and numbness
D: cold, aching, burning and numbness

17. A doctor consults with a male patient that has a diagnosis of CAD and COPD. The patient is currently taking Ventolin, Azmacort, Aspirin, and Theophylline. The patient complains of upset stomach, nausea and feeling uncomfortable. The doctor should:

A: Monitor the patient for theophylline toxicity.
B: Recommend the patient position himself in right sidelying.
C: Recommend the patient schedule a doctor's visit in one week.
D: Recommend a hold on the drug-Azmacort

18. A doctor reviewed the arterial blood gas reading of a 25 year-old male. The doctor should be able to conclude the patient is experiencing which of the following conditions?

Bicarbonate ion-25 mEq/l
PH-7.41
PaCO2-29 mmHg
PaO2-54 mmHg
(FiO2)-.22

A: metabolic acidosis
B: respiratory acidosis
C: metabolic alkalosis
D: respiratory alkalosis

19. Syphilis has been directly linked to?

A: *Streptococcus (anaerobic species)*
B: *Treponema pallidum*
C: *Borrelia burgdorferi*

D: *Chlamydia trachomatis*

20. Tricyclics (Antidepressants) sometimes have which of the following adverse affects on patients that have a diagnosis of depression?

A: Shortness of breath
B: Fainting
C: Large Intestine ulcers
D: Distal muscular weakness

21. A doctor is instructing a patient about the warning signs of (Digitalis) side effects. Which of the following side effects should the doctor tell the patient are sometimes associated with excessive levels of Digitalis?

A: Seizures
B: Muscle weakness
C: Depression
D: Anxiety

22. A doctor is assessing a patient's right lower extremity. The extremity is warm to touch, red and swollen. The patient is also running a low fever. Which of the following conditions would be the most likely cause of the patient's condition?

A: Herpes
B: Scleroderma
C: Dermatitis
D: Cellulitis

23. A doctor is assessing a patient's breath sounds. The patient has had a pneumonectomy to the right lung performed 48 hours ago. Which of the following conditions most likely exists?

A: Decreased breath sound volume
B: Elevated tidal volume
C: Elevated respiratory capacity
D: Wheezing

24. A doctor is assessing a patient in the ICU. The patient has the following signs: weak pulse, quick respiration, acetone breath, and nausea. Which of the following conditions is most likely occurring?

A: Hypoglycemic patient
B: Hyperglycemic patient
C: Cardiac arrest
D: End-stage renal failure

25. Medical records indicate a patient has developed a condition of respiratory alkalosis. Which of the following clinical signs would not apply to a condition of respiratory alkalosis?

A: Muscle tetany
B: Syncope
C: Numbness
D: Anxiety

26. Which of the following lab values would indicate symptomatic AIDS in the medical chart? (T4 cell count per deciliter)

A: Greater than 1000 cells per deciliter

B: Less than 500 cells per deciliter
C: Greater than 2000 cells per deciliter
D: Less than 200 cells per deciliter

27. A doctor is assessing a 18 year-old female who has recently suffered a TBI. The doctor notes a slower pulse and impaired respiration. The patient is experiencing which of the following conditions?

A: Increased intracranial pressure
B: Increased function of cranial nerve X
C: Sympathetic response to activity
D: Meningitis

28. A doctor taking a patient's history realizes the patient is complaining of SOB and weakness in the lower extremities. The patient has a history of hyperlipidemia, and hypertension. Which of the following may be occurring?

A: The patient is developing CHF
B: The patient may be having a MI
C: The patient may be developing COPD
D: The patient may be having an onset of PVD

29. A doctor has been assigned a patient who has recently been diagnosed with Guillain-Barre' Syndrome. Which of the following statements is the most applicable when discussing the impairments with Guillain-Barre' Syndrome with the patient?

A: Guillain-Barre' Syndrome gets better after 5 years in almost all cases.
B: Guillain-Barre' Syndrome causes limited sensation in the abdominal region.
C: Guillain-Barre' Syndrome causes muscle weakness in the legs.
D: Guillain-Barre' Syndrome does not effect breathing in severe cases.

30. Which of the following is not considered a RNA related virus?

A: Cytomegalovirus
B: Rabies virus
C: Influenza virus
D: Poliovirus

31. A doctor is assessing a patient in the rehab unit. The patient has suffered a TBI 3 weeks ago. Which of the following is the most distinguishing characteristic of a neurological disturbance?

A: LOC (level of consciousness)
B: Short term memory
C: + Babinski sign
D: + Clonus sign

32. Which of the following microorganisms has not been linked directly to UTI's?

A: *Proteus mirabilis*
B: *Streptococcus faecalis*
C: *Escherichia coli*
D: *Streptococcus pneumoniae*

33. A doctor is caring for a patient in the step down unit. The patient has signs of increased intracranial pressure. Which of the following is not a sign of increased intracranial pressure?

A: Bradycardia
B: Increased pupil size bilaterally
C: Change in LOC

D: Vomiting

34. The charge nurse on a cardiac unit tells you a patient is exhibiting signs of right-sided heart failure. Which of the following would not indicate right-sided heart failure?

A: Nausea
B: Anorexia
C: Rapid weight gain
D: SOB (shortness of breath)

35. A 62 year-old female is being seen on a home visit by a doctor. The patient reports she has been taking Premarin for years to the doctor. Which of the following would indicate an over-dosage of Premarin in this case?

A: Lower extremity edema
B: Sensory changes in the upper extremities
C: Increased occurrence of fractures
D: Decreased peripheral blood flow

36. A 46 year-old has returned from a heart catheterization and wants to get up to start walking 3 hours after the procedure. The doctor should:

A: Tell the patient to remain with the leg straight for at least another hour.
B: Allow the patient to begin limited ambulation with assistance.
C: Ordera physical therapy consultation for ambulation.
D: Tell the patient to remain with leg straight for another 6 hours.

37. A doctor is reviewing a patient's ECG report. The patient exhibits a flat T wave, depressed ST segment and short QT interval. Which of the following medications can cause all of the above effects?

A: Morphine
B: Atropine
C: Procardia
D: Digitalis

38. A patient has just been prescribed Minipress to control hypertension by a doctor. The doctor should instruct the patient to be observant of the following:

A: Dizziness and light headed sensations
B: Weight gain
C: Sensory changes in the lower extremities
D: Fatigue

39. A patient is complaining of severe chest pain during a stress test. Which of the following medications is the most appropriate to relieve this discomfort?

A: Aspirin
B: Diazoxide
C: Procardia
D: Mannitol

40. A 15 year-old high school wrestler has been taking diuretics to loose weight to compete in a lower weight class. Which of the following medical tests is most like to be given?

A: Lab values of Potassium and Sodium
B: Lab values of glucose and hemoglobin
C: ECG
D: CT scan

41. A 55 year-old female asks a doctor the following, “Which mineral/vitamin is the most important to prevent progression of osteoporosis. The doctor should state:

A: Potassium
B: Magnesium
C: Calcium
D: Vitamin B12

42. A patient has recently been diagnosed with symptomatic bradycardia. Which of the following medications is the most recognized for treatment of symptomatic bradycardia?

A: Questran
B: Digitalis
C: Nitroglycerin
D: Atropine

43. A patient has recently been prescribed Lidocaine Hydrochloride. Which of the following symptoms may occur with over dosage?

A: Memory loss and lack of appetite
B: Confusion and fatigue
C: Heightened reflexes
D: Tinnitus and spasticity

44. A patient has recently been prescribed Albuterol. Which of the following changes are not associated with Albuterol?

A: Tachycardia
B: Hypertension

C: Bronchodilation

D: Sensory changes

45. Which of the following arterial blood gas values indicates a patient may be experiencing a condition of metabolic acidosis?

A: PaO2 (90%)

B: Bicarbonate 159

C: CO(2) 47 mm Hg

D: pH 7.34

46. A patient presents with a lesion in the brain with the following signs and symptoms: III cranical nerve involvement, ptosis, and contralateral hemiparesis. What is the location of the lesion?

A: Third ventricle

B: Midbrain

C: Pons

D: Precentral gyrus

47. A doctor suspects a patient is developing Bell's Palsy. The doctor wants to test the function of cranial nerve VII. Which of the following would be the most appropriate testing procedures?

A: Test the taste sensation over the back of the tongue and activation of the facial muscles.

B: Test the taste sensation over the front of the tongue and activation of the facial muscles.

C: Test the sensation of the facial muscles and sensation of the back of the tongue.

D: Test the sensation of the facial muscles and sensation of the front of the

tongue.

48. A doctor is reviewing a patient's serum glucose levels. Which of the following scenarios would indicate abnormal serum glucose values for a 30 year-old male.

A: 70 mg/dl
B: 55 mg/dl
C: 110 mg/dl
D: 100 mg/dl

49. A patient presents with a lesion in the brain with the following signs and symptoms: Contralateral hemiplegia, hemisensory loss and homonymous hemianopsia. What is the location of the lesion?

A: Internal capsule
B: Pineal gland
C: Prefrontal area
D: Uncus

50. A patient has recently been prescribed Zidovudine (Retrovir). The patient has AIDS. Which of the following side effects should the patient specifically watch out for?

A: Weakness and SOB
B: Fever and anemia
C: Hypertension and SOB
D: Fever and hypertension

51. A patient has recently been prescribed (Norvasc). Which of the following side effect/s should the patient specifically watch out for?

A: Hypotension and Angina
B: Hypertension
C: Lower extremity edema
D: Peripheral sensory loss and SOB

52. A doctor is reviewing a patient's arterial blood gas values. Which of the following conditions apply under the following values?

pH- 7.49
Bicarbonate ion 24 mEq/dl
PaCO2 – 31 mmHg
PaO2 – 52 mmHg
FiO2 - .22

A: respiratory acidosis
B: respiratory alkalosis
C: metabolic acidosis
D: metabolic alkalosis

53. A 28 year-old male has a diagnosis of AIDS. The patient has had a two year history of AIDS. The most like cognitive deficits include which of the following?

A: Disorientation
B: Sensory changes
C: Inability to produce sound
D: Hearing deficits

54. A patient has been admitted to the hospital with a HNP L4-5 segment diagnosis. After 24 hours the patient is able to ambulate with assistance with

reduced muscle spasms. Which of the following medications was the most beneficial in changing the patient's mobility status?

A: Mivacron
B: Atropine
C: Bethanechol
D: Flexeril

55. Which of the following medications is not considered a neuromuscular blocker?

A: Anectine
B: Pavulon
C: Pitressin
D: Mivacron

56. A doctor is caring for a 10 year-old boy who has just been diagnosed with a congenital heart defect. Which of the following clinical signs does not indicate congenital heart defect?

A: Increased body weight
B: Elevated heart rate
C: Lower extremity edema
D: Compulsive behavior

57. A patient presents with a lesion in the brain with the following signs and symptoms: Cranial nerve VI involvement, ipsilateral facial paralyis, locked-in syndrome, contralateral hemiparesis. What is the location of the lesion?

A: Internal capsule
B: Pons

C: Corpus callosum

D: Third ventricle

58. Which of the following effects is unrelated to Morphine's effects on a patient?

A: Depressed function of the CNS

B: Increased blood flow

C: Decreased venous capacity

D: Pain relief

59. A doctor is reviewing a patient's current Lithium levels. Which of the following values is outside the therapeutic range?

A: 1.0 mEq/L

B: 1.1 mEq/L

C: 1.2 mEq/L

D: 1.3 mEq/L

60. Dermatome screening indicates sensory loss over the lateral forearm. Myotome screening indicates weak wrist extension on the same side. Which cervical nerve root level could be involved?

A: C4

B: C5

C: C6

D: C7

61. Which of the following side effects is not associated with Tegretol?

A: Sore throat

B: Vertigo

C: Fever
D: Shortness of breath

62. A doctor has prescribed Klonapin for the first time. Which of the following side effects is not associated with Klonapin?

A: Drowsiness
B: Ataxia
C: Salivation elevated
D: Diplopia

63. A patient has been diagnosed with diabetes mellitus. Which of the following is not a clinical sign of diabetes mellitus?

A: Polyphagia
B: Polyuria
C: Metabolic acidosis
D: Lower extremity edema

64. A patient has fallen off a bicycle and fractured the head of the proximal fibula. A cast was placed on the patient's lower extremity. Which of the following is the most probable result of the fall?

A: Peroneal nerve injury
B: Tibial nerve injury
C: Sciatic nerve injury
D: Femoral nerve injury

65. Which of the following applies to Buck's traction?

A: A weight greater than 10 lbs. should be used.

B: The line of pull is upward at an angle.
C: The line of pull is straight
D: A weight greater than 20 lbs. should be used.

66. Which of the following motions is identified with the corresponding action? (Action- Turning palm of hand over to face in the anterior direction, dorsum of the hand is pointed downward toward the floor.)

A: Pronation
B: Supination
C: Abduction
D: Adduction

67. What type of cells secretes insulin?
A: alpha cells
B: beta cells
C: CD4 cells
D: helper cells

68. Which of the following is not considered one of the main mechanisms of Type II Diabetes treatment?

A: Medications
B: Nutrition
C: Increased activity
D: Continuous Insulin

69. What type of cells create exocrine secretions?

A: alpha cells
B: beta cells

C: acinar cells

D: plasma cells

70. A doctor is caring for a patient who has experienced burns to the right lower extremity. According to the Rule of Nines which of the following percents most accurately describes the severity of the injury?

A: 36%

B: 27%

C: 18%

D: 9%

71. A patient has experienced a severe third degree burn to the trunk in the last 36 hours. Which phase of burn management is the patient in?

A: Shock phase

B: Emergent phase

C: Healing phase

D: Wound proliferation phase

72. A doctor is reviewing a patient's medical record. The record indicates the patient has limited shoulder flexion on the left. Which plane of movement is limited?

A: Horizontal

B: Sagittal

C: Frontal

D: Vertical

73. What is the name of a tumor that tends to be encapsulated and is usually benign?

A: Neuroma
B: Meningioma
C: Glioblastoma
D: Lymphoma

74. If your patient is acutely psychotic, which of the following independent medical interventions would not be appropriate?

A: Conveying calmness with one on one interaction
B: Recognizing and dealing with your own feelings to prevent escalation of the patient's anxiety level
C: Encourage client participation in group therapy
D: Listen and identify causes of their behavior

75. A doctor is teaching a client about self-administration of Haldol 15 mg po hs. For which side effect/s must the client seek medical attention?

A: SOB and fatigue
B: restlessness and muscle spasms
C: dry mouth
D: diarrhea

Answer Key

1. (B) Teres Minor, Infraspinatus, Supraspinatus, and Subscapularis make up the Rotator Cuff.

2. (B) The patient experiencing neurovascular changes should have the highest priority. Pain following a TKR is normal, and breakdown over the heels is a gradual process. Moreover, a subacute ankle sprain is almost never a medical emergency.

3. (A) All of these factors indicate a DVT.

4. (B) Pain may be indicating neurovascular complication.

5. (A) *Neisseria gonorrhoeae* is a gram-negative cocci.

6. (D) *Staphylococcus aureus* is a gram-positive cocci.

7. (B) The new onset of urinary incontinence may require additional medical assessment.
8. (B) The suicide plan may have been decided.

9. (D) *Streptobacillus moniliformis* is linked to abscesses, bacteremia, and endocarditis.

10. (D) Do not administer pain medication or start a central line without MD orders.
11. (A) Negative culture results would indicate absence of infection.

12. (A) Purse lip breathing will help decrease the volume of air expelled by increased bronchial airways.

13. (B) The Mantoux is the most accurate test to determine the presence of TB.

14. (A) The frontal lobe is responsible for behavior and emotions.

15. (C) >10cm/H(2)0 may indicate a condition of pericarditis

16. (A) CBAN, cold, burn, ache, numbness

17. (A) Theophylline toxicity may be occurring.

18. (D) Respiratory alkalosis-elevated pH, and low carbon dioxide levels, no compensation noted.

19. (B) Syphilis is linked to *Treponema pallidum.*

20. (B) Fainting and hypotension can be caused by Tricyclics.

21. (B) Palpitations and muscle weakness are found with excessive levels of Digitalis.

22. (D) Inflammation of cellular tissue associated with a fever most likely indicates cellulitis.

23. (A) Breath sounds would be softer.

24. (B) All of the clinical signs indicate a hyperglycemic condition.

25. (D) Anxiety is a clinical sign associated with respiratory acidosis.

26. (D) <200 T4 cells/deciliter

27. (A) The patient is at high risk of developing increased intracranial pressure (ICP).

28. (B) Myocardial infarction may be associated with SOB and muscle weakness.

29. (C) Muscle weakness in the lower extremities is found in acute cases of Guillain-Barre' Syndrome.

30. (A) All of the others are RNA related viruses.

31. (A) LOC is the most critical indicator of impaired neurological capabilities.

32. (D) Streptococcus pneumoniae linked to otitis, arthritis, sinusitis, and pneumonia.

33. (B) Unilateral pupil changes indicate changes in ICP.

34. (D) Left sided heart failure exhibits signs of pulmonary compromise (SOB).

35. (A) Edema in the lower extremities may indicate a Premarin (over-dosage).

36. (A) The patient should keep the leg straight for at least 4 hours.

37. (D) Digitalis can cause all of the listed symptoms.

38. (A) Hypotension may be result of over correction of a hypertensive condition.

39. (C) Procardia can provide the quickest relief of ischemic chest pain that is severe in this case.

40. (A) Diuretics can disturb the sodium and potassium balance resulting in cardiac complications. An ECG is not indicated without evidence of cardiac conditions.

41. (C) Calcium is the most recognized osteoporosis treatment.

42. (D) Atropine encourages increased rate of conduction in the AV node.

43. (B) Lidocaine Hydrochloride can cause fatigue and confusion if an over dosage occurs.

44. (D) Tachycardia, hypertension, and bronchodilation can all occur with Albuterol.

45. (B) The bicarbonate value is below normal, indicating a condition of metabolic acidosis.

46. (B) All of the listed signs and symptoms match up with a midbrain lesion.

47. (B) The facial nerve (VII) is motor to the face and sensory to the anterior tongue.

48. (B) 60-115 mg/dl is standard range for serum glucose levels.

49. (A) All of the signs and symptoms match up with a lesion in the internal capsule.

50. (B) Anemia and fever are associated with Zidovudine's side effects.

51. (A) Both angina and hypotension are associated with Norvasc's side effects.

52. (B) Elevated pH and low CO2 level indicate respiratory alkalosis, no compensation is noted.

53. (A) Cognitive changes may include confusion and disorientation.

54. (D) Flexeril is a muscle relaxant for acute muscle pain and spasms.

55. (C) Pitressin is a hormone replacement medication.

56. (D) Compulsive behavior does not indicate congenital heart defect.

57. (B) All of the signs and symptoms match up with a lesion in the pons.

58. (C) Venous capacity increases with morphine use.

59. (D) 1.0-1.2 mEq/L is considered standard therapeutic range for patient care.

60. (C) C6 Nerve Root intervates the wrist extensors and is sensory to the lateral forearm.

61. (D) A-C are associated side effects of Tegretol.

62. (D) A-C are associated side effects of Klonapin.

63. (D) A-C are associated with diabetes mellitus.

64. (A) The head of the proximal fibula is in close proximity to the peroneal nerve.

65. (C) A straight line of pull is indicated with Buck's traction.

66. (B) Supination- “Holding a bowl of soup in your hand.”

67. (B) Beta cells secrete insulin.

68. (D) Insulin is not required in continuous treatment for every Type II diabetic.

69. (C) Acinar cells create exocrine secretions.

70. (C) Each lower extremity is scored as 18% according to the Rule of Nines.

71. (A) The shock phase is considered the first 24-48 hours in wound management.

72. (B) Sagittal motion occurs in the midline plane of the body.

73. (B) Meningiomas tend to be encapsulated and found outside of actual brain tissue. Meningiomas are also usually benign and slow growing.

74. (C) Acutely psychotic patients will disrupt group activities.

75. (B) Muscle spasms and restlessness are side effects of Haldol

Special Report- Which USMLE Step 1 Study Guides and Practice Tests Are Worth Your Time

We believe the following practice tests and guide present uncommon value to our customers who wish to "really study" for the USMLE Step 1 test. While our manual teaches some valuable tricks and tips that no one else covers, learning the basic coursework tested on the USMLE is also necessary.

Practice Tests

Official USMLE Step 1 Practice Test

http://www.usmle.org/step1/default.htm

Study Guides

First Aid for the USMLE Step 1

http://www.amazon.com/exec/obidos/ASIN/0071399127/qid=1070726883/sr=2-1/ref=sr_2_1/104-1702128-0109532

NMS Review for USMLE Step 1 (Book with CD-ROM)

http://www.amazon.com/exec/obidos/ASIN/0781732921/qid=1070726883/sr=2-3/ref=sr_2_3/104-1702128-0109532

These guides are THE best comprehensive coursework guides to the USMLE Step 1. If you want to spend a couple months in preparation to squeeze every last drop out of your score, buy these books!

Special Report- Musculature/Innervation Review of the Arm and Back

Muscle	**Origin**	**Insertion**	**Nerve**
Trapezius	Ext. Occipit Protuberance, Spines of T Vertebrae	Lateral Clavicle, Spine of the Scapula	Spinal Accessory Nerve CN XI
Latissimus Dorsi	Spines of Lower 6 T Vertebrae, Iliac Crest and Lower 4 Ribs	Bicipital Groove	Thoracodorsal
Levator Scapulae	Transverse Process of C1-C4	Upper Medial Border of Scapula	Dorsal Scapula
Rhomboid Major	Spinous Process of T2-T5	Medial Border Scapula Below Spine	Dorsal Scapular
Rhomboid Minor	Spinous Process of C7-T1	Medial Border Scapula Opp. Spine	Dorsal Scapular
Teres Major	Lateral Dorsal Inferior Angle of Scapula	Bicipital Groove	Lower Subscapular
Teres Minor	Lateral Scapula 2/3 way down	Greater Tubercle of Humerus	Axillary
Deltoid	Lateral 1/3 Clavicle and Acromion Process, Spine of	Deltoid Tuberosity	Axillary

	the Scapula		
Supraspinatus	Supraspinatus Fossa	Greater Tubercle of Humerus	Suprascapular
Infraspinatus	Infaspinatus Fossa	Greater Tubercle of Humerus	Suprascapular
Subscapularis	Subscapular Fossa	Lesser Tubercle of Humerus	Upper and lower Subscapular
Serratus Anterior	Slips of Upper 8-9 Ribs	Ventral-Medial Border Scapula	Long Thoracic
Subclavius	Inferior Surface of the Clavicle	First Rib	Nerve to the Subclavius
Pectoralis Major	Medial ½ clavicle and Side of Sternum	Bicipital Groove	Medial and Lateral Pectoral
Pectoralis Minor	Ribs 3,4,5 or 2,3,4	Coracoid Process	Medial Pectoral
Biceps Branchii	Supraglenoid Tubercle	Posterior Margin of Radial Tuberosity	Musculocutaneous
Coracobrachialis	Coracoid Process	Medial Humerus at Deltoid Tuberosity Level	Musculocutaneous
Brachialis	Anterior-Lateral ½ of Humerus	Ulnar Tuberosity and Coronoid Process	Musculocutaneous
Triceps Brachii	Infraglenoid Tubercle, Below and Medial to the Radial Groove	Olecranon Process	Radial
Anconeus	Posterior, Lateral Humeral Condyle	Upper Posterior Ulna	Radial

Brachioradialis	Lateral Supracondylar Ridge of Humerus	Radial Styloid Process	Radial
Pronator Teres	Medial Epicondyle and Supracondylar Ridge	½ Way Down on Lateral Radius	Median
Pronator Quadratus	Distal-Medial Ulna	Distal-Lateral Radius	Anterior Interosseous

Musculature/Innervation Review of the Forearm

Muscle	**Origin**	**Insertion**	**Nerve**
Brachioradialis	Lateral Supracondylar Ridge of Humerus	Radial Styloid Process	Radial
Pronator Teres	Medial Epicondyle and Supracondylar Ridge	½ Way Down on Lateral Radius	Median
Pronator Quadratus	Distal-Medial Ulna	Distal-Lateral Radius	Anterior Interosseous
Supinator	Lateral Epicondyle of Humerus	Upper ½ Lateral, Posterior Radius	Posterior Inter-Deep Radial
Flexor Carpi Radialis	Medial Epicondyle of Humerus	2nd and 3rd Metacarpal	Median
Flexor Carpi Ulnaris	Medial Epicondyle of Humerus	Pisiform, Hamate, 5th Metacarpal	Ulnar

Palmaris Longus	Medial Epicondyle of the Humerus	Palmar Aponeurosis and Flexor Retinaculum	Median
Flexor Digitorum Suerficialis	Medial Epicondyle, Radius, Ulna	Medial 4 Digits	Median
Flexor Digitorum Profundus	Ulna, Interosseous Membrane	Medial 4 Digits (distal part)	Median (lateral 2 digits), Ulnar (median 2 digits)
Flexor Pollicis Longus	Radius	Distal Phalanx (thumb)	Anterior Inter-Deep Median
Extensor Carpi Radialis Longus	Lateral Condyle and Supracondylar Ridge	2nd Metacarpal	Radial
Extensor Carpi Radialis Brevis	Lateral Epicondyle of Humerus	3rd Metacarpal	Posterior Inter-Deep Radial
Extensor Carpi Ulnaris	Lateral Epicondyle of Humerus	5th Metacarpal	Posterior Inter-Deep Radial
Extensor Digitorum	Lateral Epicondyle of Humerus	Extension Expansion Hood of Medial 4 Digits	Posterior Inter-Deep Radial
Extensor Digiti Minimi	Lateral Epicondyle of Humerus	Extension Expansion Hood of (little finger)	Posterior Inter-Deep Radial
Abductor Pollicis Longus	Posterior Radius and Ulna	Radial Side of 1st Metacarpal	Posterior Inter-Deep Radial
Extensor Indicis	Ulna and Interosseous Membrane	Extension Expansion Hood (index finger)	Posterior Inter-Deep Radial

Extensor Pollicis Longus	Ulna and Interosseous Membrane	Distal Phalanx (thumb)	Posterior Inter-Deep Radial
Extensor Pollicis Brevis	Radius	Proximal Phalanx (thumb)	Posterior Inter-Deep Radial

Musculature/Innervation Review of the Hand

Muscle	**Origin**	**Insertion**	**Nerve**
Adductor Policis	Capitate and Base of Adjacent Metacarpals	Proximal Phalanx (thumb)	Deep Branch of Ulnar
Lumbricals	Tendons of Flexor Digitorum Profundas	Extension Expansion Hood of Medial 4 Digits	Deep Branch Ulnar (medial 2 Ls), Median (lateral 2 Ls)
Dorsal Interosseous Muscles (4)	Sides of Metacarpals	Extension Expansion Hood of Digits 2-4	Deep Branch Ulnar
Palmar Interosseous (3)	Sides of Metacarpals	Extension Expansion Hood, Digits 2,4,5	Deep Branch Ulnar
Palmaris Brevis	Anterior Flexor Retinaculum and Palmar Aponeurosis	Skin-Ulnar Border of Hand	Superficial Ulnar
Abductor Pollicis Brevis	Flexor Retinaculum,	Lateral Proximal Phalanx (thumb)	Median (thenar branch)

	Trapezium		
Flexor Pollicis Brevis	Flexor Retinaculum, Trapezium	Lateral Proximal Phalanx (thumb)	Median (thenar branch)
Opponens Pollicis	Flexor Retinaculum, Trapezium	Radial Border (1st Metacarpal)	Median (thenar branch)
Abductor Digiti Minimi	Flexor Retinaculum, Pisiform	Proximal Phalanx (little finger)	Deep Branch Ulnar
Flexor Digiti Minimi	Flexor Retinaculum, Hamate	Proximal Phalanx (little finger)	Deep Branch Ulnar
Opponens Digiti Minimi	Flexor Retinaculum, Hamate	Ulnar Medial Border (5th Metacarpal)	Deep Branch Ulnar

Musculature/Innervation Review of the Thigh

Muscle	**Origin**	**Insertion**	**Nerve**
Psoas Major	Bodies and Discs of T12-L5	Lesser Trochanter	L2,3
Psoas Minor	Bodies and Discs of T12 and L1	Pectineal Line of Superior Pubic Bone	L2,3
Iliacus	Upper 2/3 Iliac Fossa	Lesser Trochanter	Femoral L2-4
Pectinius	Pubic Ramus	Spiral Line	Femoral

Iliposoas	Joining of Psoas Major and Iliacus	Lesser Trochanter	L2-4
Piriformis	Anterior Surface of the Sacrum	Greater Trochanter	S1, S2
Obturator Internus	Inner Surface of the Obturator Membrane	Greater Trochanter	Sacral Plexus
Obturator Externus	Outer Surface of the Obturator Membrane	Greater Trochanter	Obturator
Gemellus Superior	Ischial Spine	Greater Trochanter	Sacral Plexus
Gemellus Inferior	Ischial Tuberosity	Greater Trochanter	Sacral Plexus
Quadratus Femoris	Ischial Tuberosity	Quadrate Tubercle of the Femur	Sacral Plexus
Gluteus Maximus	Outer Surface of Ilium, Sacrum and Coccyx	Iliotibial Tract, Gluteal Tubercle of the Femur	Inferior Gluteal
Gluteus Minimus	Outer Surface of the Ilium	Greater Trochanter	Superior Gluteal
Gluteus Medius	Outer Surface of the Ilium	Greater Trochanter	Superior Gluteal
Satorius	Anterior Superior Iliac Spine	Upper Medial Tibia	Femoral
Quadriceps Femoris	Anterior Inferior Iliac Spine, Femur-Lateral and Medial	Tibial Tuberosity	Femoral

Gracilis	Pubic Bone	Upper Medial Tibia	Obturator (anterior branch)
Abductor Longus	Pubic Bone	Linea Aspera	Obturator (anterior branch)
Abductor Brevis	Pubic Bone	Linea Aspera	Obturator (anterior branch)
Abductor Magnus	Pubic Bone	Entire Linea Aspera	Sciatic, Obturator
Tensor Faciae Latae	Iliac Crest	Iliotibial Band	Superior Gluteal
Biceps Femoris	Ischial Tuberosity, Linea Aspera	Head of Fibula, Lateral Condyle of Tibia	Sciatic-Tibial portion and Common Peroneal Portion
Semimembranosus	Ischial Tuberosity	Upper Medial Tibia	Sciatic-Tibial Portion
Semitendinosus	Ischial Tuberosity	Upper Medial Tibia	Sciatic-Tibial Portion

Musculature/Innervation Review of the Calf and Foot

Muscle	**Origin**	**Insertion**	**Nerve**
Tibialis Anterior	Upper 2/3 Lateral Tibia and Interosseous Membrane	1st Cuneiform and Base of 1st Metatarsal	Deep Peroneal
Extensor Digitorum Longus	Upper 2/3 Fibula and Interosseous	4 Tendons-Distal Middle Phalanges	Deep Peroneal

	Membrane		
Extensor Hallucis Longus	Middle 1/3 of Anterior Fibula	Base of Distal Phalanx of Big Toe	Deep Peroneal
Peroneus Tertius	Distal Fibula	Base of 5th Metatarsal	Deep Peroneal
Extensor Hallucis Brevis	Dorsal Calcaneus	Extensor Digitorum Longus Tendons	Deep Peroneal
Peroneus Longus	Upper 2/3 Lateral Fibula	1st Metatarsal and 1st Cuneiform	Superficial Peroneal
Peroneus Brevis	Lateral Distal Fibula	5th Metatarsal Tuberosity	Superficial Peroneal
Soleus	Upper Shaft of Fibula	Calcaneus via Achilles Tendon	Tibial
Flexor Digitorum Longus	Middle 1/3 of Posterior Tibia	Base of Distal Phalanx of Lateral 4 Toes	Tibial
Flexor Hallucis Longus	Middle and Lower 1/3 of Posterior Tibia	Distal Phalanx of Big Toe	Tibial
Tibialis Posterior	Posterior Upper Tibia, Fibula	Navicular Bone and 1st Cuneiform	Tibial
Popliteus	Upper Posterior Tibia	Lateral Condyle of Femur	Tibial
Flexor Digitorum Brevis	Calcaneus	Middle Phalanges of Lateral 4 Toes	Medial Plantar
Abductor Hallucis	Calcaneus	Medial Proximal Phalanx of Big Toe	Medial Plantar

Abductor Digiti Brevis	Calcaneus	Lateral Proximal Phalanx of Big Toe	Lateral Plantar
Quadratus Plantae	Lateral and Medial Side of the Calcaneus	Tendons of Flexor Digitorum Longus	Lateral Plantar
Lumbricals	Tendons of Flexor Digitorum Longus	Extensor Tendons of Toes	Medial Plantar/Lateral Plantar
Flexor Hallucis Brevis	Cuboid Bone	Splits on Base of Proximal Phalanx of Big Toe	Medial Plantar
Flexor Digiti Minimi Brevis	Base of 5th Metatarsal	Base of Proximal Phalanx of Little Toe	Lateral Plantar
Abductor Hallucis	Metatarsals 2-4	Base of Proximal Phalanx of Big Toe	Lateral Plantar
Interossei	Sides of Metatarsal Bones	Base of 1st Phalanx and Extensor Tendons	Lateral Plantar

Special Report– Basic Review of Types of Fractures

A fracture is defined as a break in a bone that may sometimes involve cartilaginous structures. A fracture can be classified according to its cause or the type of break. The following definitions are used to describe breaks.

1. Traumatic fracture – break in a bone resulting from injury
2. Spontaneous fracture – break in a bone resulting from disease
3. Pathologic fracture – another name for a spontaneous fracture
4. Compound fracture – occurs when fracture bone is exposed to the outside by an opening in the skin
5. Simple fracture - occurs when a break is contained within the skin
6. Greenstick fracture - a traumatic break that is incomplete and occurs on the convex surface of the bend in the bone
7. Fissured fracture – a traumatic break that involves an incomplete longitudinal break
8. Comminuted fracture – a traumatic break that involves a complete fracture that results in several bony fragments
9. Transverse fracture – a traumatic break that is complete and occurs at a right angle to the axis of the bone
10. Oblique fracture- a traumatic break that occurs at an angle other than a right angel to the axis of the bone.
11. Spiral fracture – a traumatic break that occurs by twisting a bone with extreme force

A compound fracture is much more dangerous than a simple break. This is due to the break in skin that can allow microorganisms to infect the injured tissue. When a fracture occurs, blood vessels within the bone and its periosteum are disrupted. The periosteum, covering of fibrous connective tissue on the surface of the bone, may also be damaged or torn.

Special Report– Quick Reference Lesion Review

Occipital Lobe	Homonymous hemianopsia, partial seizures with limited visual phenomena
Thalamus	Contralateral thalamus pain, contralateral hemisensory loss
Pineal gland	Early hydrocephalus, papillary abnormalities, Parinaud's syndrome
Internal capsule	Hemisensory loss, homonymous hemianopsia, contralateral hemiplegia
Basal ganglia	Contralateral dystonia, Contralateral choreoathetosis
Pons	Diplopia, internal strabismus, VI and VII involvement, contralateral hemisensory and hemiparesis loss, issilateral cerebellar ataxia
Broca's area	Motor dysphasia
Precentral gyrus	Jacksonian seizures, generalized seizures, hemiparesis
Superficial parietal lobe	Receptive dysphasia
Cerebellar hemisphere	Ipsilateral cerebellar ataxia with hypotonia, dysmetria, intention tremor, nystagmus to side of lesion
Midbrain	Loss of upward gaze, III involvement, ipsilateral cerebellar signs, diplopia
Angular gyrus	Finger agnosia, allochiria, agraphia, acalculia
Temporal lobe	Contralateral homonymous upper quadrantanopsia, partial complex

	seizures
Paracentral lobe	Urgency of micturition, incontinence, progressive spastic paraparesis
Third Ventricle	Hydrocephalus
Fourth Ventricle	Hydrocephalus, progressive spastic hemiparesis
Optic Chiasm	Bitemporal hemianopsia, optic atrophy
Uncus	Partial complex seizures
Superior temporal gyrus	Receptive dysphasia
Prefrontal area	Apathy, poor attention span, loss of judgement, release phenomena, distractible
Orbital surface frontal lobe	Paroxysmal atrial tachycardia
Hypothalmus	Amenorrhea, cachexia, hypopituitarism, hypothyrodism, impotence, diencephalic autonomic seizures

Special Report- Myotome and Dermatome Screening Reference

Myotome Screening Cervical	*(ASIA) Scale*
C1-2	Neck flexion/extension
C3	Lateral neck flexion
C4	Shoulder Shrug
C5	Elbow flexors
C6	Wrist extensors
C7	Triceps
T1	Finger flexion

Dermatome Screening Cervical	*(ASIA) Scale*
C4	Deltoid Region
C5	Lateral Arm
C6	Lateral Forearm
C7	Middle Finger
C8	Digits 4/5
T1	Medial forearm
T2	Axilla Region

Myotome Screening Lumbar	*(ASIA) Scale*
L2	Hip flexors
L3	Knee Extension
L4	Ankle Dorsiflexion

L5	Great Toe Extension
S1	Plantar flexion

Dermatome Screening Lumbar	*(ASIA) Scale*
L1	Groin (Lateral>Medial)
L2	Upper Anterior Thigh
L3	Lower Anterior Thigh
L4	Knee/Medial leg
L5	Lateral leg/web space
S1	Lateral ankle/foot

Special Report- High Frequency USMLE Step 1 Terms

The following terms were compiled as high frequency USMLE Step I terms. I recommend printing out this list and identifying the terms you are unfamiliar with. Then, use a medical dictionary or the internet to look up the terms you have questions about. Take one section per day if you have the time to maximize recall.

A

Acquired immunodeficiency syndrome
Acromegaly
Acute lymphoblastic leukemia
Acute myelogenous leukemia
Acute nonlymphocytic leukemia
Adenocarcinoma
Adjuvant disease
Agoraphobia
Alopecia
Alzheimer's dementia
Amebiasis
Amenorrhea
Amyloidosis
Anastomoses
Aneurysm
Angina pectoris
Angiogenesis
Anklyosing spondylitis
Anxiety
Appendicitis
Arterial disease
Arteriosclerosis
Arthralgia
Arthritis bacterial
Arthritis (Crohn's disease)
Arthritis (gouty)
Arthritis (Reiter's syndrome)
Arthritis (Rheumatoid arthritis
Atypical angina
Avascular necrosis
AZT

B

Barrett's oesophagus
Back pain (Sciatica)
Back pain (tumor)

Barlow's syndrome
Basal cell carcinoma
Behçet's disease
Benign prostate hypertrophy
Biliary disease
Bilirubin
Biliverdin
Blood cultures
Boerhaave's syndrome
Bornholm disease
Bowen's disease
Bradycardia
Braxton-Hicks contractions
Bronchiectasis
Budd-Chiari syndrome
Buerger's disease
Bulimia
Burkitt Lymphoma

C
CAD
Cancer (basal cell)
Cancer (pancreatic)
Cancer (prostate)
Cancer (squamous cell)
Candidiasis
Cardiac disease
Cardiac valvular disease
Carpal tunnel syndrome
Catecholamines
Cauda equina syndrome
Centriacinar emphysema
Charcot-Marie-Tooth disease
Chest pain
Chest x-ray
Cholecystectomy
Cholecystitis
Chondroma
Chronic lymphocytic leukemia
Chronic myelogenous leukemia
Chvostek's sign
Cirrhosis
Click-murmur syndrome
Clonidine
Coccygodynia
COLD

Colles' fracture
Combined hormone replacement
Computed tomography (CT) scan of head
Confusion
Conjunctivitis
Connective tissue disease
Conn's syndrome
Coombs' test
Cor pulmonale
Corticosteroids
CREST syndrome
Cretinism
Creutzfeldt-Jakob disease
Crohn's disease
Cushing's syndrome

D
Dactylitis
Degenerative heart disease
Dermatitis
Diabetes insipidus
Diabetes mellitus
Diabetic nephropathy
Dialysis
Diaphoresis
Dietary modification
Diffuse lymphoma
Digitalis
Dopamine
Down's syndrome
Duchenne muscular dystrophy
DVT
Dysmenorrhea
Dyspnea

E
Ecchymosis
Ectopic pregnancy
Electrocardiogram (ECG)
Embolism
Emphysema
Encephalopathy
Endocrine system
Epinephrine
Epstein-Barr virus

Erythropoietien
Erythema nodosum
Esophagitis
Ewing's sarcoma
Exophthalmos

F
Fabry's disease
Fallopian tube
Fallot's tetralogy
Fanconi's syndrome
Fatigue
Fecal incontinence
Fibrillation
Fibromyalgia syndrome
Fibrous ankylosis
Follicle-stimulating hormone
Fuch's corneal dystrophy
Full blood count (FBC)
Functional dyspepsia

G
Gamma globulin
Gangrene
Gaucher's disease
Gestatoin
Giant cell tumor
Gilbert's syndrome
Gliosis
Glucagon
Glucose tolerance test
Goodpasture's syndrome
Graves disease
Guillai-Barre' syndrome
Gynecomastia

H
Haemochromatosis
Hand-foot syndrome
Hashimoto's thyroiditis
Hartmann's solution
Heart failure
Heart rate
Helper T cells
Hemarthrosis

Hematuria
Hemophilia
Hemorrhage
Henoch-Schönlein syndrome
Heparin
Hepatic encephalopathy
Hepatitis (A-E)
Herpes zoster
Hiatal hernia
Hirschsprung's disease
HIV
Hodgkin's disease
Homans sign
Homocystinuria
Hormone replacement therapy
Huntington's chorea
Hurler's syndrome
Hunter's syndrome
Hyalinization
Hypercortisolism
Hyperglycemia
Hyperplasia
Hyperparathyroidism
Hypnotic preparations
Hypochromia
Hyponatremia
Hypothyroidism
Hypoxia
Hysterectomy

I

IBD Inflammatory bowel disease
IBS Irritable bowel syndrome
Immune serum globulin
Immunoglobulins (IgE, IgG, IgM)
Inderal
Induration
Infectious arthritis
Inflammatory bowel disease
Inhibitors
Interferon
Interleukin (I), (II)
Interstitial cystitis
Intramedullary tumors
Iridocyclitis

Ischemic Heart Disease
Isographs
Isotonic solution

J
Jaundice
Joint pain (gout)
Joint pain (psoriatic arthritis)
Joint sepsis
Jevenile rheumatoid arthritis

K
Kaposi's sarcoma
Kawasaki disease
Kehr's sign
Kernicterus
Ketoacidosis
Kidney failure
Kidney stones
Kleihauer test
Korsakoff's psychosis
Krabbe's disease
Kreim test
Kupffer's cells
Kussmaul's respirations

L
Labile hypertension
Lactation
Large cell carcinoma
Lesch-Nyhan syndrome
Leukemias
Leukopenia
Lewy body dementia
Lhermitte's sign
Lipoproteins
Lobar pneumonia
Low back pain
Low density lipoprotein
Lumbar pain
Lupus carditis
Lupus erythematosus
Lyme disease
Lymph nodes
Lymphocyctes

Lymphoid cells
Lymphotoxin

M
Macrophages
Malignant melanoma
Mallory-Weiss tear
Mantoux test
Marie-Strumpell disease
Mastodynia
Meckel's diverticulum
Medial cartilage tear
Melanoma
Menarche
Ménière's disease
Menorrhagia
Metabolic acidosis
Metabolic alkalosis
Metabolism
Metaplasia
Mid-stream specimen of urine
Mineral supplements
Mitral valve prolapse
Monocytes
Morpheamultiple myeloma
Multiple sclerosis
Munchausen's syndrome
Myalgias
Myopathy

N
Neck pain
Neomycin
Neoplasms
Neoplastic disease
Neurogenic back pain
Neurologic disorders
Neurotransmitters
Niemann-Pick disease
Night sweats
Nitrates
Nitroglycerin
Nocturnal angina
Non-Hodgkin's lymphoma
Norepinephrine
Nystagmus

O
Oat cell carcinoma
Obstipation
Ochronosis
Oliguria
Oncogenesis
Oophorectomy
Orthostatic hypotension
Osteitis deformans
Osteoarthritis
Osteoblastoma
Osteochondroma
Osteomyelitis
Osteopenia
Osteoporosis
Overlap syndrome

P
Paget's disease
Pain–joint
Pain-sources
Palmar erythema
Palpitations
Pancoast's tumors
Pancreatic carcinoma
Pancreatitis
Papilledema
Parathyroid hormone
Paraneoplastic syndromes
Paresthesia
Parkinson's disease
Paroxysmal
Pelvic inflammatory disease (PID)
Periarthritis
Pericarditis
Peripheral arterial disease
Perthes disease
Phagocytosis
Phrenic nerve
Pick's disease
Plasma cell myeloma
Pleural pain
Pneumonia
Polycythemia
Polyneuropathy

Polyuria
Posttraumatic stress disorder
Pregnancy
Prinzmetal's angina
Pruritus
Psoriatic arthropathy
Psychological support
Pulmonary edema
Purpura
Pyoderma
Pyrophosphate arthropathy

Q
Quadriceps

R
RA- Rheumatoid arthritis
Radiograph
Raynaud's disease
Reactive arthritis
Rectocele
Referred pain
Reidel's thyroiditis
Reiter's syndrome
Relaxin
Renal failure
Renal tuberculosis
Respiration
Reticuloendothelial
Retrovirus
Rheumatic chorea
Rheumatic fever
Rickets
Right ventricular failure

S
Sacral pain
Sacroilitis
Salpingitis
Sarcoma
Satiety
Sciatica
Scleroderma
Serotonin
Serum cholesterol

Serum urea and electrolytes concentration
Sengstaken-Blakemore tube
Sex hormones
Shoulder pain
Sickle cell anemia
Sinus bradycardia
Sinus tachycardia
Sjogren's syndrome
SLE- systemic lupu erythematosus
Smoking
Spastic colitis
Spondylotic
Stem cells
Stool culture
Stokes-Adams attacks
Swan-Ganz catheter
Syndesmophyte
Synovitis
Systemic disease
Systolic rate

T
T4 cell count
Takayasu disease
Tay-Sachs disease
T lymphocytes
Tendinitis
Tenesmus
Testosterone
Thoracic aneurysms
Thrombin
Thrombosis
Thyroid function tests
Thyroid gland
Tietze's syndrome
Tissue necrosis
Toxins
Tourette syndrome
Tracheal pain
Transfer factor
Trauma
Tuberculosis
Tumor-benign
Tumor-metastatic
Tumor markers
Turner syndrome

U
Ulceration
Ultrasound abdomen
Umbilical pain
Ureter obstruction
Urethritis
Urinary bladder
Urinary tract infection
Urogilinogen
Urologic pain
Urticaria
UTI
Uveitis

V
Vaginal bleeding
Vaginal lubricant
Vaginal oestrogen therapy
Vascular disorders
Venous insufficiency
Ventricular failure
Vertebral osteomyelitis
Vertigo
Visceral back pain
Visceral pericardium
Vital signs
Vomiting
Von Willebrand's disease

W
Weight gain
Wenckebach phenomenon
Wernicke's encephalopathy
Wet pleurisy
Wilson's disease
Wolff-Parkinson-White syndrome
Wright-Schober test

Special Report: What Your Test Score Will Tell You About Your IQ

Did you know that most standardized tests correlate very strongly with IQ? In fact, your general intelligence is a better predictor of your success than any other factor, and most tests intentionally measure this trait to some degree to ensure that those selected by the test are truly qualified for the test's purposes.

Before we can delve into the relation between your test score and IQ, I will first have to explain what exactly is IQ. Here's the formula:

Your IQ = 100 + (Number of standard deviations below or above the average)*15

Now, let's define standard deviations by using an example. If we have 5 people with 5 different heights, then first we calculate the average. Let's say the average was 65 inches. The standard deviation is the "average distance" away from the average of each of the members. It is a direct measure of variability - if the 5 people included Jackie Chan and Shaquille O'Neal, obviously there's a lot more variability in that group than a group of 5 sisters who are all within 6 inches in height of each other. The standard deviation uses a number to characterize the average range of difference within a group.

A convenient feature of most groups is that they have a "normal" distribution-makes sense that most things would be normal, right? Without getting into a bunch of statistical mumbo-jumbo, you just need to know that if you know the average of the group and the standard deviation, you can successfully predict someone's percentile rank in the group.

Confused? Let me give you an example. If instead of 5 people's heights, we had 100 people, we could figure out their rank in height JUST by knowing the

average, standard deviation, and their height. We wouldn't need to know each person's height and manually rank them, we could just predict their rank based on three numbers.

What this means is that you can take your PERCENTILE rank that is often given with your test and relate this to your RELATIVE IQ of people taking the test - that is, your IQ relative to the people taking the test. Obviously, there's no way to know your actual IQ because the people taking a standardized test are usually not very good samples of the general population- many of those with extremely low IQ's never achieve a level of success or competency necessary to complete a typical standardized test. In fact, professional psychologists who measure IQ actually have to use non-written tests that can fairly measure the IQ of those not able to complete a traditional test.

The bottom line is to not take your test score too seriously, but it is fun to compute your "relative IQ" among the people who took the test with you. I've done the calculations below. Just look up your percentile rank in the left and then you'll see your "relative IQ" for your test in the right hand column-

Percentile Rank	Your Relative IQ		Percentile Rank	Your Relative IQ
99	135		59	103
98	131		58	103
97	128		57	103
96	126		56	102
95	125		55	102
94	123		54	102
93	122		53	101
92	121		52	101
91	120		51	100
90	119		50	100
89	118		49	100
88	118		48	99
87	117		47	99
86	116		46	98
85	116		45	98
84	115		44	98

83	114		43	97
82	114		42	97
81	113		41	97
80	113		40	96
79	112		39	96
78	112		38	95
77	111		37	95
76	111		36	95
75	110		35	94
74	110		34	94
73	109		33	93
72	109		32	93
71	108		31	93
70	108		30	92
69	107		29	92
68	107		28	91
67	107		27	91
66	106		26	90
65	106		25	90
64	105		24	89
63	105		23	89
62	105		22	88
61	104		21	88
60	104		20	87

Special Report: Retaking the Test: What Are Your Chances at Improving Your Score?

After going through the experience of taking a major test, many test takers feel that once is enough. The test usually comes during a period of transition in the test taker's life, and taking the test is only one of a series of important events. With so many distractions and conflicting recommendations, it may be difficult for a test taker to rationally determine whether or not he should retake the test after viewing his scores.

The importance of the test usually only adds to the burden of the retake decision. However, don't be swayed by emotion. There a few simple questions that you can ask yourself to guide you as you try to determine whether a retake would improve your score:

1. What went wrong? Why wasn't your score what you expected?

Can you point to a single factor or problem that you feel caused the low score? Were you sick on test day? Was there an emotional upheaval in your life that caused a distraction? Were you late for the test or not able to use the full time allotment? If you can point to any of these specific, individual problems, then a retake should definitely be considered.

2. Is there enough time to improve?

Many problems that may show up in your score report may take a lot of time for improvement. A deficiency in a particular math skill may require weeks or months of tutoring and studying to improve. If you have enough time to improve an identified weakness, then a retake should definitely be considered.

3. How will additional scores be used? Will a score average, highest score, or most recent score be used?

Different test scores may be handled completely differently. If you've taken the test multiple times, sometimes your highest score is used, sometimes your average score is computed and used, and sometimes your most recent score is used. Make sure you understand what method will be used to evaluate your scores, and use that to help you determine whether a retake should be considered.

4. Are my practice test scores significantly higher than my actual test score?

If you have taken a lot of practice tests and are consistently scoring at a much higher level than your actual test score, then you should consider a retake. However, if you've taken five practice tests and only one of your scores was higher than your actual test score, or if your practice test scores were only slightly higher than your actual test score, then it is unlikely that you will significantly increase your score.

5. Do I need perfect scores or will I be able to live with this score? Will this score still allow me to follow my dreams?

What kind of score is acceptable to you? Is your current score "good enough?" Do you have to have a certain score in order to pursue the future of your dreams? If you won't be happy with your current score, and there's no way that you could live with it, then you should consider a retake. However, don't get your hopes up. If you are looking for significant improvement, that may or may not be possible. But if you won't be happy otherwise, it is at least worth the effort.

Remember that there are other considerations. To achieve your dream, it is likely that your grades may also be taken into account. A great test score is usually not the only thing necessary to succeed. Make sure that you aren't overemphasizing the importance of a high test score.

Furthermore, a retake does not always result in a higher score. Some test takers will score lower on a retake, rather than higher. One study shows that one-fourth of test takers will achieve a significant improvement in test score, while one-sixth of test takers will actually show a decrease. While this shows that most test takers will improve, the majority will only improve their scores a little and a retake may not be worth the test taker's effort.

Finally, if a test is taken only once and is considered in the added context of good grades on the part of a test taker, the person reviewing the grades and scores may be tempted to assume that the test taker just had a bad day while taking the test, and may discount the low test score in favor of the high grades. But if the test is retaken and the scores are approximately the same, then the validity of the low scores are only confirmed. Therefore, a retake could actually hurt a test taker by definitely bracketing a test taker's score ability to a limited range.

Special Report: What is Test Anxiety and How to Overcome It?

The very nature of tests caters to some level of anxiety, nervousness or tension, just as we feel for any important event that occurs in our lives. A little bit of anxiety or nervousness can be a good thing. It helps us with motivation, and makes achievement just that much sweeter. However, too much anxiety can be a problem; especially if it hinders our ability to function and perform.

"Test anxiety," is the term that refers to the emotional reactions that some test-takers experience when faced with a test or exam. Having a fear of testing and exams is based upon a rational fear, since the test-taker's performance can shape the course of an academic career. Nevertheless, experiencing excessive fear of examinations will only interfere with the test-takers ability to perform, and his/her chances to be successful.

There are a large variety of causes that can contribute to the development and sensation of test anxiety. These include, but are not limited to lack of performance and worrying about issues surrounding the test.

Lack of Preparation

Lack of preparation can be identified by the following behaviors or situations:

Not scheduling enough time to study, and therefore cramming the night before the test or exam
Managing time poorly, to create the sensation that there is not enough time to do everything
Failing to organize the text information in advance, so that the study material consists of the entire text and not simply the pertinent information

Poor overall studying habits

Worrying, on the other hand, can be related to both the test taker, or many other factors around him/her that will be affected by the results of the test. These include worrying about:

Previous performances on similar exams, or exams in general
How friends and other students are achieving
The negative consequences that will result from a poor grade or failure

There are three primary elements to test anxiety. Physical components, which involve the same typical bodily reactions as those to acute anxiety (to be discussed below). Emotional factors have to do with fear or panic. Mental or cognitive issues concerning attention spans and memory abilities.

Physical Signals

There are many different symptoms of test anxiety, and these are not limited to mental and emotional strain. Frequently there are a range of physical signals that will let a test taker know that he/she is suffering from test anxiety. These bodily changes can include the following:

Perspiring
Sweaty palms
Wet, trembling hands
Nausea
Dry mouth
A knot in the stomach
Headache
Faintness
Muscle tension

Aching shoulders, back and neck
Rapid heart beat
Feeling too hot/cold

To recognize the sensation of test anxiety, a test-taker should monitor him/herself for the following sensations:

The physical distress symptoms as listed above
Emotional sensitivity, expressing emotional feelings such as the need to cry or laugh too much, or a sensation of anger or helplessness
A decreased ability to think, causing the test-taker to blank out or have racing thoughts that are hard to organize or control.

Though most students will feel some level of anxiety when faced with a test or exam, the majority can cope with that anxiety and maintain it at a manageable level. However, those who cannot are faced with a very real and very serious condition, which can and should be controlled for the immeasurable benefit of this sufferer.

Naturally, these sensations lead to negative results for the testing experience. The most common effects of test anxiety have to do with nervousness and mental blocking.

Nervousness

Nervousness can appear in several different levels:

The test-taker's difficulty, or even inability to read and understand the questions on the test
The difficulty or inability to organize thoughts to a coherent form

The difficulty or inability to recall key words and concepts relating to the testing questions (especially essays)
The receipt of poor grades on a test, though the test material was well known by the test taker

Conversely, a person may also experience mental blocking, which involves:

Blanking out on test questions
Only remembering the correct answers to the questions when the test has already finished.

Fortunately for test anxiety sufferers, beating these feelings, to a large degree, has to do with proper preparation. When a test taker has a feeling of preparedness, then anxiety will be dramatically lessened.

The first step to resolving anxiety issues is to distinguish which of the two types of anxiety are being suffered. If the anxiety is a direct result of a lack of preparation, this should be considered a normal reaction, and the anxiety level (as opposed to the test results) shouldn't be anything to worry about. However, if, when adequately prepared, the test-taker still panics, blanks out, or seems to overreact, this is not a fully rational reaction. While this can be considered normal too, there are many ways to combat and overcome these effects.

Remember that anxiety cannot be entirely eliminated, however, there are ways to minimize it, to make the anxiety easier to manage. Preparation is one of the best ways to minimize test anxiety. Therefore the following techniques are wise in order to best fight off any anxiety that may want to build.

To begin with, try to avoid cramming before a test, whenever it is possible. By trying to memorize an entire term's worth of information in one day, you'll be shocking your system, and not giving yourself a very good chance to absorb the information. This is an easy path to anxiety, so for those who suffer from test anxiety, cramming should not even be considered an option.

Instead of cramming, work throughout the semester to combine all of the material which is presented throughout the semester, and work on it gradually as the course goes by, making sure to master the main concepts first, leaving minor details for a week or so before the test.

To study for the upcoming exam, be sure to pose questions that may be on the examination, to gauge the ability to answer them by integrating the ideas from your texts, notes and lectures, as well as any supplementary readings.

If it is truly impossible to cover all of the information that was covered in that particular term, concentrate on the most important portions, that can be covered very well. Learn these concepts as best as possible, so that when the test comes, a goal can be made to use these concepts as presentations of your knowledge.

In addition to study habits, changes in attitude are critical to beating a struggle with test anxiety. In fact, an improvement of the perspective over the entire test-taking experience can actually help a test taker to enjoy studying and therefore improve the overall experience. Be certain not to overemphasize the significance of the grade - know that the result of the test is neither a reflection of self worth, nor is it a measure of intelligence; one grade will not predict a person's future success.

To improve an overall testing outlook, the following steps should be tried:

Keeping in mind that the most reasonable expectation for taking a test is to expect to try to demonstrate as much of what you know as you possibly can. Reminding ourselves that a test is only one test; this is not the only one, and there will be others.
The thought of thinking of oneself in an irrational, all-or-nothing term should be avoided at all costs.
A reward should be designated for after the test, so there's something to look forward to. Whether it be going to a movie, going out to eat, or simply visiting friends, schedule it in advance, and do it no matter what result is expected on the exam.

Test-takers should also keep in mind that the basics are some of the most important things, even beyond anti-anxiety techniques and studying. Never neglect the basic social, emotional and biological needs, in order to try to absorb information. In order to best achieve, these three factors must be held as just as important as the studying itself.

Study Steps

Remember the following important steps for studying:

Maintain healthy nutrition and exercise habits. Continue both your recreational activities and social pass times. These both contribute to your physical and emotional well being.
Be certain to get a good amount of sleep, especially the night before the test, because when you're overtired you are not able to perform to the best of your best ability.
Keep the studying pace to a moderate level by taking breaks when they are needed, and varying the work whenever possible, to keep the mind fresh instead of getting bored.

When enough studying has been done that all the material that can be learned has been learned, and the test taker is prepared for the test, stop studying and do something relaxing such as listening to music, watching a movie, or taking a warm bubble bath.

There are also many other techniques to minimize the uneasiness or apprehension that is experienced along with test anxiety before, during, or even after the examination. In fact, there are a great deal of things that can be done to stop anxiety from interfering with lifestyle and performance. Again, remember that anxiety will not be eliminated entirely, and it shouldn't be. Otherwise that "up" feeling for exams would not exist, and most of us depend on that sensation to perform better than usual. However, this anxiety has to be at a level that is manageable.

Of course, as we have just discussed, being prepared for the exam is half the battle right away. Attending all classes, finding out what knowledge will be expected on the exam, and knowing the exam schedules are easy steps to lowering anxiety. Keeping up with work will remove the need to cram, and efficient study habits will eliminate wasted time. Studying should be done in an ideal location for concentration, so that it is simple to become interested in the material and give it complete attention. A method such as SQ3R (Survey, Question, Read, Recite, Review) is a wonderful key to follow to make sure that the study habits are as effective as possible, especially in the case of learning from a textbook. Flashcards are great techniques for memorization. Learning to take good notes will mean that notes will be full of useful information, so that less sifting will need to be done to seek out what is pertinent for studying. Reviewing notes after class and then again on occasion will keep the information fresh in the mind. From notes that have been taken summary sheets and outlines can be made for simpler reviewing.

A study group can also be a very motivational and helpful place to study, as there will be a sharing of ideas, all of the minds can work together, to make sure that everyone understands, and the studying will be made more interesting because it will be a social occasion.

Basically, though, as long as the test-taker remains organized and self confident, with efficient study habits, less time will need to be spent studying, and higher grades will be achieved.

To become self confident, there are many useful steps. The first of these is "self talk." It has been shown through extensive research, that self-talk for students who suffer from test anxiety, should be well monitored, in order to make sure that it contributes to self confidence as opposed to sinking the student. Frequently the self talk of test-anxious students is negative or self-defeating, thinking that everyone else is smarter and faster, that they always mess up, and that if they don't do well, they'll fail the entire course. It is important to decreasing anxiety that awareness is made of self talk. Try writing any negative self thoughts and then disputing them with a positive statement instead. Begin self-encouragement as though it was a friend speaking. Repeat positive statements to help reprogram the mind to believing in successes instead of failures.

Helpful Techniques

Other extremely helpful techniques include:

Self-visualization of doing well and reaching goals
While aiming for an "A" level of understanding, don't try to "overprotect" by setting your expectations lower. This will only convince the mind to stop studying in order to meet the lower expectations.

Don't make comparisons with the results or habits of other students. These are individual factors, and different things work for different people, causing different results.
Strive to become an expert in learning what works well, and what can be done in order to improve. Consider collecting this data in a journal.
Create rewards for after studying instead of doing things before studying that will only turn into avoidance behaviors.
Make a practice of relaxing - by using methods such as progressive relaxation, self-hypnosis, guided imagery, etc - in order to make relaxation an automatic sensation.
Work on creating a state of relaxed concentration so that concentrating will take on the focus of the mind, so that none will be wasted on worrying.
Take good care of the physical self by eating well and getting enough sleep. Plan in time for exercise and stick to this plan.

Beyond these techniques, there are other methods to be used before, during and after the test that will help the test-taker perform well in addition to overcoming anxiety.

Before the exam comes the academic preparation. This involves establishing a study schedule and beginning at least one week before the actual date of the test. By doing this, the anxiety of not having enough time to study for the test will be automatically eliminated. Moreover, this will make the studying a much more effective experience, ensuring that the learning will be an easier process. This relieves much undue pressure on the test-taker.

Summary sheets, note cards, and flash cards with the main concepts and examples of these main concepts should be prepared in advance of the actual studying time. A topic should never be eliminated from this process. By omitting a topic because it isn't expected to be on the test is only setting up the test-taker for anxiety should it actually appear on the exam. Utilize the

course syllabus for laying out the topics that should be studied. Carefully go over the notes that were made in class, paying special attention to any of the issues that the professor took special care to emphasize while lecturing in class. In the textbooks, use the chapter review, or if possible, the chapter tests, to begin your review.

It may even be possible to ask the instructor what information will be covered on the exam, or what the format of the exam will be (for example, multiple choice, essay, free form, true-false). Additionally, see if it is possible to find out how many questions will be on the test. If a review sheet or sample test has been offered by the professor, make good use of it, above anything else, for the preparation for the test. Another great resource for getting to know the examination is reviewing tests from previous semesters. Use these tests to review, and aim to achieve a 100% score on each of the possible topics. With a few exceptions, the goal that you set for yourself is the highest one that you will reach.

Take all of the questions that were assigned as homework, and rework them to any other possible course material. The more problems reworked, the more skill and confidence will form as a result. When forming the solution to a problem, write out each of the steps. Don't simply do head work. By doing as many steps on paper as possible, much clarification and therefore confidence will be formed. Do this with as many homework problems as possible, before checking the answers. By checking the answer after each problem, a reinforcement will exist, that will not be on the exam. Study situations should be as exam-like as possible, to prime the test-taker's system for the experience. By waiting to check the answers at the end, a psychological advantage will be formed, to decrease the stress factor.

Another fantastic reason for not cramming is the avoidance of confusion in concepts, especially when it comes to mathematics. 8-10 hours of study will

become one hundred percent more effective if it is spread out over a week or at least several days, instead of doing it all in one sitting. Recognize that the human brain requires time in order to assimilate new material, so frequent breaks and a span of study time over several days will be much more beneficial.

Additionally, don't study right up until the point of the exam. Studying should stop a minimum of one hour before the exam begins. This allows the brain to rest and put things in their proper order. This will also provide the time to become as relaxed as possible when going into the examination room. The test-taker will also have time to eat well and eat sensibly. Know that the brain needs food as much as the rest of the body. With enough food and enough sleep, as well as a relaxed attitude, the body and the mind are primed for success.

Avoid any anxious classmates who are talking about the exam. These students only spread anxiety, and are not worth sharing the anxious sentimentalities.

Before the test also involves creating a positive attitude, so mental preparation should also be a point of concentration. There are many keys to creating a positive attitude. Should fears become rushing in, make a visualization of taking the exam, doing well, and seeing an A written on the paper. Write out a list of affirmations that will bring a feeling of confidence, such as "I am doing well in my English class," "I studied well and know my material," "I enjoy this class." Even if the affirmations aren't believed at first, it sends a positive message to the subconscious which will result in an alteration of the overall belief system, which is the system that creates reality.

If a sensation of panic begins, work with the fear and imagine the very worst! Work through the entire scenario of not passing the test, failing the entire

course, and dropping out of school, followed by not getting a job, and pushing a shopping cart through the dark alley where you'll live. This will place things into perspective! Then, practice deep breathing and create a visualization of the opposite situation - achieving an "A" on the exam, passing the entire course, receiving the degree at a graduation ceremony.

On the day of the test, there are many things to be done to ensure the best results, as well as the most calm outlook. The following stages are suggested in order to maximize test-taking potential:

Begin the examination day with a moderate breakfast, and avoid any coffee or beverages with caffeine if the test taker is prone to jitters. Even people who are used to managing caffeine can feel jittery or light-headed when it is taken on a test day.

Attempt to do something that is relaxing before the examination begins. As last minute cramming clouds the mastering of overall concepts, it is better to use this time to create a calming outlook.

Be certain to arrive at the test location well in advance, in order to provide time to select a location that is away from doors, windows and other distractions, as well as giving enough time to relax before the test begins.

Keep away from anxiety generating classmates who will upset the sensation of stability and relaxation that is being attempted before the exam.

Should the waiting period before the exam begins cause anxiety, create a self-distraction by reading a light magazine or something else that is relaxing and simple.

During the exam itself, read the entire exam from beginning to end, and find out how much time should be allotted to each individual problem. Once writing the exam, should more time be taken for a problem, it should be abandoned, in order to begin another problem. If there is time at the end, the unfinished problem can always be returned to and completed.

Read the instructions very carefully - twice - so that unpleasant surprises won't follow during or after the exam has ended.

When writing the exam, pretend that the situation is actually simply the completion of homework within a library, or at home. This will assist in forming a relaxed atmosphere, and will allow the brain extra focus for the complex thinking function.

Begin the exam with all of the questions with which the most confidence is felt. This will build the confidence level regarding the entire exam and will begin a quality momentum. This will also create encouragement for trying the problems where uncertainty resides.

Going with the "gut instinct" is always the way to go when solving a problem. Second guessing should be avoided at all costs. Have confidence in the ability to do well.

For essay questions, create an outline in advance that will keep the mind organized and make certain that all of the points are remembered. For multiple choice, read every answer, even if the correct one has been spotted - a better one may exist.

Continue at a pace that is reasonable and not rushed, in order to be able to work carefully. Provide enough time to go over the answers at the end, to check for small errors that can be corrected.

Should a feeling of panic begin, breathe deeply, and think of the feeling of the body releasing sand through its pores. Visualize a calm, peaceful place, and include all of the sights, sounds and sensations of this image. Continue the

deep breathing, and take a few minutes to continue this with closed eyes. When all is well again, return to the test.

If a “blanking” occurs for a certain question, skip it and move on to the next question. There will be time to return to the other question later. Get everything done that can be done, first, to guarantee all the grades that can be compiled, and to build all of the confidence possible. Then return to the weaker questions to build the marks from there.

Remember, one’s own reality can be created, so as long as the belief is there, success will follow. And remember: anxiety can happen later, right now, there’s an exam to be written!

After the examination is complete, whether there is a feeling for a good grade or a bad grade, don’t dwell on the exam, and be certain to follow through on the reward that was promised…and enjoy it! Don’t dwell on any mistakes that have been made, as there is nothing that can be done at this point anyway.

Additionally, don’t begin to study for the next test right away. Do something relaxing for a while, and let the mind relax and prepare itself to begin absorbing information again.

From the results of the exam - both the grade and the entire experience, be certain to learn from what has gone on. Perfect studying habits and work some more on confidence in order to make the next examination experience even better than the last one.

Learn to avoid places where openings occurred for laziness, procrastination and day dreaming.

Use the time between this exam and the next one to better learn to relax, even learning to relax on cue, so that any anxiety can be controlled during the next exam. Learn how to relax the body. Slouch in your chair if that helps. Tighten and then relax all of the different muscle groups, one group at a time, beginning with the feet and then working all the way up to the neck and face. This will ultimately relax the muscles more than they were to begin with. Learn how to breath deeply and comfortably, and focus on this breathing going in and out as a relaxing thought. With every exhale, repeat the word "relax."

As common as test anxiety is, it is very possible to overcome it. Make yourself one of the test-takers who overcome this frustrating hindrance.

Special Report: Additional Bonus Material

Due to our efforts to try to keep this book to a manageable length, we've created a link that will give you access to all of your additional bonus material.

Please visit http://www.mo-media.com/usmle/bonuses to access the information.