Sierra College Biological Sciences Department

Biological Sciences 4

MICROBIOLOGY
STUDY GUIDE

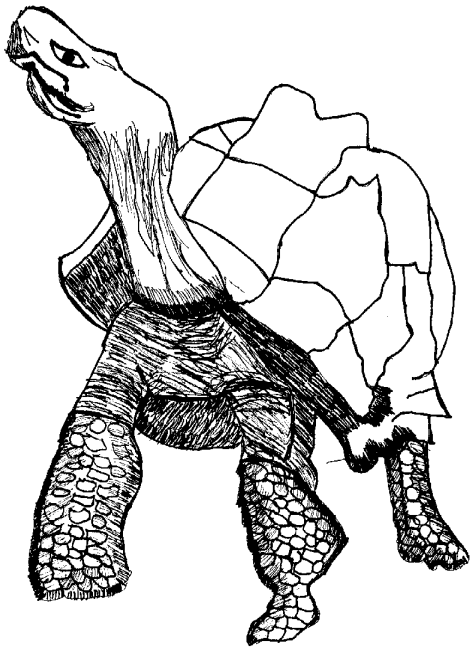
STUDYING

MICROBIOLOGY

TAKES

TIME AND

EFFORT !



Instructor: Harriet Wilson

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Microbiology Study Guide

Sierra College Biological Sciences Department
Bio. Sci. 4

The questions included in this study guide are **representative** of those found on quizzes and exams given in the microbiology course provided by Harriet Wilson. For your convenience, the sample lecture questions (from quizzes and exams) have been divided into sets according to the topics indicated on your lecture schedule. Four sample lab exams (two for lab exam #1 and two for lab exam #2) are also included. Most duplicate questions have been eliminated; however, some questions containing different wording but requiring the same answers are included.

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History of Microbiology:

(5) 1. Define:

Microbiology

Abiogenesis

Koch's postulates

Etiological (etiologic)

"Magic bullet"

(1) 2. Microorganisms were being used by humans long before they were observed or recognized to exist. What were they used for?

(2) 3. _____ may be defined as the science or study of living organisms too small to be observed with the naked eye. What types of organisms fall into this category, i.e., what groups of organisms would be identified as microbes?

(2) 4. _____ is sometimes credited with being the founder of microbiology because he was the first to observe living microbes and because he documented his findings. However, microbiology could not become a true science until the theory of _____ was shown to be invalid.

(2) 5. Anton Van Leeuwenhoek is sometimes referred to as the "father of microbiology". What did he do to receive this recognition?

(2) 6. The theory of _____ or the spontaneous generation of living organisms was shown to be invalid at the macroscopic level by Francesco Redi (working with flies on meat). This long accepted theory was disproved at the microscopic level by several investigators including Lazzaro Spallanzani and _____.

(2) 7. Two individuals given credit for disproving the theory of abiogenesis at the microscopic level are _____ and _____.

(2) 8. While working as a chemist for the French wine industry, Louis Pasteur discovered that microorganisms were responsible for the _____ process (converting grape juice into ethanol or other substances). Pasteur also developed a heat treatment that could be used to control the populations of microbes within juice without

destroying the flavor. This treatment is called _____ and is still used to control microorganisms in food materials today.

(2) 9. _____ was an English surgeon recognized for developing and using aseptic or antiseptic techniques in his surgical procedures. What methods did he use?

(1) 10. What was the significance of Koch's postulates at the time they were developed?

(1) 11. If an investigator were using Koch's postulates to identify an etiological agent, and the microbe had been isolated and grown in pure form, what would be the <u>next</u> step in the investigation?

(1) 12. What important contribution did Richard Petri make to the study of microbiology?

(1) 13. Louis Pasteur is credited with being the first microbiologist to use attenuated microbial cultures to prevent disease in humans. Pasteur used the term _____ to identify such cultures, thus relating his work to that of Edward Jenner.

(2) 14. By the late 1800s it was recognized that microorganisms were responsible for causing a variety of diseases. The work of Jenner and Pasteur indicated that microorganisms could also be used to _____ disease, and later investigations conducted by Alexander Fleming showed that the products of microorganisms could be used to _____ disease.

(1) 15. What contribution did Fanny Hess make to the science of microbiology?

(1) 16. _____ coined the term "magic bullet" in reference to chemicals that could be taken internally to kill disease causing microorganisms without doing damage to the body.

<u>Characteristics of Life and Biochemistry:</u>

(5) 1. Define:

Assimilation

Protoplasm

Electrolyte

Polysaccharide

Triglyceride

(2) 2. Two characteristics that all living organisms have in common are the ability to _____ and _____.

(2) 3. All living organisms are able to reproduce, grow via a process called _____, carry out metabolic processes, respond to stimuli, _____ and maintain a high degree of organization.

(1) 4. _____ is the name given to the living dynamic material that all cells are made of. This material is sometimes referred to as the chemical and physical basis for life.

(1) 5. The thirteen elements that make up about 99% of any living organism (by weight) are: _____ _____ (Chemical symbols are adequate here.)

(1) 6. Positively charged particles of matter (may be atoms or molecules) are known as _____.

(1) 7. Negatively charged particles of matter (may be atoms or molecules) are known as _____.

(1) 8. An inorganic compound that aids transport, helps maintain cell size and shape, resists temperature change and serves as an important solvent within living cells is _____.

(2) 9. Chemical reactions that involve the splitting of water and the splitting of organic compounds may be referred to as _____ reactions. When small organic monomers are joined together by removing water molecules, the reactions involved may be called _____ reactions.

(3) 10. Organic compounds referred to as _____ contain carbon, hydrogen and oxygen and serve as an important source of energy and carbon for living organisms. If these compounds contain six carbons, are sweet to the taste and soluble in water they are called _____ if they are macromolecules containing many sugar units, do not taste sweet and are insoluble in water they are referred to as _____.

(1) 11. Carbohydrates such as arabinose, ribose and deoxyribose contain five carbon atoms and are referred to as _____.

(2) 12. Sucrose, lactose and maltose are examples of carbohydrates known as _____, while starch, glycogen, cellulose and agar are examples of carbohydrates known as _____ because they are made up of many sugar units.

(2) 13. The primary structure of a protein is determined by the sequence of _____ present in that protein. If a protein contains more than one polypeptide chain, it is said to have _____ structure.

(1) 14. The formation of a protein molecule involves the removal of _____ molecules (condensation or dehydration synthesis) and the formation of covalent bonds called _____ bonds between adjacent amino acids. A long chain of amino acids may also be called a polypeptide.

(1) 15. Lipids that contain three fatty acid chains attached to a glycerol "backbone" are called _____.

(2) 16. Lipids that contain the maximum number of hydrogen atoms possible are referred to as _____ fats and tend to be solid at room temperature. Those that contain one or more _____ have fewer hydrogen atoms and tend to be liquid at room temperature.

(2) 17. Lipids that contain two fatty acid chains and a phosphate group attached to a glycerol "backbone" are referred to as _____. These molecules have both polar (hydrophilic) and non-polar (hydrophobic) parts in their structure, and so are said to be _____.

(2) 18. Nucleotides are small organic compounds that serve as the "building blocks" for long chain molecules known as _____. Explain two <u>other</u> functions of nucleotides.

(3) 19. The nucleic acids, DNA and RNA are long chain molecules made up of smaller units called _____. These small units are also important to cell function in that they serve as chemical messengers and as _____ essential to metabolism. They may also take on extra phosphate groups to become high energy compounds, e.g., _____.

(5) 20. Matching - Important compounds: Match the terms on the left with the most appropriate statements on the right and place the letters of correct matches in the blanks provided.

____ Monosaccharides	A. Used to make high energy compounds, coenzymes and chemical messengers.
____ Nucleic acids	B. Composed of three polysaccharide chains attached to a glycerol "backbone".
____ Proteins	C. Amphipathic (amphiphilic) molecules associated with cell membranes.
____ Polysaccharides	D. Two or more polypeptide chains coming together to form a single protein.
____ Disaccharides	E. Glucose, fructose, galactose, ribose, arabinose, and deoxyribose.
____ Nucleotides	F. Composed of three fatty acid chains attached to a glycerol "backbone".
____ Phospholipids	G. Long chain molecules made up of amino acids connected by peptide bonds.
____ Anions	H. Positively charged particle of matter.
	I. Lactose, sucrose and maltose
____ Quaternary structure	J. Negatively charged particle of matter.

K. Glycogen, cellulose, chitin and starch.

____ Triglycerides

L. Made up of many nucleotides joined together by phosphodiester bonds.

Cell Membrane Structure and Function:

(5) 1. Define:

Plasma membrane

Amphipathic (amphiphilic)

Diffusion

Exocytosis

Phototaxis

(3) 2. The living dynamic layer that surrounds and limits a cell is called the _____, and is so thin that it is not visible with a light microscope. According to the currently accepted model, the chemical composition of this structure includes about 50% _____ and 50% _____.

(3) 3. Proteins that extend through the cell membrane (contact the surface on both sides) are called _____ proteins and may serve a variety of functions within the membrane. Some of these proteins pump ions such as _____ across the membrane while others serve as carrier molecules in a passive transport process called _____.

(2) 4. About 65% of the lipids associated with eukaryotic cell membranes are amphiphilic/amphipathic molecules called _____. The polar phosphate groups associated with these molecules contact the watery environments outside and inside the cell while the non-polar _____ "tails" form the lipid bilayer surrounding the cytoplasm.

(2) 5. Small molecules such as oxygen and carbon dioxide can move into or out of cells via a passive transport process called _____. This process involves the movement of materials "down" their _____ gradients.

(2) 6. Water can move into or out of cells via a passive transport process called _____. If cells are placed into an environment that has a high solute

concentration (5% NaCl), water will move out of the cells. Such an environment is said to be _____.

(1) 7. Cells placed into a hypotonic environment would tend to _____ water via a passive transport process called osmosis.

(1) 8. Active transport differs from facilitated diffusion in that it requires energy and can be used to move particles (molecules and/or ions) against _____ gradients.

(1) 9. If two different types of material are being transported across a cell membrane in different directions at the same time (by the same protein complex) they are said to be moving in _____.

(1) 10. Explain briefly how facilitated diffusion differs from active transport.

(2) 11. Eukaryotic cells such as protozoa are able to take in large particles (macromolecules and other cells) via an active transport process known as _____ or "cell eating" (please be specific). Cells can also take in smaller particles (not visible with a light microscope) by means of a process called _____ or "cell drinking".

(1) 12. The directed movement of a protozoan toward a chemical (food) source is technically referred to as _____ (be specific)

(1) 13. Bacteria that move away from a light source would be said to display _____ _____ (be specific).

(2) 14. The cell membranes of typical bacteria differ from eukaryotic cell membranes in that they contain little or no _____ and are involved in the synthesis of materials such as wall components and _____. Note - the cytoplasmic membranes of archaea contain branched, isophrenoid, ether-linked lipids rather than fatty-acid, ester-linked lipids, so are unlike the membranes of other cells.

Eukaryotic and Prokaryotic cells:

(5) 1. Define:

Organelle

Ribosome

Histone

Glycocalyx

Sporulation

(1) 2. _____ may be defined as the science or study of cells.

(1) 3. Eukaryotic cells contain a large number of membrane bound structures called _____ that carry out a variety of specific functions.

(2) 4. A complex membranous organelle that serves as a transport system, a site for storage and for lipid synthesis is called the _____. Sometimes this structure is made "rough" by the presence of small granular bodies called ribosomes. These serve as the site for _____ synthesis within the cell.

(3) 5. A membranous organelle known as the _____ is involved in storage, the synthesis of polysaccharides, and the assembly of complex organic compounds (glycoproteins, glycolipids, etc.). What <u>other functions</u> are associated with this organelle?

(2) 6. _____ and _____ are eukaryotic structures that contain their own DNA, make ATP and are thought to have originated as prokaryotic cells.

(2) 7. Most microbiologists believe that mitochondria and chloroplasts were originally prokaryotic cells that were taken in by, and formed symbiotic relationships with larger eukaryotic cells. What evidence is available to support this theory?

(2) 8. Both mitochondria and chloroplasts contain inner membranes that are involved in ATP synthesis. In mitochondria these inner membranes form folds called _____, while in chloroplasts they are arranged in flat, membranous vesicles called _____.

(3) 9. Single-celled organisms digest the "food" materials they consume by bringing them into contact with digestive enzymes called _____. These enzymes are stored within organelles called _____. Organelles containing enzymes involved in hydrogen peroxide metabolism are referred to as _____.

(1) 10. Many types of fresh-water protozoa contain osmoregulatory organelles called _____ _____. These structures serve to pump excess water out of cells.

(3) 11. Most eukaryotic cells contain many tubular protein complexes called _____ that provide structural support and allow for intracellular motion. These tubular structures appear to be arranged in a characteristic pattern (nine groups of two plus an additional two in the middle) within locomotor structures called _____ and _____.

(2) 12. Microtubules are made up of proteins called _____ arranged in linear strands that can be taken apart or assembled as needed. Microtubule associated proteins such as _____ can move materials along these strands and play a major role in intracellular transport.

(1) 13. Some eukaryotic cells contain bodies called _____ that are made up of microtubules arranged in nine groups of three. These give rise to spindle fibers and aid in chromosome separation during mitosis and meiosis.

(3) 14. All single-celled eukaryotic microorganisms contain one or more centrally located structures called _____ that serve to control all cellular activities (they are sometimes referred to as the "brains" of these cells). The protoplasm within these structures is largely composed of a thread-like material called _____ that is made up of _____ and protein.

(2) 15. A dark staining body within the nucleus is known as the _____ and serves as the site of _____ synthesis, and the assembly of 60s and 40s subunits.

(2) 16. The cells of most "plant-like" microorganisms (algae and fungi) are surrounded by rigid layers of non-living material known as _____. What functions do these layers of material serve?

(2) 17. Describe two ways (other than size) in which Eukaryotic cells differ from prokaryotic cells.

(2) 18. Many microorganisms (both eukaryotic and prokaryotic cells) are motile by means of locomotor structures called _____. In eukaryotic cells, these structures are surrounded by membrane, contain a cytoskeleton made of _____, and move with a whip-like motion.

(2) 19. Prokaryotic cells that have flagella distributed fairly evenly all over their cell surfaces are said to have a _____ flagellar arrangement. If a cell has flagella located at both ends it is said to have a polar or _____ flagellar arrangement.

(3) 20. Describe three ways in which the flagella of prokaryotic cells differ from the flagella of eukaryotic cells.

(1) 21. Many types of Gram negative bacteria are covered with thin, hair- like structures called _____ that serve to attach the bacteria to various surfaces including other cells.

(1) 22. Gram negative bacteria such as *Escherichia coli* sometimes produce one or more thin, tube-like structures called _____ from proteins called pilins. These tubes play a role in the cell-to-cell transfer of DNA.

(1) 23. Structures known as _____ or as periplasmic flagella occur within the periplasmic space of spirochete bacteria.

(3) 24. A layer of organic material (polysaccharide or protein) found outside the cell wall of a prokaryotic cell is referred to as a glycocalyx and may be a dense, well-organized _____ or a loosely organized _____. This layer is produced only under certain circumstances and may serve a variety of functions. It

may aid in attachment and in pathogenicity, may protect the cell against dehydration, and serves as a _____.

(10)25. Matching - Cell Structure and Function:
Match the term or terms on the left with the most appropriate functions on the right, and indicate in the second blank provided whether the structure is most commonly found in association with eukaryotic cells, prokaryotic cells, or both.

____ Histones ____	A. Contain enzymes involved in hydrogen peroxide metabolism.
____ Ribosomes ____	B. Made of protein pilin, allow for attachment and genetic exchange.
____ Cell walls ____	C. Homogeneous proteins associated with linear strands of chromatin.
____ Glycocalyx ____	D. Reservoir of stored food which aids in attachment and pathogenicity.
____ Thylakoids ____	E. Extrachromosomal loops of DNA carrying genes not essential to cell function.
____ Peroxisomes ____	F. Composed of RNA and protein, are the site of all protein synthesis.
____ Nucleoid ____	G. A non-living extracellular layer which provides support and protection.
____ Golgi complex ____	H. Primary site of packaging, secretion, and polysaccharide synthesis.
____ Pili ____	I. Not bounded by a membrane, contains one circular chromosome.
____ Plasmids ____	J. Membranous structures with enzymes for ATP synthesis via photophosphorylation.

(2) 26. A _____ is a layer of material found outside the cell wall, and is usually composed of protein or polysaccharide. If this layer is dense and well organized it is called a capsule and if it is lose it is called a slime layer. What functions are associated with this layer?

(1) 27 The rigid cell walls of typical Gram positive and Gram negative bacteria are composed of a unique organic material known as _____. In Gram positive cells this layer is quite thick, while in Gram negative cells it is thin.

(2) 28. Gram positive bacteria have thicker cell walls and are generally more resistant to _____ _____ than are ordinary Gram negative bacteria. The Gram negative cells have an outer membrane associated with their cell wall and so are more resistant to _____ than are Gram positive cells.

(1) 29. The cell membranes of some prokaryotic cells fold inward to form structures known as _____. These contain enzymes involved in phosphorylation and

may play a role in cell division. Many investigators believe these membrane folds are actually artifacts formed during the preparation of cells for electron microscopy.

(2) 30. Cyanobacteria are photosynthetic prokaryotes that contain membranous vesicles called _____ . These are usually located parallel to the cell membrane, but appear to be separate from it. They contain enzymes involved in the formation of _____ via photophosphorylation.

(1) 31. The cytoplasmic region of a prokaryotic cell contains no membrane bound organelles, but does contain ribosomes and a variety of inclusions. _____ are inclusions which contain enzymes involved in "fixing" carbon dioxide into organic compounds.

(2) 32. Some bacteria contain cytoplasmic inclusions called _____ that serve as a source of intracellular phosphate (a sort of energy reserve). Bacteria living in water environments often contain inclusions called gas vacuoles. What function do these serve?

(2) 33. The chromosome of a prokaryotic cell is not contained within a nucleus with a nuclear membrane, but is contained within a region known as the nuclear region (area, body) or _____. Many bacteria also contain one or more small extrachromosomal loops of DNA known as _____. These generally carry genetic information that is not essential to the survival of the cell under most circumstances.

(2) 34. Some types of Gram positive bacteria produce dormant structures called _____ which allow these cells to survive periods of unfavorable conditions. These dormant structures are highly resistant to environmental factors such as _____ and may live in a nearly inactive state for hundreds or thousands of years.

(2) 35. Explain how endospores differ from vegetative cells in terms of their composition and function. Include information about nucleic acids, water, calcium, dipicholinic acid, resistance to environmental factors, metabolic activity levels and longevity.

(2) 36. Bacteria in the genera *Bacillus* and *Clostridium* often form dormant structures known as _____ . These contain high levels of DNA, calcium and dipicholinic acid but very little RNA and almost no water. They are metabolically inactive and resistant to both physical and chemical damage. What is the overall function of these structures?

(1) 37. Exospores undergo a process called _____ when they find an environment suitable for their growth, and have been subjected to the proper "triggering" stimuli.

(2) 38. Cyanobacteria such as *Anabaena* often form specialized cell types that carry out specific functions. Specialized cells called _____ contain enzymes involved in nitrogen fixation, while thick-walled, granular-looking cells called _____ are highly resistant to cold and desiccation thus allowing bacteria to survive cold winters and/or dry summers.

Taxonomy and Classification:

(5) 1. Define:

Taxonomy

Binomial nomenclature

Psychrophile

Photoheterotroph

Microaerophile

(2) 2. _____ may be defined as the science or study of biological classification, and provides a system for arranging living organisms into specific groups or categories. According to the five kingdom system proposed in 1969 by R.H. Whittaker, all bacteria belong within the kingdom _____.

(2) 3. According to the binomial system of nomenclature as developed by Carolus Linnaeus (1735), the scientific name of an organism is composed of the _____ and the _____ names of that organism.

(1) 4. A taxonomic rank that is less encompassing than a class but more encompassing than a family would be known as a/an _____.

(2) 5. The five kingdom system of classification was proposed in 1969 by _____. According to this system, all single-celled eukaryotic organisms such as algae and protozoa belong within the kingdom _____.

(1) 6. Features such as size, shape, arrangement, color, etc. are generally referred to as _____ characteristics, and are more useful in the identification of multicellular organisms then they are in the identification of bacteria.

(2) 7. Organisms which can obtain their energy from chemicals, but require organic compounds for their source of carbon are nutritionally categorized as _____. If

these organisms can only grow and reproduce while inside another living cell they are said to be _____ or obligate intracellular parasites.

(1) 8. Algae are nutritionally categorized as _____ because they can obtain energy from light, and use inorganic compounds as sources of carbon.

(2) 9. Chemoheterotrophs that live on or inside other organisms and obtain their carbon and energy from these organisms are referred to as _____. Most fungi obtain their energy and carbon from dead and decaying organic materials and so are referred to as _____.

(1) 10. Many types of bacteria are able to obtain both carbon and energy from inorganic chemicals. Organisms with this ability are categorized as _____ and often live in unusual environments.

(1) 11. Organisms which use inorganic compounds (usually oxygen) as their final electron acceptors are said to have a _____ type metabolism.

(2) 12. An organism that is able to grow with or without oxygen in its environment is said to be a _____ organism and may use either a respiratory or a _____ type metabolism.

(1) 13. Many types of bacteria can grow and reproduce only in environments that contain very little or no oxygen. These organisms are referred to as _____ and may be damaged or killed by exposure to molecular oxygen.

(2) 14. _____ are organisms which grow best in cold environments (where temperatures range between -5 and 20 degrees C.). The term _____ applies to organisms which can tolerate or endure very cold temperatures. These organisms are not able to grow at such cold temperatures, but they are not killed by them either. Most bacteria have this characteristic.

(2) 15. Organisms that grow best in hot environments (those with temperatures above 60^{o} C) are referred to as _____. Although most bacteria in the genera *Bacillus* and *Clostridium* do not fit within this category, they can survive exposure to high temperatures because they form endospores that are _____.

(1) 16. The pH of an environment is a measure of what?

(1) 17. Chemical substances called _____ change color in response to shifts in the acidity or alkalinity of their environment, and are often added to media as a means of monitoring the metabolic activity of microorganisms.

(1) 18. An organism is said to be an extreme _____ if it can grow and reproduce only in extremely salty environments.

(2) 19. When two or more different types of organisms are found living together in a close association, they may be said to form a _____ relationship. For example,

many bacteria live on and inside our bodies and help us survive in our environment. Only a few types of bacteria cause disease and so are considered _____.

(1) 20. In our microbiology laboratory we commonly use a type of biochemical analysis known as _____ when attempting to identify various different types of bacteria.

(2) 21. Two techniques used in the identification of unknown bacteria include _____ _____ (a method which involves mixing known antibodies with the bacteria) and phage typing, a method which involves mixing known types of _____ with unknown bacteria.

(2) 22. Bacteria are recognized as specific serotypes or serovars if they have been identified by being mixed with specific types of _____. Bacteria can also be identified by mixing them with known types of _____ in a technique known as phage typing.

(1) 23. Polyacrylamide gel-electrophoresis, percent base composition (C+G and A+T), hybridization, and nucleotide sequencing are all techniques used in the biochemical analysis of _____.

(1) 24. Both DNA "finger printing" and nucleotide sequencing involve the use of a biochemical analysis method called polyacrylamide _____ (PAGE).

(2) 25. Briefly describe two aspects of nucleic acid analysis which involve the use of Polyacrylamide gel-electrophoresis (PAGE).

(1) 26. What is the human genome project?

Introduction to Bacteria:

(5) 1. Define:

Spirochete

Luciferase

Coliform

Methanogenic

Anoxygenic

(1) 2. The _____ are bacteria which have flexible cell walls and axial filaments (periplasmic flagella). Some organisms in this group are important human pathogens.

(2) 3. Bacteria in the genus *Pseudomonas* are unique in that they can consume a wide range of organic compounds as "food". Explain one of the ways this feature of pseudomonads is currently being used by humans.

(3) 4. Although leguminous plants such as beans, clover and alfalfa are often credited with the ability to add nitrogen to soil, this activity is actually accomplished by soil bacteria in the genus _____ that form symbiotic relationships with the plant roots. Many types of deep sea fish and squid are said to be bioluminescent, when actually the ability to produce light is associated with bacteria living on them. Bacteria in the genus _____ are able to form a type of enzyme called _____ that allows them to convert chemical energy into light energy, and so to produce light.

(1) 5. _____ is a type of Gram negative rod-shaped bacteria which is used extensively in genetic research, serves as an indicator in the bacteriological examination of water, and is known to be a significant pathogen (especially when consumed in raw or poorly cooked ground beef).

(2) 6. Bacteria are said to be _____ if they can produce their own light. The ability to convert chemical energy into light energy involves enzymes coded for by a gene known as the _____.

(1) 7. Gram positive, catalase positive, aerobic cocci that commonly form bright colored colonies (red, yellow, orange, pink) on air plates are classified within the genus _____.

(1) 8. Endospore-forming bacteria within the genus _____ are of interest to scientists because they often infect and kill insect larvae and so can be used to make biological insecticides.

(2) 9. *Halobacterium salinarium* (formerly *H. halobium*) is one member of an ancient group of bacteria known as the _____. These organisms are unique in that they trap light energy using a pigment known as _____ (which is similar to one of the pigments found in the human retina).

(1) 10. Bacteria that are able to carry out oxygenic photophosphorylation are commonly referred to as _____ or blue-green algae.

(1) 11. Soil bacteria in the genus *Streptomyces* are currently the focus of extensive investigation since they have been found to be an important source of _____.

(5) 12. Match the bacteria on the left with the most appropriate characteristics on the right and place the letters of correct matches in the blanks provided.

____ *Mycobacterium*	A. Nitrogen "fixing" bacteria which live in root nodules of leguminous plants.
____ Spirochetes	B. Oxygenic phototrophic bacteria which were initially thought to be algae.
____ *Clostridium*	C. Thin spirilla with flexible cell walls and axial filaments or periplasmic flagella.
____ *Bdellovibrio*	D. Play an important role in biogeochemical cycles involving iron, sulfur, and nitrogen.
____ *Mycoplasma*	E. Gram positive, catalase negative, cocci often used in food processing.
____ Cyanobacteria	F. Bacteria unique in their ability to use unusual organic compounds for carbon, used in bioremediation.
____ *Rhizobium*	G. Acid-fast bacteria with high levels of mycolic acid in their cell walls. Some are important human pathogens.
____ *Streptococcus*	H. Gram negative bacteria that are known to be parasites of other bacteria.
____ Chemolithotrophs	I. Gram positive, endospore-forming soil bacteria that are anaerobic, some are important human pathogens.
____ *Pseudomonas*	J. Tiny Gram negative bacteria that have no peptidoglycan in their cell walls.

Introduction to Fungi:

(5) 1. Define:

Mycology

Hyphae

Karyogamy

Dermatophytes

Opportunistic pathogen

(1) 2. _____ may be defined as the science or study of fungi.

(2) 3. In the five kingdom system of classification, fungi are not classified as plants (kingdom Plantae) because they are _____ (i.e., lack green pigments) and have a _____ mode of nutrition.

(1) 4. Organisms in the kingdom Myceteae (fungi) are achlorophyllous chemoheterotrophs that are made up of _____ type cells, and which have cell walls containing cellulose, chitin, glucan or a combination of these polysaccharides.

(2) 5. The thallus of a mold-type fungus is made up of many thin thread-like filaments called _____ which come together to form visible mats called mycelia. If the fungus is parasitic, and the filaments are specialized to penetrate host cells and absorb nutrients, they are referred to as _____ .

(2) 6. The thallus of a mold-type fungus is made up of many thin thread-like filaments called hyphae which come together to form a mat-like structure called a _____. Hyphae may be septate or aseptate; but in either case, the cells involved are all connected, and so form a true _____ or multinucleated mass of protoplasm.

(1) 7. Many types of fungi form symbiotic relationships with plant roots. Some fungi form specialized hyphae called _____ that actually help plants to absorb water and minerals from the soil. These fungi are essential to the forest ecosystem.

(2) 8. That portion of a mold-type fungus that extends above the substrate upon which the fungus is growing (agar, soil, rotting wood, etc.) is referred to as the _____ and is involved in reproduction (either sexual or asexual). The portion of the fungus that extends into the substrate is called the _____ and is involved in food getting.

(1) 9. Yeast type fungi typically reproduce asexually via a process called _____ during which there is uneven division of the cytoplasm, one "daughter" cell being much smaller than the other.

(1) 10. Fungi often reproduce asexually by budding, fragmentation, or by producing numerous reproductive structures called spores. If these spores are contained within a sac-like structure they are called _____.

(2) 11. The sexual reproductive process of fungi involves three steps or stages. That stage which involves the coming together of the protoplasm is called _____ while that which allows the diploid zygote to divide into four haploid cells is called _____.

(2) 12. Sexual reproduction as it occurs in fungi involves three stages or steps. The stage during which the nuclei join to form a diploid zygote is called _____, while the stage which allows the zygote to return to the haploid state is called _____.

(2) 13. Explain two ways in which fungi are considered to be of value or beneficial to humans.

(2) 14. Fungi are used industrially in the production of food, antibiotics, _____, and a variety of _____.

(2) 15. Although some forms of fungi are the causative agents of _____ (fungal induced diseases) in man, others serve as a source of _____ (such as penicillin) which are used to treat disease.

(3) 16. _____ may be defined as infections or diseases that are caused by fungi. If these diseases involve the deep tissues of the body (blood, lungs, lymphatics, etc.) they are said to be deep or _____ infections and typically involve fungi which enter their host by _____.

(2) 17. Two factors which have contributed to an increase in fungal induced diseases in people living in the US are:
a) _____
b) _____

(1) 18. The primary factor determining if or not an individual will be likely to develop a serious mycosis after being exposed to potentially pathogenic fungi is _____ _____.

(2) 19. Name two genera of fungi that are known to cause deep or systemic mycoses (you may include opportunistic pathogens).
a) _____ b) _____

(2) 20. Superficial fungal infections are often caused by fungi in the genera *Epidermophyton*, *Trichophyton* and *Microsporum*. These fungi are collectively referred to as the _____ and cause a variety of infections including _____.

(2) 21. A soil fungus in the genus _____ may cause deep or systemic infection in people with compromised immune function. These fungi typically enter the body via _____. (More than one answer is possible in the first blank above.)

(1) 22. _____ is the name given to a mycotoxin produced by *Aspergillus flavus*.

(2) 23. Two genera of fungi known to produce mycotoxins that can cause severe illness or death when consumed by humans are _____ and _____.

(1) 24. An opportunistic pathogen known to cause the formation of fungus balls in the lungs of compromised individuals is classified within the genus _____.

(4) 25. Match the terms on the left with the most appropriate statements on the right and place the letters of correct matches in the blanks provided.

____ Dermatophytes	A. Soil fungus which causes San Joaquin Valley fever or desert rheumatism.
____ Tinea corporis	B. Pathogenic fungus often associated with soil rich in bird or bat feces.
____ Chromomycosis	C. Genus of yeast-like fungi known to be a pathogen in immunocompromised individuals.
____ *Coccidioides*	D. Recognized as the source of aflatoxin and sometimes a respiratory pathogen.
____ *Cryptococcus*	E. Fungus known to produce a mycotoxin that sometimes causes fatal intoxication in humans.
____ *Histoplasma*	F. Superficial mycosis sometimes caused by fungi in the genus *Epidermophyton*.
____ *Aspergillus*	G. A subcutaneous mycosis caused by various pigmented fungi called black molds.
____ *Amanita*	H. Group of fungi known to be the cause of superficial mycoses.

Introduction to Algae:

(5) 1. Define:

Phycology

Endophytic

Eutrophication

Paralytic shellfish poisoning

Diatomaceous earth

(1) 2. _____ may be defined as the science or study of algae, and in this class will be restricted to microscopic varieties.

(2) 3. Algae contain light trapping pigments and use inorganic carbon (carbon dioxide) to form organic compounds, so are nutritionally categorized as _____.

Algae are beneficial to other organisms in that they produce _____ and serve as a source of _____.

(1) 4. Algae (probably with the help of certain bacteria) are thought to produce as much as 70% of the _____ on this planet.

(2) 5. Although algae are very important environmentally in that they are the primary source of _____ present in our atmosphere, they can also cause problems to fish by using up this substance at night (when no light is available) if water bodies have undergone _____.

(2) 6. All Algae contain green-colored pigments called _____, but these are sometimes masked by red-colored pigments called _____.

(1) 7. Many types of single-celled algae contain yellow or orange-colored pigments called _____ and so appear golden or brownish rather than green.

(1) 8. Filamentous algae typically reproduce asexually via a process known as _____.

(2) 9. Sexual reproduction as it occurs in algae (like fungi) involves three stages or steps. The joining of the nuclei is called _____ and results in the formation of a diploid cell or zygote. In algae, these diploid cells make up what is known as the _____ generation, and are morphologically indistinguishable from haploid cells.

(2) 10. _____ may be defined as an increase in algae population within a body of water. Although this may be considered beneficial in the sense that algae provide food for various other organisms, it may also be considered detrimental because?

(2) 11. Certain types of green algae live symbiotically with fungi in organisms known as _____. Other types of algae live inside organisms such as anemones, flatworms and protozoa and so are said to be _____.

(1) 12. Although algae are not usually considered pathogens, toxins produced by *Gonyaulax* and *Gymnodinium* can cause a disease called _____ which causes muscle paralysis in humans and other animals.

(1) 13. The glass cell walls of algae known as _____ are used as a filter material, as insulation, as an abrasive in cleansers, and in reflective paint.

(1) 14. Why are algae in the phylum Rhodophyta (Rhodophycophyta) important to bacteriologists?

(1) 15. The glass cell walls of algae called diatoms are used in a variety of ways including:
_____

Introduction to Protozoa:

(5) 1. Define:

Cirri

Trophozoite

Cytostome

Contractile vacuole

Schizogony

(2) 2. All protozoa, like fungi, are eukaryotic organisms that can be nutritionally categorized as _____ because they obtain their carbon and energy from preformed organic compounds. Some protozoa are parasites, a few cause disease in humans and other animals, so are important as _____ ; but most are free-living organisms.

(3) 3. Protozoa have a number of specializations that allow them to move about and obtain food in fresh-water environments. Amoeba-like protozoa have locomotor structures called _____ that can be extended out and around prey organisms during phagocytosis. Organisms such as *Paramecium* swim through water by means of short, hair-like structures called _____. These may also be arranged in tufts called _____ and can be used for walking or jumping.

(1) 4. Amoeba-like protozoa move about by extending portions of their protoplasm called _____ (false feet) into the environment, and flowing along after them.

(2) 5. Protozoa often possess structures which serve both for locomotion and for food getting. Two examples of such dual-purpose structures are _____ and _____.

(2) 6. All protozoa are chemoheterotrophs, and many of them are predators. Protozoa that catch and consume whole organisms as their prey are said to have a _____ type of nutrition. Food materials are often taken into these cells via a specific site known as the _____ or cell mouth.

(1) 7. Fresh water protozoa usually contain osmoregulatory organelles known as _____ which pump excess water out of their cells.

(2) 8. Several types of protozoa are intestinal pathogens, and enter their host in their inactive or _____ stage because these are resistant to the acidic conditions of the stomach. Once they reach the intestine, the protozoa emerge as _____, the active (feeding, growing, reproducing, etc.) form of the parasite.

(2) 9. Many protozoa produce structures that can be used for protection or for defense. The outer surfaces of ciliated protozoa are protected by a tough, flexible layer called a _____, radiolarians have shells or external skeletons made of glass and foraminiferans live inside tests made of calcium carbonate. Some ciliates such as Paramecium form and use dart-like protective structures called _____ that can be shot out in response to certain stimuli.

(3) 10. Most protozoa reproduce asexually by undergoing _____, although some protozoa form buds, and some undergo schizogony. Sexual reproduction most commonly involves _____ a process that involves the exchange of genetic material between two cells or _____, a process that results in the formation of a diploid zygote.

(6) 11. Matching - Diseases of fungi, algae and protozoa.
Match the terms on the left with the most appropriate statements on the right and place the letters of correct matches in the blanks provided.

____ Chromomycosis	A. A superficial fungal infection (mycosis) associated with the feet.
____ *Gonyaulax*	B. Opportunistic respiratory pathogens and source of aflatoxin.
____ Dermatophytes	C. May be caused by specific organisms in the genera *Balantidium* or *Entamoeba*.
____ Encephalitis	D. Vaginal flagellates that may be acquired through sexual contact or poorly maintained pools and hot tubs
____ *Trypanosoma*	E. Subcutaneous infection caused by various fungi known as black molds.
____ *Coccidioides*	F. Opportunistic pathogens that may infect the mouth or genital tract, can cause septicemia.
____ *Candida*	G. Fungi in the genera *Epidermophyton*, *Microsporum* and *Trichophyton*.
____ Dysentery	H. Hemoflagellates recognized as the causative agents of African sleeping sickness.
____ *Aspergillus*	I. Dinoflagellates known to be the cause of paralytic shellfish poisoning.
____ *Toxoplasma*	J. Sporozoeans which can cause severe nervous system damage in fetuses.
____ *Trichomonas*	K. Soil fungi which are the causative agents of San Joaquin Valley fever.

____ Tinea pedis

L. May be caused by amoebas that live in soil or hot springs, enter their host via nasal passages.

(1) 12. Protozoa can enter into a dormant stage known as the _____ stage in order to survive periods of unfavorable conditions, such as hot dry summer weather, or the acid conditions of a hosts stomach.

(2) 13. Protozoa within the genus *Plasmodium* reproduce sexually via a process called _____ while within their mosquito host, and reproduce asexually via a process called _____ or multiple fission while within their mammalian host.

(2) 14. Two types of human diseases that can be caused by amoeba-like protozoa are _____ and _____.

(2) 15. Although the hemoflagellates that cause African sleeping sickness and Chaga's disease occur only in tropical areas, there are some flagellated parasites that occur locally. Intestinal parasites identified as _____ are common in rivers, streams and lakes in Placer County, while a vaginal parasite called _____ may be acquired by swimming or bathing in pools or hot tubs that are not properly maintained.

(2) 16. *Plasmodium* organisms enter their mammalian host while in their _____ stage and then travel to the deep tissues of the body (e.g., liver). After a period of time, they enter RBCs and reproduce asexually. Each infected RBC will eventually rupture and release many protozoa in their _____ stage. These infect and eventually destroy other RBCs.

(5) 17. Describe the life cycle of *Plasmodium vivax* as explained in lecture. Be sure to include the mechanisms of sexual and asexual reproduction, and where they occur.

(1) 18. Malaria, African sleeping sickness and Chaga's disease are similar in that all are caused by protozoa that are transmitted from one host to another by _____.

Introduction to Multicellular Parasites:

(5) 1. Define:

Helminth

Definitive host

Redia

Vector

Monoecious

(2) 2. Multicellular endoparasites (flatworms and roundworms) are commonly referred to as _____ (a term meaning worms) and are adapted to a life within the gut, bloodstream, or tissues of another organism. One of the characteristics common to these organisms (especially the flatworms) is a highly developed _____ system.

(3) 3. Organisms within the phylum Platyhelminthes have very poorly developed _____ and _____ systems, but often have both male and female reproductive systems so are said to be _____ or hermaphroditic.

(2) 4. Many helminths have complex life cycles that involve more than one host. The host in which the adult form of a parasite is found is called the _____ host, while the host in which the larval parasites are found is called the _____ host.

(2) 5. Many helminth parasites have complex life cycles that allow their offspring or larvae to live in an environment or host organism away from the parents. What are two advantages of this arrangement?
a) _____
b) _____

(5) 6. Describe the life cycle of *Fasciola hepatica* as presented in lecture and explain why having alternate hosts is an advantage to this organism.

(3) 7. Each egg of the sheep liver fluke, *Fasciola hepatica*, may hatch into a ciliated larval form called a _____. If the environmental conditions are appropriate, these larvae swim about in search of an intermediate host, which is a _____. Then they burrow in, undergo asexual reproduction, and eventually exit their host as tadpole-like fluke larvae called _____.

(1) 8. Blood flukes, *Schistosoma*, are important human pathogens in some parts of the world. Why is it hazardous to swim or wade in fresh-water lakes or rivers where blood flukes are prevalent?

(2) 9. Hookworms and filarial worms both belong to the phylum Aschelminthes (roundworms). Hookworms enter their hosts by _____. while filarial worms enter via _____.

(2) 10. Two multicellular parasites which may be acquired by eating raw or poorly cooked pork are _____ and _____. (Common names are worth half credit here.)

(2) 11. Roundworm parasites identified as *Trichinella spiralis* and *Necator americanus*, can both use humans as their definitive hosts. In both cases the adult parasites live in the intestine. How do these parasites differ in terms of how their larvae reach a new host?

(4) 12. Describe the life cycle of the hookworm, *Necator americanus*, as presented in lecture.

(1) 13. Ectoparasites in the phylum Arthropoda are of interest to microbiologists because they often serve as _____.

(1) 14. Multicellular organisms such as fleas, ticks, lice and mosquitoes are referred to as _____ because they live outside their host.

(1) 15. The canine heartworm, *Dirofilaria immitis*, is an important parasite known to exist in this area. Why is it so important that dog owners treat their animals for this parasite?

Microbial Nutrition and Growth:

(5) 1. Define:

In vitro

Enriched media

Fastidious (microbe)

Lag phase (microbial growth)

Stationary phase (microbial growth)

(2) 2. Most of the bacteria grown in our microbiology laboratory use preformed organic compounds for both carbon and energy so are nutritionally categorized as _____. The mixture of materials that provides all the nutrients these organisms need to grow and reproduce is referred to as the _____.

(2) 3. Most bacteria reproduce asexually by means of _____. What is the first thing bacteria must do in order to begin this process? _____

(1) 4. The term growth, when applied to a bacterial culture, refers to an increase in _____ _____ rather than to an increase in the size of a single organism.

(2) 5. Most bacteria reproduce via a process called _____ during which one cell becomes two. The _____ portion of this

process requires that sections of the peptidoglycan wall be broken down and that new wall material be synthesized.

(1) 6. During the elongation phase of its reproductive cycle, a bacterial cell undergoes a number of changes. Describe the elongation process as it was explained in lecture.

(1) 7. Bacterial cells placed into a container of sterile nutrient medium do not increase in number immediately, but enter into a phase known as the lag phase during which there is an increase in _____ but not in cell number.

(1) 8. Bacterial cells may not undergo physical separation at the end of their fission process. If they don't, and fission always occurs in the same plane, the cells will form an arrangement known as _____ (cocci or bacilli). What arrangement would cocci achieve if their fission plane was initially horizontal, and then vertical? _____

(1) 9. During the lag phase of its growth, an in vitro bacterial population does not increase in number, but does change in many other ways including: _____
_____

(2) 10. Bacteria growing in vitro can reproduce exponentially only for a limited period of time. What causes an in vitro bacterial population to stabilize and then go into an exponential death phase?

(2) 11. The maximum number of cells that can be supported in vitro is referred to as the m-concentration and is usually around _____ cells per ml. This number cannot be exceeded because the bacteria have reached the _____ of their environment and one or more essential factors have become limited in supply.

(2) 12. The _____ phase is a phase of bacterial growth during which the number of new cells being formed equals the number of cells dying. The bacterial population cannot exceed the m-concentration because they have reached the _____ of their environment, and factors critical to their survival have become limited.

(2) 13. Where in a bacterial colony would you expect to find the "youngest" cells and why?

(2) 14. Bacteria grown in a closed system or batch culture will eventually go into an _____ _____ because they will run out of nutrients and they will be damaged by the build up of toxic metabolic waste products. It is possible to maintain bacteria in an exponential growth phase for an unlimited period time by doing what?

(1) 15. The growth curve demonstrated by a bacterial population grown in a closed system has what implications relative to the human population on the planet earth?

Microbial Metabolism, Enzymes and ATP:

(5) 1. Define:

Metabolism

Endergonic

Holoenzyme

Phosphorylation

Oxidation

(2) 2. _____ may be defined as energy transfer mechanisms occurring within living organisms, and is closely associated with metabolism. Chemical reactions that are anabolic (building reactions) require an input of energy (take up energy) and so are said to be _____ while catabolic (breakdown) reactions give off more energy than is required to initiate them.

(2) 3. _____ may be defined as all the chemical reactions which occur within living organisms and includes both building and breakdown reactions. Each different type of reaction is catalyzed by a globular protein molecule known as a/an _____.

(1) 4. Anabolic reactions which result in the formation of ATP (or other high energy phosphate compounds) are referred to as _____ reactions and may be categorized as substrate level, oxidative, or photo.

(2) 5. Chemical reactions which result in the release of energy (give off more energy than was required to get them started) are catabolic in nature and are called _____ reactions. The energy released during the catabolism of organic compounds such as carbohydrates is not used directly to drive cell processes, but is instead used to form high energy phosphate compounds such as ATP. Such reactions are called _____ reactions and may be categorized as substrate level, oxidative or photo.

(2) 6. Living cells use a type of energy "currency" known as _____ to drive physiological processes such as flagellar movement, active transport and anabolic reactions. A single eukaryotic cell may use as many as 2 million of these molecules per second. What other types of high energy compounds may be found within living cells? _____

(1) 7. When an atom or molecule loses oxygen, or if it gains electrons and hydrogen protons, it is said to have been _____. (Remember, LEO-GER)

(1) 8. A molecule is said to have been _____ if it has gained oxygen or has given up one or more electrons and hydrogen protons.

(2) 9. According to the models presented in lecture, enzymes exert their influence by: 1) _____ _____ and 2) _____.

(3) 10. Globular proteins which serve as biochemical catalysts and which increase the rate at which chemical reactions occur within living cells are called _____. The function of these molecules can be influenced by a variety of factors including _____, _____ and concentration.

(2) 11. Enzymes are globular protein molecules that serve as biochemical catalysts. Their overall function is to _____. Enzymes are usually very specific in their action, but are not changed by the reactions they catalyze, so can be _____.

(2) 12. Enzymes that are functional as proteins alone are called simple enzymes, but if they require some type of "helper" group, they are called _____ enzymes. Inorganic "helper" groups (Ca^{++}, Mg^{++}, etc.) are referred to as _____ and may be associated with more than one type of enzyme.

(2) 13. The rate at which enzymes catalyze chemical reactions is influenced by factors such as pH, temperature and _____ (of enzyme or substrate). Enzyme activity may also be influenced by chemicals known as _____ which can bind to the active site of an enzyme in place of the normal substrate molecules and block the enzyme's action. Toxins such as cyanide and arsenic exert their action in this manner.

(1) 14. An enzyme inhibitor which binds to a site other than the active site, and thereby changes the active site so it can no longer function is called an _____ inhibitor.

(1) 15. Enzymes which are released into the environment and so are active outside the cell are called _____. Bacteria use this type of enzyme to break down food materials, so they are easier to transport across the cell membrane.

(1) 16. A _____ is a non-protein organic group which can bind to an apoenzyme and make it a holoenzyme.

(2) 17. NAD, FAD, and NADP are examples of non-protein organic "helpers" known as _____ and are much less specific than are enzymes. FAD is derived from the B-complex vitamin _____.

(5) 18. Matching - Enzymes: Match the terms on the left with the most appropriate statements on the right and place the letters of correct matches in the blanks provided.

____ Coenzyme	A. Catalyzes the transfer of phosphate groups between organic compounds.
____ Holoenzyme	B. Catalyzes the conversion of organic compounds into their chemical isomers.
____ Competitive	C. Pigmented enzyme which has an iron prosthetic group that can accept or donate electrons.
____ Allosteric	D. Active form of a conjugated enzyme, made up of protein plus a "helper" of some type.
____ Kinase	E. Protein portion of a conjugated enzyme. This portion is inactive alone.
____ Apoenzyme	F. Non-protein organic group which can bind with an apoenzyme to form a holoenzyme.
____ Cytochrome	G. Enzyme which is active as a protein alone, i.e., does not require a "helper".
____ Simple enzyme	H. Inhibitor that binds to a site other than the active site and changes the configuration of the active site.
____ Isomerase	I. Inorganic group which can bind with an apoenzyme to form a holoenzyme.
____ Cofactor	J. Inhibitor which binds to the active site in place of the normal substrate.

(1) 19. _____ is a coenzyme derived from the B-complex vitamin niacin.

(2) 20. A group of enzymes called _____ are pigmented proteins with iron prosthetic groups. The function of the prosthetic groups bound to these enzymes is to _____.

(1) 21. Enzymes that are always present within the cell (are not inducible nor repressible) are referred to as _____ enzymes.

(3) 22. Enzyme names often end in “ase” and provide information about the enzyme (what it acts on or what it does). Proteinases and lipases are enzymes that catalyze _____ _____. An enzyme called a carboxylase would be expected to _____ _____ to molecules, and a polymerase is an enzyme that _____.

Fermentation and Cellular Respiration:

(5) 1. Define:

Glycolysis

Fermentation

Heterofermentative

Kreb's cycle

Cytochromes

(1) 2. _____ may be defined as the catabolism of glucose to two pyruvic acids with the associated production of two molecules of ATP and reduction of two molecules of NAD to NADH + H^+.

(1) 3. A biochemical pathway known as glycolysis allows glucose to be catabolized to _____ _____ with the formation of 2 ATP (net) and the reduction of two NAD to NADH + H^+.

(2) 4. Toward the beginning of the glycolysis pathway, glucose is converted to glucose-6-phosphate, and fructose-6-phosphate is converted to fructose-1,6-diphosphate. These reactions are catalyzed by _____ enzymes and require energy (energy of activation) which is provided by _____.

(2) 5. During glycolysis, _____ is catabolized to pyruvic acid, two molecules of ATP are formed and two molecules of NAD gain electrons so are said to be _____.

(1) 6. Kinase enzymes are those which catalyze reactions involving the transfer of _____ groups between organic compounds.

(2) 7. Enzymes which catalyze the transfer of phosphate groups between organic compounds are called _____ enzymes. Those which catalyze the reconfiguration of molecules into their chemical isomers are called _____.

(1) 8. The series of chemical reactions known as glycolysis cannot continue unless they are linked to one or more additional reactions, i.e., glycolysis occurs as a part of fermentation or cellular respiration. Why is this so?

(2) 9. _____ may be defined as the anaerobic decomposition of organic compounds which involves an organic compound (e.g., pyruvic acid) as the final electron acceptor. If organisms can form only one end product (lactic acid) via this pathway, they are said to be _____.

(1) 10. Homofermentative organisms such as *Lactococcus lactis* produce _____ as the only product of their fermentation activities.

(3) 11. The fermentation of glucose by bacteria such as *Lactococcus lactis* results in a net yield of _____ (#) ATP molecules per glucose. These ATP are produced via _____ phosphorylation. The coenzymes reduced during the glycolysis portion of fermentation are reoxidized by passing their electrons to _____ (the final electron acceptor).

(2) 12. Organisms which yield lactic acid as their only fermentation product are said to be _____ and are often used in food processing. One organism which has this characteristic is _____.

(2) 13. Organisms which can produce a variety of end products in association with fermentation are said to be _____. One microorganism which has this characteristic and is often used in food processing is _____.

(2) 14. Chemoheterotrophs which have a _____ type metabolism, can catabolize glucose (and other organic compounds) more completely than can fermentative organisms. They can also capture more of the energy available in these compounds and so can make more _____ molecules per glucose catabolized, i.e., 36/38 rather than 2.

(2) 15. Bacteria such as *Pseudomonas* can completely catabolize glucose to carbon dioxide and water by means of a metabolic process called _____. This process is often divided into three steps or stages; what are they?

(1) 16. During cellular respiration, pyruvic acid is decarboxylated (has a carboxyl group removed) and then binds with a coenzyme to form _____ (a high energy compound).

(2) 17. In order for pyruvic acid to enter the Kreb's cycle, a _____ group is removed from it, and the remaining two-carbon unit is bound to _____ to form acetyl-coA, a high energy compound.

(2) 18. The _____ is a cyclic series of chemical reactions catalyzed by enzymes found in the matrix of mitochondria. These reactions allow organic acids to be catabolized and the energy released to be captured in the form of _____ _____ .

(1) 19. The carboxyl groups removed from various acids just prior to and during the Kreb's cycle are released from the cell as _____, a gaseous waste product.

(1) 20. The energy needed to bind the two-carbon remains of pyruvic acid to oxaloacetic acid at the beginning of the Kreb's cycle is provided by the catabolism of _____, a high energy compound.

(2) 21. The primary function of the Kreb's cycle (citric acid cycle or tricarboxylic acid cycle) is _____, a process that allows cells to release the energy stored in these molecules. What additional functions can be associated with this metabolic pathway?

(3) 22. The enzyme helper most often required for the reactions of the Kreb's cycle is a coenzyme called _____ and is derived from the B-complex vitamin _____.

(2) 23. In eukaryotic cells the enzymes associated with glycolysis are found throughout the cytoplasm, those associated with the Kreb's cycle are found in the _____ _____ and those associated with the electron transport chain are bound to _____ in these same organelles.

(3) 24. $NADH+H^+$ and $FADH_2$ can be reoxidized by passing their electrons to the electron transport chain. This series of reactions involves a number of pigmented enzymes called _____ that have iron prosthetic groups, and are bound to membranes (most of them are integral proteins). Each $NADH+H^+$ that is reoxidized via this pathway yields enough energy to make _____ (#) ATP and each $FADH_2$ reoxidized yields enough energy to make_____ (#) ATP.

(2) 25. In respiratory organisms, the coenzymes reduced during the reactions of glycolysis and the Kreb's cycle are eventually reoxidized by passing their electrons to the _____ _____. This is a series of membrane bound proteins (enzymes), most of which have iron prosthetic groups that can be alternately oxidized and reduced. The final electron acceptor at the end of this chain is an exogenous oxidizing agent such as _____ _____ or nitrate.

(3) 26. When cellular respiration occurs under aerobic conditions, the final electron acceptor is usually _____. This inorganic compound picks up electrons and hydrogen protons to become _____. Explain briefly why a final electron acceptor is needed, i.e., explain what function it serves. _____.

(3) 27. The ATP molecules formed in association with the electron transport chain of respiration are produced via _____ phosphorylation, and the energy required is provided by the flow of _____ across a membrane. Prokaryotic organisms produce approximately _____ (#) molecules of ATP for each molecule of glucose they catabolize.

(2) 28. The proton motive force generated in association with the electron transport chain of respiration is the gradient that causes hydrogen protons to flow through the _____ enzymes of membranes, thus providing the energy to make ATP. Research indicates that _____ (#) hydrogen protons must cross the membrane in order to make one molecule of ATP.

(3) 29. Most of the electron acceptors in the electron transport chain are _____ (pigmented proteins with iron prosthetic groups). The passage of electrons along this chain of proteins provides energy used to pump hydrogen protons across the membrane and to create a concentration and electrical gradient known as the _____. This gradient then causes protons to flow through an enzyme complex called _____ thus providing the energy needed to make ATP.

(2) 30. In eukaryotic cells, the passage of electrons along the electron transport chain causes _____ to accumulate within the intermembrane space of a mitochondrion. The reoxidation of one molecule of $FADH_2$ creates enough of an electrical and concentration gradient to drive the synthesis of (what and how many?) _____.

(3) 31. Lipid catabolism involves many of the same biochemical pathways used in the catabolism of carbohydrates. When a triglyceride is catabolized, the three-carbon glycerol "backbone" can be phosphorylated to form dihydroxyacetone phosphate (DHAP) and then catabolized via the _____ pathway. The fatty acid chains can then undergo a process called _____ during which they are cut into two-carbon units and bound to a coenzyme to form _____. This can then be catabolized by the reactions of the Kreb's cycle.

(2) 32 During protein catabolism, the amino acids are separated and _____ to yield substances that can be catabolized via glycolysis or the Kreb's cycle, thus yielding energy. During anabolism, metabolites such as pyruvate, oxaloacetate and α-ketoglutarate are used to make _____ that are then assembled into new proteins.

Photosynthesis:

(5) 1. Define:

Photophosphorylation

Ferredoxin

Bacteriochlorophyll

Anoxygenic

Calvin-Benson cycle

(1) 2. Phototrophic microorganisms such as algae, cyanobacteria and some other types of bacteria use light energy to produce ATP by means of a process called _____. These reactions are sometimes called the "light reactions" of photosynthesis.

(2) 3. Photophosphorylation as it occurs in the green and purple sulfur bacteria involves light trapping pigment molecules called _____ and is said to be cyclic because the electrons that leave the pigments eventually return to them. These bacteria do not produce oxygen as a by product of their photosynthetic activities, and so are said to be _____ phototrophs.

(2) 4. ATP production via photophosphorylation is very similar to ATP production via oxidative phosphorylation. In both processes, the flow of electrons along an electron transport chain provides energy used to pump hydrogen protons across a membrane to form a concentration and electrical gradient known as the _____. When these hydrogen ions flow back across the membrane "down hill" they pass through an enzyme complex called _____ and provide the energy required for the conversion of ADP + Pi into ATP.

(3) 5. Algae and cyanobacteria use non-cyclic photophosphorylation reactions to capture light energy. During these reactions, electrons "bounce" away from certain atoms in green pigment molecules called _____ and are passed to electron acceptors. Electrons captured by _____ are passed along a series of cytochromes and then back to green pigments. Electrons that are captured by _____ are ultimately passed to NADP and are not returned to the pigments.

(2) 6. The light trapping pigments and electron acceptors involved in photophosphorylation are found in association with membranes called _____ in both cyanobacteria and eukaryotic cells. Similar pigments and electron acceptors are found in association with the _____ of anoxygenic phototrophic bacteria.

(2) 7. Algae and cyanobacteria utilize an electron acceptor called _____ to trap electrons leaving the pigment molecules of photosystem II. Since the electrons are not returned, the chlorophyll molecules "pull" replacement electrons away from water molecules and form _____ as a by-product.

(2) 8. The pigments associated with photosystem I (pigment system I) in algae and cyanobacteria pass their electrons to an acceptor molecule known as _____. These electrons do not return, but are passed to a coenzyme called _____.

(1) 9. The oxygen formed by oxygenic phototrophs such as algae and cyanobacteria are produced by splitting _____ molecules.

(2) 10. The cytochromes involved in photophosphorylation are bound to membranes called _____ in both cyanobacteria and eukaryotic cells. Enzymes which catalyze the reactions of the Calvin-Benson cycle are associated with inclusions called _____ in prokaryotic cells and with the stroma of chloroplasts in eukaryotic cells.

(1) 11. A series of chemical reactions known as the _____ are catalyzed by enzymes found within the stroma of chloroplasts or within carboxysomes.

(2) 12. The chemical reactions associated with non-cyclic photophosphorylation trap light energy in two ways, i.e., result in the formation of two types of energy-rich compounds, these are _____ and _____.

(3) 13. Autotrophic organisms use an anabolic pathway known as the _____ to "fix" inorganic carbon (in the form of carbon dioxide) into organic compounds (sugars). This pathway requires energy which is provided by _____ and _____.

(2) 14. Autotrophic microorganisms use an enzyme called _____ to bind carbon dioxide to a five carbon sugar molecule called ribulose biphosphate (ribulose diphosphate) at one point in the Calvin-Benson cycle. How many reactions must this enzyme catalyze in order to form one molecule of fructose?

(2) 15. The Calvin-Benson cycle is a series of chemical reactions which allow autotrophic organisms to _____. The enzymes needed to run this pathway are associated with structures (inclusions) called _____ in prokaryotic cells.

(2) 16. A series of chemical reactions which allow autotrophic organisms to "fix" carbon from carbon dioxide into organic compounds (sugars) is known as the _____. The enzymes which catalyze the reactions of this cycle are found in association with the _____ in eukaryotic cells.

(2) 17. The chemical reactions of photosynthesis are sometimes represented by the following formula: $6CO_2 + 6H_2O$ + energy from light will yield $C_6H_{12}O_6 + 6O_2$. Although this is generally true for algae and cyanobacteria, it does not apply to all organisms. Bacteria that are nutritionally categorized as photoheterotrophs are able to make ATP using light energy, but cannot _____ _____. Bacteria that are categorized as chemoautotrophs can use inorganic carbon to make sugar, but cannot _____. Some bacteria are able to run both the light reactions and dark reactions of photosynthesis, but are anoxygenic.

(1) 18. Phototrophic bacteria in the genus *Halobacterium* use a light sensitive pigment called _____ to capture light energy and to pump hydrogen protons across membranes. ATP production in these organisms does not require cytochromes in an electron transport chain.

DNA, RNA and Protein Synthesis:

(5) 1. Define:

Nucleotide

Okazaki fragments

Phosphodiester bonds

Sigma factor

Aminoacyl-t-RNA-synthetase

(2) 2. The nucleic acids, DNA and RNA, are long chain molecules made up of smaller units called _____ that are connected together by phosphodiester bonds. In RNA these smaller units contain a sugar called _____ while in DNA they do not.

(2) 3. _____ are long chain molecules made up of small repeating units called nucleotides. The 5' end of each nucleotide is bound to the 3' end of the next via a covalent bond known as a _____ bond.

(2) 4. Cellular DNA molecules differ from cellular RNA molecules in that they are double stranded rather than single, are much larger (longer), contain the pentose sugar _____ and the pyrimidine base _____.

(2) 5. Cellular DNA molecules (and some viral RNA molecules) are double stranded, i.e., the purine bases in one strand are complimentary to specific _____ bases in the other and are bound to them by _____ bonds.

(2) 6. In the DNA double helix (duplex), the nitrogenous bases Adenine and Guanine (bases with two rings in their structure) are called _____. These will form hydrogen bonds with their _____ bases Thymine and Cytosine, respectively.

(1) 7. The two strands of a DNA double helix are oriented in opposite directions 5' to 3', or are "up-side-down" relative to one another, and so are said to be _____.

(2) 8. A _____ is made up of a pentose sugar, a nitrogenous base, and a phosphate group. If a polymer is formed by connecting a series of these small molecules together, what chemical group would be located at the 5' end? _____

(2) 9. The process by which DNA molecules reproduce themselves is sometimes called semi-conservative _____ because each new duplex formed contains half of the original DNA. This process is initiated at sites on an existing DNA strand called _____. Circular chromosomes usually have only one of these, while linear chromosomes have many.

(2) 10. DNA replication as it occurs in *E. coli*, requires a number of enzymes. These include DNA and RNA _____ , enzymes that can catalyze the attachment of nucleotides to the free 3' end of existing nucleotide strands; and _____ , an enzyme that serves to bind the fragments of the lagging strand into a single long chain).

(2) 11. Prokaryotic microorganisms reproduce their chromosomal and plasmid DNA by a process called _____. This process begins at a site called the origin, and usually proceeds around the loop in both directions. Since polymerase enzymes can only "build" DNA in the 5' to 3' direction, one strand is formed in a continuous sequence, and the other is formed in a series of segments called _____.

(3) 12 The polymerase enzymes involved in building DNA can only "build" in one direction because they can only add nucleotides (bases) to the _____ end of a growing nucleotide strand. As a consequence of this, the leading strand is built as a continuous sequence, while the lagging strand must be built in segments as the duplex unwinds. In *E. coli*, the enzyme required to start each Okazaki fragment is DNA dependent _____. The Okazaki fragments are eventually spliced together by _____ enzymes, and the DNA duplex is completed.

(2) 13. The process by which cellular RNA molecules are formed is called RNA synthesis or _____ and is similar to replication in that it requires a single strand of DNA as a template (pattern) and energy as provided by _____.

(3) 14. Transcription is the process by which _____ are made, and is similar to semi- conservative replication in that:
1.) it requires a single strand of DNA to serve as a template.
2.) _____
3.) _____

(2) 15. Transcription requires DNA as a template or pattern and can only be initiated at specific locations. The region on a DNA strand where transcription begins is called the _____ site and is recognized by a protein called _____ (which is a portion of the RNA polymerase enzyme complex). Transcription also requires _____ which is provided by the nucleotides (rNTPs) involved in the process.

(2) 16. That portion of DNA dependent RNA polymerase which determines where transcription will begin and in which direction it will proceed is called _____. Once this protein binds to the promoter site of the DNA molecule, the core enzyme can bind, and transcription can proceed. Each _____ molecule formed via this process is essentially a copy of one small segment of one strand of the DNA.

(2) 17. In eukaryotic cells most genes are split genes, so transcription is followed by a process called _____ during which RNA molecules are modified by having their _____ removed and by having a cap and a poly-A tail added. This process is accomplished in part by s-RNA.

(2) 18. Eukaryotic cells produce small or short RNA molecules (s-RNA) that bind to proteins to form structures called _____. These are involved in post-transcriptional modification, and apparently recognize where RNA molecules are to be cut and spliced. After the intervening regions are removed, segments of RNA called _____ are spliced together and the resulting molecule is given a cap and a poly-A tail.

(2) 19. RNA molecules that coordinate the attachment of t-RNA to m-RNA during protein synthesis are called _____ while RNA molecules called _____ carry individual amino acids to the ribosomes for protein synthesis.

(2) 20. RNA molecules known as _____ are actually copies of small segments of DNA known as structural genes. In prokaryotic cells, these RNA molecules often contain information that allows them to code for more than one polypeptide chain (protein) because transcription is _____.

(2) 21. Individual t-RNA molecules carry specific amino acids to the ribosome during the synthesis of proteins. The enzymes catalyzing reactions attaching specific amino acids to t-RNA are called _____. That portion of the t-RNA which determines which amino acid is added to the polypeptide next is called the _____ region and forms hydrogen bonds with m-RNA at the ribosome.

(2) 22. The sequence of codons on a _____ molecule determines the sequence of amino acids in a polypeptide, but the amino acids cannot recognize nor bind to these molecules. Instead, each amino acid is carried by a specific t-RNA molecule. The factor that insures each t-RNA is carrying the correct amino acid is _____.

(2) 23. The primary factor determining which t-RNA will bind to the A-site of the ribosome at any given moment is whether or not the _____ region of that t-RNA can form hydrogen bonds with the complimentary bases of m-RNA. The enzymes which insure that each t-RNA is carrying the correct amino acid are called _____.

(1) 24. A _____ may be defined as a set of three bases on m-RNA which codes for a specific amino acid. This same term can also be applied to a set of three bases on a DNA strand.

(2) 25. The process by which proteins are made is called protein synthesis or _____ and occurs in association with structures called _____ in both prokaryotic and eukaryotic cells.

(3) 26. During the translation process, the _____ regions of a t-RNA molecules form hydrogen bonds with the codons of _____ as they pass through the ribosome. The enzyme which catalyzes the formation of a peptide bond between two adjacent amino acids is called _____ and is part of the ribosome itself.

(2) 27. The primary factor determining which t-RNA will bind to the A-site of the ribosome at any given moment is whether or not the _____ region of that t-RNA can form hydrogen bonds with the _____ (set of three complimentary bases) of m-RNA.

(1) 28. Three sets of nucleotides (nitrogenous bases) known as "ocher", "amber" and "umber" do not code for individual amino acids, but instead code for _____.

(4) 29. Use the DNA sequence shown and the genetic code handout provided to complete the statements below. If the sense strand of DNA has the base sequence TCTACAGTTTGGGCATACCTTACCAAC

Transcription of this DNA will yield _____

Translation of the RNA represented above will yield _____ _____

Does the polypeptide represented above contain the same number of amino acids as there are codons in the m-RNA formed? _____ Explain why or why not.

(1) 30. Explain briefly how the nucleotide sequence of a structural gene can have a significant influence on metabolism (i.e., how genetic information influences cell activity).

(3) 31. Each amino acid being added to a growing polypeptide chain is bonded to the previous amino acid by a covalent bond called a _____ bond. This bonding is catalyzed by an enzyme called peptidyl transferase which is part of the _____. The termination of a growing polypeptide chain is signaled by the presence of a _____ on the m-RNA molecule.

(1) 32. The term _____ may be used to describe a unit formed by many ribosomes attached to and translating a single m-RNA molecule.

(2) 33. A single m-RNA molecule is normally attached to several ribosomes during the translation process, forming a unit referred to as a _____. The ribosomes provide an enzyme called _____ which catalyzes the formation of peptide bonds between the individual amino acids thus forming a polypeptide chain.

Regulation of Gene expression (Genetic Control):

(5) 1. Define:

Operon

Promoter

Operator

Catabolite repression

Constitutive enzyme

(1) 2. Early investigations into the regulation of metabolic processes indicated that many enzymatic pathways are controlled by _____ a process which allows the product of a metabolic pathway to influence the activity of the enzymes in that pathway.

(2) 3. Both prokaryotic and eukaryotic cells can regulate some of their metabolic activity at the enzyme level by means of a mechanism called feedback inhibition. This regulation involves the _____ (be specific) of an enzyme, usually the first in a series, by the end product of the metabolic pathway. In what way might this process be considered less efficient than end-product repression?

(1) 4. _____ is a process or mechanism which allows the end-product of a metabolic pathway to inhibit its own production by acting as an allosteric inhibitor for the first enzyme in the pathway.

(2) 5. In eukaryotic organisms, one m-RNA molecule is essentially a copy of the genetic information contained within an area of DNA known as a _____. In prokaryotic cells, transcription is often polycistronic. How does this influence the resulting m-RNA molecule?

(2) 6. In prokaryotic cells, the genes coding for enzymes involved in a single metabolic pathway are often located adjacent to one another within a single _____ (region of DNA containing structural genes and the control elements regulating their transcription). The transcription of these genes is said to be _____ because they are not transcribed individually, but are transcribed together as a single unit. Translation of the resulting m-RNA often begins before transcription is completed.

(2) 7. An _____ is a segment of DNA which includes a sequence of structural genes plus the control elements involved in regulating their transcription. RNA

polymerase binds and begins transcription at a site within this segment known as the _____ site.

(1) 8. The promoter site (P-site) of an operon has what function?

(2) 9. In the repressible system controlling tryptophan biosynthesis, the R-gene codes for a protein known as the _____. This protein is not active alone, so can bind to the _____ site only when it has been activated by the corepressor tryptophan.

(2) 10. In the repressible system controlling tryptophan biosynthesis in E. coli, the R-gene (regulatory gene) codes for a protein called the _____. This protein can bind to the operator site and block transcription only if it is aided by _____.

(3) 11. Tryptophan biosynthesis in *E. coli* is regulated at the genetic level through a _____ _____. The genes coding for the enzymes involved in tryptophan biosynthesis are transcribed together as one large m-RNA (transcription is polycistronic), or are not transcribed at all. If excess tryptophan is present within the cell, it acts as a _____ to activate the repressor protein. The repressor-tryptophan complex then binds to the _____ site (be specific) on the DNA and blocks the transcription of all the genes coding for enzymes used in tryptophan biosynthesis.

(3) 12. In *E. coli* the utilization of lactose is controlled at the genetic level through an _____ _____. A type of enzyme called □-galactoside _____ allows lactose to enter the cell and a type of enzyme called thiogalactoside transacetylase converts some of the lactose to _____. This molecule then acts as an inducer for the lactose utilization system.

(2) 13. The transcription of genes needed in the utilization of lactose can be partially induced by binding _____ to the repressor protein, thus inactivating it. However, even after the repressor is removed, transcription will be minimal until cyclic-AMP and a protein called _____ bind near the promoter site and enhance the attachment of sigma factor.

(2) 14. The operon controlling lactose utilization in *E coli* contains three structural genes that code for enzymes involved in lactose utilization. The enzymes include a permease (to bring lactose into the cell), one called _____ (that breaks lactose into glucose and galactose) and a transacetylase involved in forming allolactose. What is the function of the allolactose formed?

(1) 15. In the inducible system controlling lactose utilization, the repressor protein is active under what circumstances?

(1) 16. The □-galactoside premease coded for by a gene within the lactose utilization operon (lac operon) has what function? _____

(2) 17. Thiogalactoside transacetylase is an enzyme coded for by a gene in the _____ _____. The function of this enzyme is to convert lactose into _____.

(2) 18. _____ is a mechanism that allows organisms to utilize enzymatic pathways involving constitutive enzymes in favor of using those for which the enzymes must be induced. A nucleotide known as _____ serves as a regulatory molecule in this process.

(3) 19. Catabolite repression is a mechanism that allows organisms such as *E. coli* to utilize _____ in favor of a catabolite such as lactose. The enzymes involved in glucose catabolism are _____ (always present) so do not require induction. In order to use lactose, an *E. coli* cell must induce the lactose utilization operon with allolactose and must contain high levels of _____ (a nucleotide).

(2) 20. Enzymes which are always present within prokaryotic cells, i.e., are neither inducible nor repressible are said to be _____. A mechanism which allows cells to utilize these enzymes in favor of those which must be induced is called _____.

Genes and Mutations:

(5) 1. Define:

Genetics

Phenotype

Point mutation

Translocation

Mutagenic agent (mutagen)

(2) 2. _____ may be defined as the science or study of heredity and is concerned with the physical and chemical properties of hereditary material (_____ _____), and how this material is transmitted from one generation to the next.

(1) 3. Individual genes generally occupy specific locations within a chromosome, plasmid or viral genome. This is known as the _____. In some cases one or more genes may overlap within the same nucleotide sequence.

(2) 4. A sequence of nucleotides (DNA or RNA) that codes for a functional polypeptide or for a functional RNA molecule can be referred to as a _____. If this sequence includes one or more intervening regions (introns) it may be called a _____. Such sequences are common in eukaryotic cells, but uncommon in ordinary bacteria.

(1) 5. The _____ of a cell is the total DNA content of that cell and includes control elements as well as structural genes. Note - this term has evolved to have several different meanings depending on the context in which it is being used.

(2) 6. The genetic constitution of a cell or organism (content of genetic information) may be referred to as the _____ of that organism, or its genetic potential. Whether or not the genetic information is expressed is dependent upon the _____ (both outside and inside the cell).

(2) 7. The total DNA content of an organism may be referred to as the _____ of that organism and includes both chromosomal and extrachromosomal DNA. The observed behavior or appearance (physiological characteristics) of an organism is referred to as the _____ of that organism, and is greatly influenced by the environment in which the organism is placed.

(3) 8. The _____ of an organism, or the observed characteristics of that organism is dependent upon the genotype present and the _____ . Under what circumstances would genetic information not be expressed?

(1) 9. A _____ may be defined as a stable, heritable change in the nucleotide sequence of DNA (or RNA in the case of some viruses).

(2) 10. Any stable, heritable change in the base sequence of DNA (excluding those changes brought about by genetic exchange) is referred to as a _____ and is the basis for _____ or change in populations over time.

(2) 11. Spontaneous mutations, those which occur under natural conditions or for no discernible reason, occur at a rate of about _____. If a bacterial population is able to reach it's m-concentration in 24 hours, how many mutations would be expected to have occurred within the population during that time period? _____

(2) 12. Point mutations known as _____ are potentially less significant to cells than are addition or deletion type mutations. Why is this so?

(3) 13. Frame-shift mutations may be caused by either _____ _____ DNA molecules. This will cause a "shift" in the "reading frame" for all of the _____ (sets of three bases) on the m-RNA molecule that determines the amino acid sequence of a given protein. A physical mutagen known as _____ increases the frequency of such mutations by causing the formation of T-T dimers. Since these mutations are usually lethal to cells, there is a great deal of concern about the amount of this mutagen in the environment.

(2) 14. Mutations known as _____ involve the movement of one or more genes from one place to another within a chromosome, between chromosomes or between chromosomes and plasmids. These are sometimes initiated by segments of DNA called _____ or "jumping genes".

(1) 15. A _____ is a chemical or physical factor that increases the rate at which mutations occur.

(1) 16. Chemical agents that are structurally similar to naturally occurring nitrogenous bases (A, T, C or G) and so can be incorporated into DNA are known as _____. These chemicals often cause substitution-type point mutations.

(2) 17. AZT and 5 bromo-uracil are examples of mutagens known as _____ because they can be incorporated into DNA in the place of naturally occurring bases. Since these mutagens code for the wrong complimentary bases when the DNA replicates, they tend to cause _____ type point mutations.

(2) 18. Although point mutations known as _____ may or may not result in a change in amino acid sequence, mutations known as "frame shifts" most certainly will. One example of a physical mutagen known to cause "frame shift" mutations is _____.

(2) 19. _____ is a physical factor known to cause the formation of thymine-thymine dimers within DNA. Such dimers will code for only one complimentary base instead of two, and so will result in a _____ type point mutation.

(2) 20. _____ or "jumping genes" are segments of DNA which initiate their own movement from one place to another within chromosomes, between chromosomes, or between chromosomes and plasmids. Such segments may be responsible for causing non-point mutations known as _____.

(2) 21. Segments of DNA which are able to initiate their own movement from one place to another within a chromosome or between chromosomes are referred to as _____ or "jumping genes". Such segments may be responsible for causing non-point mutations known as _____.

(2) 22. Bacteria exposed to ultra violet are often killed by the formation of _____ (These will code for an incorrect number of complimentary bases, and cause deletion type point mutations). Bacteria that contain enzymes activated by visible light can repair such damage by doing what?

Mechanisms of Genetic Exchange and Recombinant DNA Techniques:

(5) 1. Define:

Transformation

Episome

Sexduction

Transduction

Restriction endonuclease

(2) 2. _____ may be defined as a combination of chromosomal DNA from more than one source. Such molecules can be constructed in vitro using a variety of genetic engineering techniques, or may occur naturally as the result of _____.

(1) 3. DNA molecules containing chromosomal material from more than one source are referred to as _____ and may be formed in bacteria via a variety of genetic exchange processes.

(1) 4. In nature, prokaryotic cells are able to exchange DNA most efficiently if they are closely related (usually within the same species). This is because bacteria produce enzymes called _____ which recognize and chop up foreign DNA.

(1) 5. In most instances, DNA which is transferred into a recipient cell will replace the _____ DNA already present (i.e., DNA that is not identical, but is coding for the same general characteristics).

(2) 6. The genetic exchange mechanisms used by bacteria are similar to one another in a number of ways. Explain any two ways in which all of these processes are similar.
a) _____
b) _____

(2) 7. All genetic exchange processes are similar in that the cells involved do not _____ _____, the DNA transfer is one-way

(from donor to recipient) and in most instances only a small portion of the genome is transferred. Under natural conditions, genetic exchange is most successful if the cells involved are closely related because?

(2) 8. _____ is a genetic exchange process which involves the transfer of DNA from a dead donor cell to a live recipient. This process was first observed to occur in bacteria in the genus _____.

(2) 9. During transformation, bacteria are able to pick up _____. Bacteria are able to undergo transformation only if they are _____, i.e., able to transport the DNA through their cell walls. This usually requires that they be undergoing the fission process.

(2) 10. A genetic exchange mechanism that involves the transfer of DNA from donor to recipient with the aid of structures called sex pili is known as _____. If the cells involved in the "mating" process are F- (F minus) and F' (F prime), and if the recipient cell becomes recombinant and a partial diploid, the process is called _____.

(2) 11. During conjugation, DNA is transferred from donor to recipient with the aid of structures known as _____. These structures are coded for by genes carried on a plasmid called _____.

(1) 12. A segment of extrachromosomal DNA that can become incorporated into the chromosome is called a/an _____ and may be either a virus or a plasmid.

(1) 13. A "male-type" *E. coli* cell that carries its "male" genes within its chromosome is referred to as a _____ because when "mated" to an F- (F minus) cell it is very likely to cause the formation of a recombinant cell.

(3) 14. A specific form of conjugation called _____ involves a transfer of DNA from an F' (F prime) cell to an F- (F minus) cell and results in the formation of a "male" type cell that is _____ and a _____.

(1) 15. The transfer of DNA from donor to recipient via a virus which was initially cytolytic is referred to as _____ (be specific).

(1) 16. The process by which DNA can be transferred from one bacterial cell to another via a virus which is initially a prophage is referred to as _____ _____ (be specific).

(1) 17. A piece of DNA that can initiate its own replication when placed into a host cell may be called a _____ and may be either a plasmid or a virus.

(1) 18. A type of cloning vector known as a _____ can be formed by combining plasmid DNA with bacteriophage lambda DNA. This type of vector can be used to transfer relatively large segments of DNA.

(5) 19. Matching - Genetic exchange: Match the terms on the left with the most appropriate statements on the right and place the letters of correct matches in the blanks provided.

____ Specialized	A. The location occupied by a specific gene on a chromosome, a plasmid or virus genome.
____ Homologous	B. An *E. coli* cell that is lacking sex pili and so is considered to be female.
____ Sexduction	C. Bacteriophage lambda DNA that is lacking lytic genes, and can be used as a cloning vector.
____ F-	D. A plasmid that carries genes coding for the formation of sex pili and the initiation of genetic exchange.
____ Cosmid	E. Segment of DNA (may be a virus or plasmid) that is a replicon, i.e., able to initiate it's own replication.
____ Hfr	F. A genetic exchange process involving a virus that was initially cytolytic.
____ F-factor	G. A specific type of conjugation that yields a male, partially diploid, recombinant recipient cell.
____ Cloning vector	H. Genes that code for the same traits or characteristics, but are not identical (also called alleles).
____ Locus	I. A genetic exchange process that involves a virus that was initially a prophage.
____ Generalized	J. When "mated" to F- (F minus) is very likely to yield a recombinant F- (F minus) cell.

Introduction to Prions, Viroids and Viruses:

(5) 1. Define:

Virion

Prophage

Lysogenic conversion

Retrovirus

Reverse transcriptase

Prion

Viroid

(1) 2. The term virus is Latin for _____ and has been applied to a variety of different disease causing agents over time.

(2) 3. A complete virus particle as it exists outside of its host (the infective form of a virus) is referred to as a _____ and always includes a nucleic acid core that is surrounded by a _____.

(2) 4. A typical virion includes a _____ core which is surrounded by a protein coat or capsid made up of units called _____. These are made up of still smaller units called protomers.

(3) 5. A typical virus particle is composed of a nucleic acid core containing _____ that is surrounded by a protein covering called a _____. In some cases, the nucleocapsid is covered by an envelope and in other cases it is equipped with an elaborate _____ that includes a collar, core, sheath, base plate, fibers and pins.

(2) 6. The nucleic acid core of a virus may be composed of DNA or RNA but never both. In what other ways do the genomes of various viruses differ from one another.

(2) 7. A _____ is a virus that infects bacteria and causes lysis (cell death) at the completion of its life cycle. The process by which such a virus attaches to its host is called _____ and involves chemical bonding between proteins (tail fibers, capsid, envelope) of the virus and specific receptor sites on the host cell surface.

(2) 8. A coliphage is said to be avirulent or _____ if it does not cause lysis of its host. When such a virus has become incorporated into the host cells chromosome, it is called a _____ and will be reproduced along with the host cells DNA.

(2) 9. The first two stages in the life cycle of a typical T-even virus are _____ (during which the tail-fibers of the virus bind with specific receptor sites on the cell surface) and _____ (during which the nucleic acid core is injected into the cell).

(2) 10. During the life cycle of a T-even bacteriophage, different viral genes are transcribed and translated at different times. The immediate early phage genes code for enzymes that _____ while the late phage genes code for _____.

(3) 11. The genes of a T-even bacteriophage are not all transcribed and translated at the same time. List the sequence in which these genes are activated, and explain what each set codes for within the host.
a) _____
b) _____
c) _____

(2) 12. After the genome of a cytolytic virus has entered its host, it uses the host cells metabolic processes to transcribe and translate its genes. What host cell materials are essential to viral reproduction?

(2) 13. A temperate phage that has become incorporated into the chromosome of its host cell is referred to as a _____. If the host takes on new phenotypic characteristics (such as the ability to produce toxins) due to the presence of the viral genes it is said to have undergone _____.

(1) 14. A bacterial cell (lysogenic cell) is said to have undergone _____ _____ when it has been infected by a virus, and has acquired some characteristics that are coded for by viral genes. The ability of certain bacteria to produce _____ is believed to be due to this process.

(1) 15. Animal viruses are sometimes surrounded by a flexible membrane-like layer called an _____ which they acquire as they exit their host cell.

(3) 16. A coliphage called _____ is a temperate or avirulent phage that can enter the chromosome of it's host to become a _____ as long as it's lytic genes are not being expressed. If the host cell becomes stressed, a proteolytic enzyme coded for by the RecA gene will degrade the specific _____ protein that is blocking transcription of the viral lytic genes. The virus will then complete a lytic cycle and kill it's host.

(3) 17. HIV is a double-stranded RNA type virus called a _____ because its genetic information is reverse transcribed into DNA after it enters its host. This virus carries with it an enzyme called RNA dependent DNA polymerase or _____. What happens to the viral DNA within the host cell?

(1) 18. The adsorption process of HIV involves binding of spike proteins on the _____ _____ with specific receptors on the host cell surface.

(1) 19. HIV is a retrovirus which must _____ it's genetic information from RNA into DNA before it can become incorporated into the hosts chromosome.

(1) 20. HIV uses an enzyme called _____ to incorporate the DNA version of its viral genome into the chromosome of its host.

(3) 21. An enzyme that allows viral RNA to be reverse transcribed into DNA is called _____ and is found in association a group of viruses called _____. Among these, the virus called _____ is of great concern to humans.

(1) 22. Viruses are known to cause a variety of diseases in humans including the common cold, chicken-pox, measles, hepatitis and AIDS. Certain viruses have also been shown to induce the formation of _____ in humans.

(4) 23. Matching - Viruses:

Match the disease on the left with the virus most likely to be the causative agent, and place the letters of correct matches in the blanks provided.

____ Hepatitis	A. Symptoms associated with infection by human herpesvirus types 1 and 2.
____ Mumps	B. Zoonosis of the nervous system, caused by a mosquito-borne arbovirus.
____ German measles	C. Highly contagious disease caused by the varicella-zoster virus.
____ Oral & Genital lesions	D. Enlargement of the parotid salivary glands caused by a paramyxovirus.
____ Encephalitis	E. Caused by a rhabdovirus transmitted via the bite (or lick) of an infected animal.
____ Rabies	F. Acute illness caused by a paramyxovirus known as the rubella virus.
____ Common cold	G. Viral induced inflammation of the liver and reduced liver function.
____ Chicken-pox/shingles	H. Upper respiratory tract infection caused by a rhinovirus.

<u>Control of Microorganisms and Antimicrobial Chemotherapy:</u>

(5) 1. Define:

Cidal

Antiseptic

Disinfectant

Antibiotic

Penicillinase

(2) 2. Microbial control methods that kill cells in large numbers are referred to as being _____. When all viable cells have been eliminated from an object or material (glassware, media, etc.) that object or material is said to have been _____.

(1) 3. Materials such as microbiological media, glassware, syringes, needles, etc. are said to have been _____ if they have been subjected to a treatment which has left them virtually free of any viable cells.

(2) 4. A microbial control method that does not kill cells, but inhibits their growth is said to be _____. One example of a physical factor that has this effect is _____.

(1) 5. Why would pasteurization or boiling for one minute not be considered an effective means of sterilizing liquids? _____

(3) 6. Temperature is a physical factor often used to control microorganisms. High temperatures (heat) may be applied in a method called _____ that involves the alternate boiling and cooling of liquids over a period of three days. Heat (steam) under pressure may be applied in a device called an _____. Cold temperature (freezing) can also be used to control microorganisms, but is _____ rather than cidal because most bacteria are psychroduric.

(2) 7. _____ is a physical factor that can be used to sterilize heat sensitive materials such as plastic Petri dishes and pipettes. This control method is highly effective, but is used less commonly than heat because it is expensive and _____.

(1) 8. Heat sensitive liquids and gasses can be sterilized by means of _____, a method that is not bactericidal, but can be used to remove all viable cells.

(2) 9. Chemical agents that are used to control pathogenic microorganisms on non-living surfaces are referred to as _____. Chemicals that are used systemically to control pathogens within the body are called _____ agents and may be either antibiotics or synthetic drugs.

(2) 10. Many chemicals have been designed for use in the control of pathogenic microorganisms outside the body. If these chemicals are to be used on a regular basis, they must meet certain criteria. They must be _____, non-hazardous to the person applying them, readily soluble, non-corrosive or not damaging to the surface they are being applied to, and _____ within a reasonable period of time.

(2) 11. What two features of a chemical agent would you be most concerned about if you were expected to use the chemical to control microbes on a regular basis (every day).
1) _____
2) _____

(1) 12. A/an _____ is a chemical agent used to control pathogenic microorganisms on non-living surfaces.

(2) 13. A chemical agent designed to control pathogenic microorganisms on living surfaces is referred to as a/an _____, while one designed for use on non-living surfaces is called a/an _____. In some cases, the same chemical may be used for both applications.

(5) 14. Matching: Match the terms on the left with the most appropriate statements on the right and place the letters of correct matches in the blanks provided.

____ Freezing	A. Treatment which renders materials or objects free of any viable cells.
____ Antiseptic	B. Cause the hydrogens of organic compounds to be replaced by methyl or ethyl groups.
____ Metal ions	C. Cidal physical factors which cause the formation of ions or free radicals.
____ Alkylating agents	D. Oxidizing agents including chlorine, bromine, fluorine, and iodine.
____ Pasteurization	E. Chemical agent used to control pathogens on non-living surfaces.
____ X-rays	F. Can be used to sterilize media even though cells are not killed.
____ Filtration	G. Treatment which is bacteristatic, but not cidal to cells which are psychroduric.
____ Disinfectant	I. Chemical agent used to control pathogens on living surfaces (skin).
____ Halogens	J. Treatment which will kill vegetative cells but not endospores.
____ Sterilization	K. Mercury, lead, zinc, copper and silver.

(2) 15. Chemicals called _____ are often mixed with other control agents because they decrease the surface tension of water and increase the penetrating ability of other disinfectants. A group of chemicals called _____ are powerful oxidizing agents that exert their effect by causing the oxidation of cellular proteins. These are often used to disinfect water and non-living surfaces, but are sometimes used as antiseptics.

(2) 16. Chemicals designed for use in the control of pathogenic microorganisms inside the body are called _____ drugs or agents. If these are (at least initially) produced by some type of microorganism, they are called _____.

(2) 17. A variety of microbes have been found to be sources of new antibiotics. Bacteria in the genera _____ and _____ are two examples of organisms which have this ability.

(3) 18. The concentration of an antimicrobial agent needed to gain clinical control of a pathogen is referred to as the _____ dose for that drug, and must be carefully monitored. What dangers exist if the concentration is too low, or too high? (explain both)
_____

(1) 19. Antibiotics which are effective against only a few types of microorganisms (sometimes only pathogens within a single genus) are referred to as _____ drugs.

(3) 20. If an antimicrobial drug/agent is able to control pathogenic microorganisms without doing damage to human cells or tissues it is said to have good _____ _____. If it is effective against a wide range of microbes (controls both Gram positive and Gram negative cells) it is called a _____ drug. Although drugs with this characteristic are useful when the identity of the pathogen is unknown, they also present a potential hazard. Why might using such drugs be less advantageous than using one with greater specificity?

(1) 21. The sulfa drugs are synthetic antimicrobial agents that inhibit cell growth by _____ _____.

(2) 22. The _____ drugs are synthetic antimicrobial agents which exert their influence by blocking the enzymatic pathway converting _____ _____ within prokaryotic cells.

(2) 23. Antimicrobial drugs known as _____ kill actively growing cells by inhibiting the formation of peptidoglycan. Tetracycline and aminoglycosides exert their antimicrobial effects by _____.

(2) 24. Penicillin is one example of an antibiotic which kills actively growing bacterial cells by inhibiting the formation of _____. This drug is said to have very good _____ because it acts only on prokaryotic cells and is not damaging to eukaryotic cells (assuming no hypersensitivity reaction is involved).

(2) 25. Penicillins and cephalosporins (□-lactam drugs) are cidal to actively growing cells because they _____. Although these drugs are effective against a variety of pathogenic microbes, some organisms have developed resistance. Organisms that are resistant to penicillins produce a type of enzyme called _____ that allows them to degrade the drugs. Genes coding for this enzyme are carried on R-factor plasmids.

(2) 26. Two examples of drugs that inhibit protein synthesis are the _____ (which are cidal) and the _____ (which are static).

(3) 27. _____ and _____ are two examples of antibiotics which control pathogens by inhibiting protein synthesis. Bacitracin exerts its effects by disrupting the _____ function of susceptible cells.

(3) 28. A group of drugs known as _____ inhibit protein synthesis by inhibiting the binding of aminoacyl-t-RNA molecules to the ribosomes. Since their effect is not permanent, these drugs are _____ rather than cidal. Why are drugs that only inhibit cell growth (do not kill cells) effective in controlling pathogenic microorganisms?

(2) 29. A group of antimicrobial agents known as aminoglycosides kill bacteria by _____ _____ (be specific). These drugs are all antibiotics, but may be produced by different types of bacteria. Streptomycin, Neomycin and Kanamycin are produced by bacteria in the genus _____, while Gentamicin and Amikacin are produced by bacteria in the genus *Micromonospora*.

(2) 30. The Polymyxins are antimicrobial drugs produced (at least initially) by bacteria in the genus _____. They exert their effects by _____ _____ and are usually cidal.

(1) 31. Rifampin and Actinomycin D are two types of antimicrobial drugs that control microbes by inhibiting _____.

(1) 32. _____ is an antimicrobial agent known to inhibit the formation of messenger RNA.

(2) 33. Prescription labels for antimicrobial drugs include the recommended dosage (amount to be taken and how often) and the length of time the drug use is to be continued. Why is it important that these guidelines be followed, i.e., what are the potential consequences of not following them?

(1) 34. Why are most of the antimicrobial drugs described in lecture not effective against viruses?

Non-specific Resistance (Innate Immunity and Normal Flora):

(5) 1. Define:

Inflammation

Pyrogen

Macrophage

Interferon

Bacteriocins

(1) 2. Immune mechanisms are said to be _____ or "built in" if they are present at birth, and require no previous exposure to a foreign agent. Most such mechanisms are non-specific.

(1) 3. One of the body's first lines of defense against microbial invasion is the skin. What features of this structure provide a mechanical barrier against infection? _____ _____

(2) 4. The epidermis of human skin provides a chemical barrier against infective agents because it is highly keratinize, _____ and _____.

(3) 5. Human _____ is a protective structure which is tough, keratinized, multi-layered and which sheds its surface cells on a regular basis. Two chemical aspects of this structure that allow it to serve as an effective barrier against pathogenic microbes are _____ and _____.

(2) 6. Human skin provides the body with a physical barrier to many types of infective agents because it is tough, it has _____ and the surface cells are _____ on a regular basis.

(2) 7. Moist surfaces of the body such as those lining the gastro- intestinal, urogenital and respiratory tracts are protected by _____ membranes. In addition to their moist secretions which tend to trap microbes, these surfaces often have lysozyme enzymes that kill microorganisms, IgA type _____ and sometimes cilia.

(2) 8. Mucous membranes produce moist secretions which tend to trap pathogenic microorganisms. In the respiratory system, these trapped microbes may be either killed by enzymes called _____ or "swept" up and out of the airways by structures called _____.

(2) 9. The body's second line of defense against foreign agents are cells known generally as _____ which seek out and consume infective agents. If such cells are agranular, and increase in number is association with chronic infections, they are called _____.

(2) 10. Neutrophils and monocytes are two types of leukocytes that are _____, i.e., able to consume dead cells and bacteria. The largest of these tend to leave the blood stream and take up residence within _____ _____ tissues, masses of spongy-like tissues which serve to "filter" blood or lymph.

(1) 11. _____ are granular leukocytes that tend to increase in number during acute infections.

(2) 12. _____ may be defined as an increase in redness, swelling and temperature in an area of traumatized tissue. Much of this response is brought about by the release of _____ a substance which dilates blood vessels and increases capillary permeability.

(2) 13. _____ is a protective response characterized by an increase in redness, swelling and temperature in an area of traumatized tissue. This response involves the release of histamine, _____ and leukotrienes by traumatized tissue cells, and increases blood flow to the traumatized area.

(2) 14. A protective response characterized by an increase in redness, swelling and temperature in an area of traumatized tissue is called an _____ response and

involves (among other things) the release of histamine. What function does histamine serve, i.e., how does it help protect the body?

(1) 15. Chemical substances called _____ tend to elevate the temperature within a tissue or within the body overall.

(1) 16. Some cells within the human body respond to viral infection by releasing proteins called _____ which act on other cells to inhibit the completion of virus life cycles.

(1) 17. _____ are proteins produced by cells infected by virus, that can (when released) travel to other cells and initiate mechanisms within them that inhibit viral life cycles.

(1) 18. _____ are plasma proteins that react with one another in a sequential manner to form "holes" through the cell membranes of pathogens or infected body cells.

(2) 19. Complement factors are plasma proteins that can react with one another in a sequential manner. When initiated, the complement "cascade" can cause the formation of _____ _____ and can cause _____.

(2) 20. Microorganisms that are normally found living in and on the human body are referred to as _____ and play a major role in defending the body against pathogens. They do this by taking up _____ and by producing chemical substances called bacteriocins.

(2) 21. Microorganisms referred to as "normal flora" can be found growing on or within various regions of the human body. These organisms do not usually cause disease, and can actually help defend the body by producing _____ and by competing against pathogens for available nutrients and _____.

(1) 22. Describe the "defensive" role played by the normal flora associated with the human body.

Specific Defense and Immunology:

(5) 1. Define:

Acquired immunity

Humoral Immunity

Lymphocyte

Interleukin-2

Cytokine

(2) 2. An adaptive (acquired) or specific immune response may be actively acquired by _____ or passively acquired by _____.

(1) 3. Adaptive (acquired) or specific immunity may be acquired (actively and artificially) by _____.

(1) 4. Adaptive or acquired immunity may be gained passively through the placenta or breast milk or by receiving _____.

(1) 5. Adaptive or acquired immunity may be acquired in a number of ways. It is considered to be passive acquisition and natural if immunity is acquired by _____. This type of immunity is available to most young mammals.

(3) 6. Adaptive or acquired immunity involves leukocytes called _____ and may be divided into two categories. That which involves B-cells and the production of antibodies is referred to as _____ immunity while cellular or cell mediated immunity involves cells which have been processed within the _____ gland.

(2) 7. Adaptive or acquired immunity involves leukocytes called _____ which are produced originally within the red bone marrow. If these cells travel to the _____ gland for processing, they emerge as T-cells and will be involved in cellular or cell mediated immunity.

(2) 8. Lymphocytes (like other blood cells) are produced initially within the _____ by multipotent stem cells. Those cells which travel to the _____ gland for "processing" will participate in cellular immunity.

(3) 9. Adaptive or acquired immunity which involves B-cells and antibodies is referred to as antibody mediated or _____ immunity. The initiation of this immune response involves cells other than B-cells including _____ (that consume antigens and then present antigenic determinants on their cell surfaces) and _____ (that release cytokines that act on the immunocompetent B-cells).

(2) 10. Immunocompetent B-lymphocytes cannot respond to foreign agents without the help of other cells. Name the cells that play a role in activating the B-cells, and explain what they do.

(2) 11. The activation of immunocompetent B-cells by specific antigens usually involves the assistance of two other cells types. These are _____ which present antigenic determinants on their cell surfaces, and _____ which bind the antigenic determinants in association with class II MHC proteins and then release cytokines that act on the B-cells.

(2) 12. The initiation of a humoral immune response usually involves the presence of cells other than B-cells. These include phagocytic white blood cells that _____ _____ and _____ that stimulate the proliferation of B-cells into clones that give rise to plasma cells and B-memory cells.

(1) 13. Immunoglobulins are quaternary _____ which are produced in response to specific antigens and which can bind specifically with those antigens.

(2) 14. Quaternary proteins that are produced by the body in response to foreign agents, and can bind specifically with those agents are called _____ or immunoglobulins. A sudden increase in their titer following a second or subsequent exposure to the same antigen is called an _____ response and is the basis for vaccination.

(2) 15. Immunoglobulins can be divided into five classes or _____ on the basis of the amino acid sequences of their constant regions. Those which contain four polypeptides, can cross the placenta and can "fix" complement are called _____ (be specific).

(1) 16. Immunoglobulins within a given class all have the same _____ within the constant regions of their heavy and light chains.

(2) 17. Immunoglobulins designated as isotype _____ can “fix” complement and play an important role in defending the body, but are too large to cross the placenta. Those designated as isotype _____ are involved in hypersensitivity reactions such as hay fever and anaphylaxis.

(2) 18. Foreign agents that enter the body and initiate the production of antibodies (and other immune substances) are referred to as _____ and have multiple chemically defined sites on their surfaces to which antibodies can bind. When these agents enter the body for the first time, many of them must be consumed and "digested" by _____ before they can be recognized by immune cells.

(1) 19. Foreign agents which enter the body and initiate the production of antibodies are called _____ and may be cells, viruses, or large molecules such as microbial toxins.

(2) 20. Foreign agents that enter the body and initiate the production of immune substances are referred to as _____ and have multiple chemically defined sites on their surfaces. These chemically defined sites are called _____ and are the sites that antibodies bind.

(2) 21. Serological reactions called _____ cause antigens (bacteria or blood cells) to clump together while those called _____ render toxic antigens non-toxic.

(1) 22. If an individual immunized against Rubeola virus at an early age were exposed to a live virulent strain of this same virus as an adult, he/she would probably experience an _____ response, i.e., a rapid increase in antibody titer, and would not develop disease symptoms.

(1) 23. A rapid increase in antibody titer following the second or subsequent exposure to the same antigen is called an _____ response and involves B-memory cells.

(3) 24. Reactions which involve the binding of antibodies to antigens in vitro are called _____ reactions and indicate how antibodies are able to protect the body. If such reactions cause soluble antigens to become insoluble and to "fall out of solution" they are called _____ reactions, and if they prevent pathogenic antigens from binding to cell surfaces, they are referred to as _____ reactions.

(2) 25. A retrovirus currently referred to as _____ has a devastating effect upon human immune function because it selectively infects (and ultimately kills) _____ lymphocytes. In most (if not all) instances, infection with this virus ultimately leads to death.

(1) 26. A cellular or cell mediated immune response cannot be initiated against bacteria or viruses alone, but can be initiated against _____ because T-lymphocytes can respond to antigens only if they are found in combination with major histocompatibility complex proteins, and these are only found on eukaryotic cells.

(3) 27. T-cells exert their effects by releasing chemical substances called _____. Two such chemicals are _____ a substance believed to stimulate cell proliferation and _____ one which kills various types of cells.

(2) 28. The only T-lymphocytes which actually defend the body by attacking and killing infected cells and eukaryotic pathogens are called _____. They exert their influence by releasing cytokines called _____.

(2) 29. T-lymphocytes do not make antibodies, but exert their effects by releasing chemicals called _____. A type of chemical called _____ stimulates the activity of phagocytic white blood cells.

(1) 30. Cellular immunity can be directed only against eukaryotic cells (protozoa, fungi, infected cells and tumor cells) because T-cells can respond to antigens only when they are found in combination with _____.

Immunization and Hypersensitivity:

(5) 1. Define:

Immunization

Vaccine

Toxoid

Hypersensitivity

Anaphylaxis

(3) 2. _____ is the process of conferring specific immunity by artificial means and may be accomplished by administering vaccines, _____ (detoxified microbial toxins) or _____.

(3) 3. _____ may be defined as the process of inducing active immunity by introducing microorganisms or their products into a host in a non-pathogenic form. A substance that contains killed or attenuated microorganisms is called a _____ , while a substance made from detoxified microbial toxin is called a _____.

(2) 4. Immunization is considered appropriate for the mass of the population if _____ _____ and _____ _____.

(2) 5. Two risks that may be associated with immunization include:
1) _____
2) _____

(3) 6. Although a number of important human diseases can be prevented by immunization, there are some potential risks associated with this procedure. Sometimes people who receive vaccines fail to develop immunity, sometimes hypersensitivity reactions are initiated. In some places, vaccines, toxoids or instruments may be _____, and vaccines made with Gram negative bacteria can be _____. Live viral vaccines should not be given to women during pregnancy because the virus may _____.

(1) 7. An abnormal physiological state in which an immune reaction causes tissue damage or malfunction is referred to as _____ or as an allergic reaction.

(2) 8. Hypersensitivity reactions that occur within minutes of exposure to the allergen are categorized as _____ reactions and involve _____.

(2) 9. Abnormal immune reactions which result in tissue damage or malfunction are known as _____ reactions and may involve either antibodies or T-cells. That which can cause the destruction of fetal RBCs by initiating the action of compliment proteins is referred to as a _____ response.

(2) 10. _____ is a type I hypersensitivity reaction that involves immunoglobulins in the class _____ and the release of histamine body wide.

(2) 11. Anaphylaxis is an immediate hypersensitivity reaction that is initiated when allergens bind to _____ attached to mast cells (be specific) throughout the body. The mast cells are then stimulated to release _____ which causes life threatening changes within the circulatory system. This reaction can lead to circulatory shock within minutes.

(1) 12. A type I hypersensitivity reaction that is localized, i.e., tends to affect only the eyes, nasal passages or skin is referred to as _____ and is usually not life threatening.

(1) 13. A type II hypersensitivity reaction known as a cytotoxic response involves IgG and plasma proteins known as _____ factors.

(2) 14. During a type II hypersensitivity reaction known as a cytotoxic response, a mother carrying an Rh positive fetus produces _____ that cross the placenta and stimulate the activity of _____. These bind to the fetal RBCs and cause them to lyse (by forming holes in their cell membranes).

(2) 15. A type III hypersensitivity reaction that is localized is called a/an _____ reaction, while one that occurs body wide is referred to as _____.

(1) 16. Immediate hypersensitivity reactions that involve IgG, IgM and complement factors cause a set of symptoms referred to as _____ disease.

(2) 17. A _____ reaction is one for which symptoms occur 24 or more hours after exposure to the allergen. An individuals reaction to poison oak would fall into this category and involves the activity of T8 lymphocytes known as _____.

(1) 18. People who receive organ transplants or tissue samples from other individuals must be immunosuppressed. This is because the rejection of such organs or tissues involves…?

(1) 19. Although immunizations can sometimes cause hypersensitivity reactions, the most common causes of allergic reactions are _____.

(4) 20. Matching - Immunology and hypersensitivity: Match the term or terms on the left with the most appropriate statements on the right, and place the letters of correct matches in the blanks provided.

____ Anaphylaxis	A. Substance which contains killed or weakened (attenuated) microorganisms.
____ Antiserum	B. Type III hypersensitivity reaction which tends to be localized within the body.
____ Cytotoxic response	C. Blood plasma that lacks clotting factors and contains a high titer of antibody.
____ Hypersensitivity	D. Life threatening hypersensitivity reaction that involves IgG and mast cells that release histamine body wide.
____ Vaccine	E. Hypersensitivity reaction that involves IgG and complement in the destruction of fetal RBCs
____ Type IV	F. Substance that contains detoxified microbial toxin.
____ Arthus reaction	G. Reactions that involve T-cells and cytokine and occur 24-48 hours or more after exposure to the allergen.
____ Toxoid	H. Any abnormal immune reaction that causes tissue damage or malfunction within an individual.

Epidemiology and Disease Transmission:

(5) 1. Define:

Epidemiology

Endemic

Reservoir

Zoonosis

Morbidity rate

(2) 2. _____ may be defined as the quantitative study of the occurrence of disease, and factors that influence disease frequency and distribution. What is the primary goal of people working in this field? _____

(2) 3. Since epidemiology is a quantitative study, it involves the collection and analysis of large quantities of data, and the making of recommendations based on the information gathered. In the United States, the agency responsible for data collection, analysis and reporting (recommendations) is the _____ with it's headquarters in Atlanta, Georgia. The agency responsible for coordinating similar activities throughout the world is the _____ with it's headquarters in Geneva, Switzerland.

(2) 4. A disease that tends to affect a relatively small percentage of a population, but at a constant rate, is said to be _____ to that population (an example would be cholera in Southeast Asia). A disease that occurs in small, localized, unpredictable outbreaks would be referred to as being _____ (Legionnaire's disease has this characteristic).

(2) 5. Diseases such as chicken-pox and measles tend to be endemic to human populations that have not received immunization; however, when the number of new cases rises significantly above the expected "background" level, the disease is said to have become an _____. If the disease is wide spread, such that it threatens people of many nations on more than one continent, it is said to be _____ (currently, AIDS falls into this category).

(2) 6. Air and water are non-living reservoirs that tend to pick up potential pathogens from living reservoirs and from _____, a non-living reservoir that supports the growth of many microorganisms. Since air and water tend to carry microbes, sometimes for long distances, they can also be considered as _____ involved in disease transmission.

(5) 7. Matching - Epidemiology: Match the term or terms on the left with the most appropriate statements on the right, and place the letters of correct matches in the blanks provided.

____ Sporadic	A. Combs, utensils, clothing, and other small items involved in disease transmission.
____ Mortality	B. The sum of all potential sources for a specific disease agent.
____ Reservoir	C. Disease which occurs in small isolated unpredictable outbreaks.
____ Morbidity	D. Number of individuals dying from a disease within a given population and time period.
____ Vector	E. Number of cases of disease is significantly above the expected "background" level.
____ Pandemic	F. Epidemic threatening several nations on more than one continent.
____ Fomite	G. An animal (usually an arthropod) which is involved in disease transmission.

____ Epidemic

____ Endemic

____ Zoonosis

H. A disease usually associated with non-human animals but which can be transmitted to man.

I. Disease which affects a small % of the population on a fairly constant basis.

J. Number of individuals infected within a given population and time period.

(1) 8. Small objects such as utensils, clothing, bedding, toiletries and money may be involved in the transmission of disease causing agents, and so are considered as _____.

(2) 9. Non-human animals often play an important role in disease transmission because they serve as _____. A disease which is normally associated with non-human animals but which can be transmitted to man is called a _____.

(1) 10. _____ play a dual role in disease transmission because they serve both as reservoirs and as vectors.

(2) 11. Sometimes virulent pathogens can colonize an individual without causing disease symptoms. When this happens, the person involved becomes a reservoir and may transmit the pathogen without being aware of it. Mary Mallon was such an individual, and became a carrier of _____. She was unwittingly transmitting the etiological agent to _____ and infected at least thirty people.

(1) 12. Smallpox was an important human disease that is now considered to have been vanquished. People are no longer immunized against it because the virus has been eliminated from the human population. Why is it highly unlikely that diseases such as bubonic plague, lyme disease and rabies will be similarly eradicated?

(1) 13. _____ transmission is that which involves contact between a susceptible host and a living reservoir.

(1) 14. If you were to acquire a *Streptococcus* infection by running barefoot on an ocean beach and stepping on broken glass, the mode of transmission involved would be _____.

(1) 15. Etiological agents require _____ transmission if they are very sensitive to environmental factors such as drying, sunlight and variation in temperature.

(3) 16. The severity of epidemics within human populations is known to be influenced by a number of factors including: 1) the number of individuals that been immunized, 2) the _____ of the population, 3) the age, nutritional status and general health of the population, 4) the _____ of the people, 5) the degree of exposure to the pathogen involved, and 6) the _____.

(2) 17. Three methods used by epidemiologists in an attempt to prevent disease are: 1) by increasing _____, 2) by decreasing the number of

_____ available, and 3) by segregating or restricting the interactions between infected and non-infected persons.

(2) 18. The number of cases of a given disease within a specified population and time period is referred to as the _____ rate. The number of people dying from that disease within the same population and time period would be the _____ rate

Pathology and Mechanisms of Pathogenicity:

(5) 1. Define:

Pathology

Latent disease

Septicemia

Leukocidin

Tetanospasmin

(2) 2. _____ may be defined as the science or study of disease and deals with the etiology, pathogenesis and the structural and functional changes brought about by disease.

(2) 3. _____ may be defined as a condition in which a pathogenic microorganisms has invaded or colonized a portion of the body (cells or tissues). If the presence and activities of these microbes causes a change in the overall health of the individual they have colonized, they are said to be causing a _____.

(1) 4. Many diseases that are caused by microorganisms are _____, i.e., readily passed from one individual to another, either directly or indirectly.

(2) 5. A disease is categorized as _____ if it's symptoms develop slowly, over a long period of time, and it persists within the body for months or years. If the symptoms of a disease develop rapidly and last a short period of time, the disease is said to be _____.

(2) 6. _____ may be defined as the condition of having viable bacteria in the blood stream and does not necessarily indicate a disease state. If the bacteria present are reproducing and causing disease (septic) symptoms, the condition is termed _____.

(2) 7. When bacteria are present within the bloodstream and are reproducing and causing septic symptoms, the condition is known as _____. If only the toxic products of bacteria are present in the bloodstream, the condition is known as _____.

(1) 8. Scarlet fever, rheumatic fever, diphtheria and tetanus are diseases that result from _____, i.e., the presence of bacterial toxins within the blood stream.

(1) 9. A single-celled microorganism that colonizes some part of another organism, and by direct interaction with that organism causes disease, is referred to as a _____.

(1) 10. _____ may be defined as a degree of pathogenicity and may be expressed in terms of ID_{50} or LD_{50}.

(2) 11. The dose or concentration of a pathogen that is required to infect 50% of a test population is referred to as the _____. The dose or concentration expected to kill 50% of the test population is called the _____.

(2) 12. In order to cause disease, pathogenic microorganisms must first gain access to the body. Those which enter via a cut, puncture, bite or other wound are said to require the _____ route as a portal of entry. Pathogenic bacteria must also be able to _____ faster than the body can eliminate them.

(2) 13. The virulence of pathogenic microbes is, to some extent, dependent upon their ability to avoid the body's immune responses. Explain two ways in which microbes may avoid or overcome normal immune mechanisms:
a) _____
b) _____

(2) 14. Bacteria produce a variety of enzymes that alter host function and so aid in their pathogenicity. These include enzymes called _____ which destroy erythrocytes (RBCs) and _____ which degrade one of the components of dense connective tissue thus increasing the pathogens invasiveness.

(2) 15. Bacterial exotoxins are proteins which tend to have very specific actions within the body. Name two types of exotoxins and describe briefly what they do.
a) _____
b) _____

(2) 16. The exotoxins produced by ordinary Gram negative bacteria are all similar to one another in that they are made up of _____ that are part of the outer membrane of the bacterial cell wall. These toxins all tend to cause similar symptoms including:

(3) 17. Pathogenic bacteria in the genera *Streptococcus* and *Staphylococcus* are often highly virulent because they produce a number of factors that allow them to avoid body defenses and weaken host resistance. These bacteria produce _____ (respectively) that allow them to avoid phagocytic WBCs, and they also produce _____

that kill WBCs. They form hemolysins that destroy host RBCs and they form _____ that break down fibrin and increase their invasiveness.

(3) 18. Bacteria in the genus *Clostridium* are responsible for both tetanus and botulism. Although the symptoms of these diseases are quite different, they are both caused by protein exotoxins that are nearly identical in structure. Describe the symptoms characteristic of botulism and tetanus, name the target (host) cells involved, and explain the action of the toxin in each case.

(1) 19. _____ is the name given to Gram positive pyogenic cocci that are known to cause a variety of infections (carbuncles, furuncles, toxic shock syndrome, endocarditis, etc.) as well as bacterial intoxication or food poisoning due to a heat stable enterotoxin.

(1) 20. Gram negative, facultatively anaerobic bacteria identified as _____ _____ are sometimes associated with diarrhea, but can also cause bladder and kidney infections, meningitis (in neonates) and hemolytic uremic syndrome.

(1) 21. New warning labels have recently been applied to meat due to the actions of a virulent strain of _____. These Gram negative enterics are also commonly associated with bladder and kidney infections.

(1) 22. Gram negative, areobic bacteria identified as _____ produce a blue-green pyocyanin pigment as well as toxins that inhibit protein synthesis. These bacteria may cause pneumonia, meningitis and infections of the skin, eyes, ears, etc.

(2) 23. Many bacteria live in the mouth and upper respiratory tract without causing much harm to their host. However, the acid produced by some bacteria can degrade tooth enamel and cause _____, and bacteria are also a major cause of _____.

(2) 24. Bacteria are known to cause a variety of problems in association with the mouth (gums and teeth). Name and briefly describe two such problems caused by mouth bacteria.
a) _____
b) _____

(3) 25. Three reasons why young sexually active females should be particularly concerned about sexually transmitted diseases are: 1) their _____ are not obvious and often go unnoticed, 2) they can cause
_____
_____ and 3) they leave their host much more susceptible to infection with _____ and therefore a wide variety of other disease agents.

(2) 26. Sexually transmitted diseases are a much more significant threat to females than they are to males for a number of reasons. Name any two:

Bacterial Diseases and Agents:

(20)27. Matching - Bacterial Diseases and Agents:

Match the disease on the left with the bacteria most likely to be the causative agent. **NOTE** that the genus and species names are in separate columns, so it will be necessary to place <u>two</u> letters in each blank provided. Genus names require capital letters (A-P); species names small letters (a-t).

____ Dysentery	A. *Bacillus*	a. *pyogenes*
____ Gas gangrene	B. *Francisella*	b. *pertussis*
____ Diphtheria	C. *Mycobacterium*	c. *anthracis*
____ Pneumonia	D. *Corynebacterium*	d. *tetani*
____ Typhoid	E. *Clostridium*	e. *tularensis*
____ Scrub typhus	F. *Shigella*	f. *perfringens*
____ Leprosy	G. *Yersinia*	g. *menengitidis*
____ Cholera	H. *Bordetella*	h. *gonorrheae*
____ Gonorrhea	I. *Streptococcus*	i. *tuberculosis*
____ Tularemia	J. *Borrelia*	j. *pallidum*
____ Tetanus	K. *Vibrio*	k. *pneumoniae*
____ Tuberculosis	L. *Rickettsia*	l. *pneumophila*
____ Syphilis	M. *Salmonella*	m. *tsutsugamushi*
____ Meningitis	N. *Treponema*	n. *typhi*
____ Lyme disease	O. *Neisseria*	o. *burgdorferi*
____ Plague	P. *Legionella*	p. *diphtheriae*
____ Legionnaire's disease		q. *cholerae*
____ Anthrax		r. *pestis*
____ Whooping cough		s. *leprae*
____ Scarlet fever		t. *dysenteriae*

Sierra College Name: _____
Microbiology October 28-29, 2003

Laboratory Exam I

Directions: Read each question carefully and completely before you write your answer. Note that the point values for all questions are listed in the margin, and that those which require observation of laboratory preparations are marked (*). Answer all questions as specifically as possible, and DO NOT BE VAGUE - GOOD LUCK!

(3) 1. Define:

Substage condenser lens

Pure culture

Anamorph state (fungi)

(1) 2. In the microbiology laboratory, students are advised to clean their section of the bench top with laboratory disinfectant, when?
_____
_____

(2) 3. This device is called a _____ and is potentially hazardous to students because it is often lit/burning during laboratory activities, and its flame is not easy to see. Students are advised to keep these devices near the center of their work area, to avoid bringing flammable materials into contact with them and to never _____ _____ when they are lit/burning.

(1) 4. Students working in the microbiology laboratory frequently handle culture tubes and plates that contain potentially pathogenic microorganisms. For this reason, students are advised to avoid any and all hand to mouth activities such as _____ _____, since these could result in the ingestion of live pathogens and gastrointestinal infection (illness).

(2) 5. According to the laboratory syllabus, glass culture tubes containing live microbial cultures should be placed in the _____ kept on the shelves within the discard cabinet when they are ready for disposal. Why is it important that these tubes be kept in a vertical position, within the discard area. _____

(3) 6. The compound microscopes used in this laboratory have two lens systems. The lenses located nearest the eyes of the observer are called _____ lenses and magnify objects 10 times while the lenses nearest the specimen being observed are called _____ lenses and can be move into a viewing position by rotating the revolving nose piece. The total magnifications possible with the American Optical microscopes used in this laboratory are _____ times (please list all four).

(2) 7. The material in this bottle is called _____ and must be applied to the surface of a slide whenever students are viewing Gram stains, acid-fast stains, or endospore stains of ordinary bacteria. This material prevents the _____ and allows for optimum resolution. Without it, the individual cells cannot be observed.

(2) 8. Students using an American Optical microscope are advised to begin focusing on any new slide preparation while using the _____ lens. This will allow for proper focusing without risking damage to _____ that would be caused by placing the weight of the revolving nosepiece on them.

(2) 9. As you increase magnification with your compound microscope, you can expect the diameter and depth of your viewing field to _____. For this reason, if you wish to keep a specimen within the field of view as you increase magnification, you must position it near the _____ of the viewing field.

(1) 10. This material is provided for student use within this laboratory. Explain what pieces of equipment or material should be cleaned with these sheets (be specific). _____ _____.

(2) 11. Proper illumination is essential to microscopy, because viewing too much light (light at a high intensity) for an extended period of time will cause students to experience _____ _____ and will make viewing difficult (will decrease the color and detail visible). What device may be opened or closed to increase or decrease the amount of light reaching a specimen on the microscope stage? _____.

(1) 12. Why is it important to turn your microscope light off before unplugging the instrument and returning it to the cabinet? _____ _____.

(2) 13. _____ is the process of comparing a measuring device to a known standard in order to assign the units of the measuring device a specific value. In this laboratory, we use a device known as a _____ as our known standard.

(2) 14. The size of a typical prokaryotic cell is usually indicated in units called _____, each of which is .001 mm. What is the average size of the cells shown here (width and length)? _____

(1) 15. A mixture of materials that provides all of the nutrients necessary for the growth of microorganisms in vitro is called _____.

(2) 16. This preparation is called a slope or slant and is prepared by adding a solidifying agent called _____ to a mixture of nutrients in water, heating it to boiling, and then allowing it to cool in a slanted position (on a slant board). What aspects of this polysaccharide material make it ideal as a solidifying agent for microbiology? _____ _____

(2) 17. Although most of the bacteria used in this laboratory obtain all the nutrients essential for their growth from their culture medium, some organisms are capable of obtaining certain elements such as _____ and _____ from air. These can then be omitted from the medium.

(2) 18. The *Pseudomonas* and *Azotobacter* enrichment media used in this laboratory were made according to the recipes provided in the syllabus. These media are examples of _____ media because they contain nutrients in relatively pure chemical form and in specified amounts. Media such as TSA, Mueller Hinton, nutrient, etc. that contain nutrients in crude form (types and amounts not specified) are called _____ media. Most of the media used in this laboratory are of this type.

(1) 19. How much of this dehydrated powder would be used to prepare 100 ml of culture medium?_____

(4) 20. Students working with live bacteria cultures in the microbiology laboratory are advised to always use _____ technique when manipulating their cultures. Explain how this technique applies to the proper handling of each of the following items:
Wire loops _____
Glass culture tube mouths _____
Plastic snap-on tube caps _____

(1) 21. In this laboratory, students are advised to keep their culture plates closed except when transferring microorganisms into or out of them. What is the negative consequence of leaving culture plates open for extended periods of time?
_____

(2) 22. According to the microbiology syllabus, the purpose of streaking a microbial culture over the broad agar surface inside a Petri plate is to _____ the culture so that the colonies formed on it will be _____.

(1) 23. In this laboratory, students are advised to incubate their Petri plates _____ in order to prevent water from condensing inside the lid, dripping back onto the agar surface and causing colonies to run together in a confluent mass.

(1) 24. Which of the plates shown here has been properly streaked? _____

(2) 25. Is the label on this Petri plate in the proper position? _____ Why is the position of the label significant? (Several answers are possible here.)

(2) 26. Which of these plates appears to contain a pure culture? _____

(4) 27. _____ may be defined as the study of external features (shape, form, color, etc.) and may be applied to both individual cells and to colonies. Describe three cultural characteristics of the bacteria colonies growing on this plate.

(2) 28. Most of the bacteria viewed in this laboratory are dead organisms that have been stained in some manner. Staining makes cells contrast with their background, and often makes certain structures visible (e.g., flagella, endospores, capsules, etc.). What advantages are gained by viewing dead cells rather than live organisms? _____ _____ What were we looking for when we made preparations containing live bacteria? _____

(1) 29. These stain reagents are referred to as basic stains because their color is associated with _____. The attraction between these charged particles and negatively charged cell surfaces causes stains to stick to cells but not to glass slides.

(1) 30. In this laboratory, bacterial smears that are being prepared for the application of stains are air-dried and _____ prior to the application of the staining reagents.

(2) 31. This material was used to prepare _____ or negative stains. This type of stain provides the best representation of cell _____ and arrangement because the cells are not subjected to heat (do not shrink) before the stain is set.

(2) 32. In this stain preparation the larger of the two cell types indicated are human cheek cells and are _____ type cells, the smaller cells are _____.

(1) 33. The Gram stain and the acid-fast stain are both known as _____ stains because they cause some cells to look different even though all the cells are treated the same way.

(2) 34. Which of the two stain preparations shown here would be expected to provide an observer with the best view of individual bacteria cells? _____ Why? _____.

(3) 35. The cell walls of most ordinary Gram-positive and Gram-negative bacteria contain a rigid layer composed of a unique material called _____. This material (considered to be one huge molecule) contains chains of _____ and N-acetyl glucosamine connected together by short amino acid side chains. In what ways are some of the amino acids found in these side chains unique in nature? _____ _____

(2) 36. At the end of the Gram stain procedure as applied in this laboratory, Gram-positive cells are stained (colored) with _____, while Gram-negative cells are stained (colored) with _____.

(3) 37. Describe the shape, arrangement and Gram stain quality (positive Vs negative) of the cells demonstrated. Shape = _____ Arrangement = _____ Gram stain characteristic = _____

(1) 38. This material can be used to determine the wall composition of bacteria without staining. Organisms that are Gram _____ will become markedly viscous (mucous-like) when mixed with this liquid because their thin walls break and their cell contents spill out.

(1) 39. What step in the Gram stain and acid-fast stain procedures is critical to the differentiation of the cell types present? _____

(2) 40. The red-colored cells present in this preparation contain a high percentage of a wax-like lipid called _____ acid in their walls. This substance makes the cells hard to stain, but very resistant to being decolorized. Such cells are said to be _____.

(3) 41. Identify the special (unique) cell structures represented in each of these slides. (Note: - the techniques used to stain these structures were all very different from one another.
a) _____ b) _____ c) _____

(3) 42. The dormant structures within these cells were stained over steam heat with a stain reagent called _____. What is the shape of the dormant structures shown? _____ Is the sporangium swollen? _____

(2) 43. This plate indicates the variety of microorganisms that may be obtained by exposing a sterile culture plate to _____ for approximately one hour. The bright-colored colonies present (red and yellow) are most likely composed of bacteria in the genus _____. These are Gram-positive, catalase-positive organisms commonly found on human skin and are not normally pathogenic.

(4) 44. The organisms shown here are oxygenic photoautotrophs commonly referred to as _____ or blue-green algae. They are classified within the Domain _____. Identify the two examples shown as to genus:
a) _____ b) _____

(9) 45. These three plates contain representative examples of three types of bacteria commonly found in soil. Students in this class used enrichment procedures to isolate these types of bacteria and then prepared Gram stains and observed them. Use the space provided on the next page to name the three types of bacteria grown, explain what techniques or special media were used in their enrichments, and explain why these were effective, i.e., what characteristics of the organisms were taken advantage of in order to separate these bacteria from other forms present in soil.

(2) 46. Fungi are often divided into three categories based on their growth habits. Fungi that grow as masses of single cells in colonies much like bacteria are called _____, those that are microscopic but filamentous are called _____, and those that form macroscopic fruiting bodies are called fleshy fungi.

Note that for all identifications beyond this point you may gain one extra credit point for each correct species name given, with an overall maximum of five points possible.

(3) 47. The fungi present on this slide are in the genus _____. Which type of reproductive process (sexual Vs asexual) is indicated by the structures at the pointer tip? _____ What name is given to these spores? _____

(4) 48. The fungi represented here belong to the genus _____ and are in the phylum _____. The structures indicated at the pointer tip are called _____ and are produced via _____ reproduction.

(6) 49. Identify the fungi represented here as to genus and phylum:

	Genus name	Phylum name
a)	_____	_____
b)	_____	_____
c)	_____	_____

(4) 50. These organisms belong to the phylum _____. Identify them as to genus:
a) _____ b) _____ c. _____

(4) 51. Identify these two unicellular algae as to genus and phylum
a) _____ _____
b) _____ _____

(6) 52. The organisms shown here are all classified within the kingdom _____ and are unique in that they have layers containing _____ outside their cell membranes. Provide the common names and phyla of these organisms.
a) _____ _____
b) _____ _____

(6) 53. Identify the following as to genus and phylum.

	Genus name	Phylum name
a.	_____	_____
b.	_____	_____
c.	_____	_____

(4) 54. These organisms belong to the phylum _____, to the class _____, and to the genus _____
According to the film "Conquest of the Parasites", these organisms are transmitted from one host to another by _____.

(5) 55. These organisms belong to the phylum _____. Identify them as to genus and class.

	Genus	Class
a.	_____	_____
b.	_____	_____

(3) 56. These organisms belong to the phylum _____. Identify them as to genus
(a.) _____ and (b.) _____

(2) 57. According to the film "Conquest of the Parasites", how do these organisms gain access to their definitive host? _____

(5) 58. These organisms belong to the Kingdom _____ and to the phylum _____. Identify each of them as to genus.

a) _____
b) _____
c) _____

(1) 59. All fungi, algae, protozoa and multicellular organisms including parasites, hydra, earthworms, and humans belong to the domain _____.

Sierra College Name: _____
Microbiology March 29-30, 2004

Laboratory Exam I

Directions: Read each question carefully and completely before you write your answer. Note that the point values for all questions are listed in the margin, and that those which require observation of laboratory preparations are marked (*). Answer all questions as specifically as possible, and DO NOT BE VAGUE - GOOD LUCK!

(3) 1. Define or explain the significance of:

Eye wash station

Aseptic technique

Morphology

(1) 2. In the microbiology laboratory, students are advised to clean their section of the bench top with _____, before and after each laboratory session involving the manipulation of live microorganisms.

(1) 3. Book bags, binders, purses and other materials should not be on the bench tops when microbial cultures are being used because _____ _____.

(2) 4. The Bunsen burners used in this laboratory are potentially hazardous because they are often lit, and their flames are not clearly visible in ordinary room light. Students were advised to position their burners near the center of their work station when they were lit, and to be careful to keep _____ away from the flames. Students were also told to never _____ when they are lit/burning.

(1) 5. Students working in the microbiology laboratory are frequently reminded to avoid hand to mouth activities such as eating candy, gum, etc. and drinking from water bottles while working in the microbiology laboratory. Why are these precautions necessary? _____ _____
(Note – the answer to this question is <u>not</u> "Because students are foolish or not thinking clearly.")

(2) 6. According to the laboratory syllabus, the large metal bins within the discard cabinet are to be used as receptacles for _____.
Glass containers such as flasks, beakers should be set on the shelf above the metal bins (or on top if not contaminated with microbial cultures) and culture tubes containing live microbial cultures should be placed in the _____ kept on the upper shelf.

(3) 7. The compound microscopes used in this laboratory have two lens systems. The lenses located nearest the eyes of the observer are called _____ lenses and magnify objects 10 times while the lenses nearest the specimen being observed are called _____ lenses and can be move into a viewing position by rotating the revolving nose piece. The total magnifications possible with the American Optical microscopes used in this laboratory are _____ times (please list all four).

(2) 8. Whenever students are viewing Gram stains, acid-fast stains, or endospore stains of ordinary bacteria they must apply a drop of _____ to the surface of their slide before moving the longest objective (red bands) into place. This material prevents the _____ and allows for optimum resolution. Without it, the outlines of the bacteria present will appear cloudy or hazy (making them difficult to see).

(2) 9. Students using an American Optical microscope are advised to begin focusing on any new slide preparation while using the _____ lens. This will allow for proper focusing without risking damage to _____ that would be caused by placing the weight of the revolving nosepiece on them.

(2) 10. As you increase magnification with your compound microscope, you can expect the diameter and depth of your viewing field to _____. For this reason, if you wish to keep a specimen within the field of view as you increase magnification, you must position it near the _____ of the viewing field.

(1) 11. This material is provided for student use within this laboratory. Explain what pieces of equipment or material should be cleaned with these sheets (be specific). _____ _____.

(2) 12. The American Optical microscopes in this laboratory are equipped with multiple light adjustment options. The silver knob to the left of the stage can be used to raise or lower the _____ _____ lens and thereby focus the light on or below the object being viewed. The metal lever under the stage can be used to open or close the _____. Most of our microscopes are also equipped with rheostats that allow for adjustment in light intensity.

(2) 13. If a student has been viewing a slide using the highest power of magnification, and then switches to viewing a slide using the lowest power, they will have to _____ the amount of light being used. Proper light adjustment is essential to microscopy because viewing slides while using too much light (light at a high intensity) for an extended period of time will cause students to experience _____ and will make viewing difficult (will decrease the color and detail visible).

(2) 14. Because the diameter of the viewing field changes as the power of magnification is changed, students were required to _____ their ocular micrometer before it could be used, i.e., they had to compare the ocular micrometer to a known standard. What are the units of measure used when measuring prokaryotic cells? _____ Note – organisms in this size range are not visible to the naked eye.

(2) 15. Which of the two knobs labeled here would be used to begin focusing with a short objective, but should never be used when focusing with the highest power of magnification? _____ What is the average size of the cells shown here (width and length)? _____

(1) 16. A culture medium is a mixture of materials that provides _____ _____.

(2) 17. Most culture media used in the microbiology laboratory contain a solidifying agent called _____ that is an extract of red algae. This polysaccharide material is an ideal solidifying agent for culture media because it stays solid at a variety of incubation temperatures and because _____

(2) 18. Although most of the bacteria used in this laboratory obtain all the nutrients essential for their growth from their culture medium, some organisms are capable of obtaining certain elements such as _____ and _____ from air. These can then be omitted from the medium.

(2) 19. The *Pseudomonas* and *Azotobacter* enrichment media used in this laboratory were made according to the recipes provided in the syllabus. These media are examples of _____ media because they contain nutrients in relatively pure chemical form and in specified amounts. Media such as TSA, Mueller Hinton, nutrient, etc. that contain nutrients in crude form (types and amounts not specified) are called _____ media. Most of the media used in this laboratory are of this type.

(1) 20. How much of this dehydrated powder would be used to prepare 100 ml of culture medium? _____ (be sure to include units).

(2) 21. According to the information provided relative to aseptic technique, the wire loops used in the transfer of microorganisms should always be flamed to redness along their entire length, when? _____ Petri plates should be kept closed except when microorganisms are being applied to or removed from the agar surface in order to prevent _____, and the plastic caps removed from culture tubes should be held in your hand while the transfer is being completed. Tube caps should never be placed on the counter surface.

(2) 22. Glass culture tubes with snap-on plastic caps should never be shaken or placed in a horizontal position because _____. When making microbial transfers, into or from glass culture tubes, students are expected to flame the mouth of the tube before and after the transfer. Why is this necessary, i.e., what are two benefits of flaming the tube mouth?
_____
_____

(2) 23. According to the microbiology syllabus, the purpose of streaking a microbial culture over the broad agar surface inside a Petri plate is to dilute the culture so that the bacteria present will grow into _____. This is one of the best methods for determining if or not a culture is pure, i.e., that it contains _____.

(2) 24. In this laboratory, students are advised to incubate their Petri plates in what position? _____ This will prevent water from condensing inside the lid and dripping back onto the agar surface. Why would water dripping onto the agar surface be a problem? _____

(1) 25. Which of the plates shown here has been properly streaked? _____

(2) 26. Students working with plate cultures in the microbiology laboratory were advised to place all plate labels where? _____ What type of information should be included on the label? _____
_____

(2) 27. Which of these plates appears to contain a pure culture? _____

(3) 28. Describe three cultural characteristics of the bacteria colonies growing on this plate.

(2) 29. Most of the bacteria viewed in this laboratory are dead organisms that have been stained in some manner. Staining makes cells more readily visible because it causes them to _____ _____. Staining can also makes internal or external structures visible that could not otherwise be seen, and because the cells are dead when they are stained they can no longer
_____.

(1) 30. These stain reagents are referred to as basic stains because their color is associated with _____. The attraction between these charged particles and negatively charged cell surfaces causes stains to stick to cells but not to glass slides.

(1) 31. In this laboratory, bacterial smears that are being prepared for the application of stains are air-dried and _____ prior to the application of the staining reagents.

(2) 32. Stains that are prepared using nigrosin are referred to as _____ stains because the nigrosin colors the background rather than the cells. Nigrosin preparations provide one of the best representations of cell _____ and arrangement because the cells are not subjected to heat (do not shrink) before the stain is set.

(2) 33. In this stain preparation the larger of the two cell types indicated are human cheek cells and are _____ type cells, the smaller cells are _____.

(1) 34. The Gram stain and the acid-fast stain are both known as _____ stains because they cause some cells to look different even though all the cells are treated the same way.

(3) 35. The cell walls of most ordinary Gram-positive and Gram-negative bacteria contain a rigid layer composed of a unique material called _____. This material (considered to be one huge molecule) contains chains of _____ and N-acetyl glucosamine connected together by short amino acid side chains. In what ways are some of the amino acids found in these side chains unique in nature?

(3) 36. During the Gram-stain procedure as applied in this laboratory, all cells are stained (colored) with _____ initially; but at the end of the procedure, some of the cells appear pink while others appear purple or violet. What portions of the Gram-staining procedure account for this variation? (Name reagents used and what they do.)

(3) 37. Describe the shape, arrangement and Gram stain quality (positive Vs negative) of the cells demonstrated. Shape = _____ Arrangement = _____ Gram stain characteristic = _____

(2) 38. Which of these materials can be used to determine the cell wall composition of bacteria without staining? _____ Organisms that are Gram-_____ will become markedly viscous (mucous-like) when mixed with this liquid because their thin walls break and their cell contents spill out.

(2) 39. Which of the cells present on the slide are acid-fast, the red bacilli or the blue cocci? _____. These cells contain a high percentage of a wax-like lipid called _____ acid in their walls and resist decolorizing even when subjected to acid alcohol.

(3) 40. Identify the special (unique) cell structures represented in each of these slides. (Note: - the techniques used to stain these structures were all very different from one another.
a) _____ b) _____ c) _____

(3) 41. The dormant structures within these cells were stained over steam heat with a stain reagent called _____. What is the shape of the dormant structures shown? _____ Is the sporangium swollen? _____

(9) 42. These three plates contain representative examples of three types of bacteria commonly found in soil. Students in this class used enrichment procedures to isolate these types of bacteria and then prepared Gram stains and observed them. Use the space provided on the next page to name the three types of bacteria grown, explain what techniques or special media were used in their enrichments, and explain why these were effective, i.e., what characteristics of the organisms were taken advantage of in order to separate these bacteria from other forms present in soil.

(2) 43. This plate indicates the variety of microorganisms that may be obtained by exposing a sterile culture plate to _____ for approximately one hour. The bright-colored colonies present (red and yellow) are most likely composed of bacteria in the genus _____. These are Gram-positive, catalase-positive organisms commonly found on human skin and are not normally pathogenic.

(4) 44. The organisms shown here are oxygenic photoautotrophs commonly referred to as _____ or blue-green algae. They are classified within the Domain _____. Identify the two examples shown as to genus:
d) _____ b) _____

(2) 45. Fungi are often divided into three categories based on their growth habits. Fungi that grow as masses of single cells in colonies much like bacteria are called _____, those that are microscopic but filamentous are called _____, and those that form macroscopic fruiting bodies are called fleshy fungi.

(1) 46. All fungi in the class _____ would be classified within the phylum Ascomycota.

Note that for all identifications beyond this point you may gain one extra credit point for each correct species name given, with an overall maximum of five points possible.

(3) 47. The fungi present on this slide are in the genus _____. Which type of reproductive process (sexual Vs asexual) is indicated by the structures at the pointer tip? _____ What name is given to these spores? _____

(4) 48. The fungi represented here belong to the genus _____ and are in the phylum _____. The structures indicated at the pointer tip are called _____ and are produced via _____ reproduction.

(6) 49. Identify the fungi represented here as to genus and phylum:

	Genus name	Phylum name
a)	_____	_____
b)	_____	_____
c)	_____	_____

(4) 50. These organisms belong to the phylum _____. Identify them as to genus:
a) _____ b) _____ c. _____

(4) 51. Identify these two unicellular algae as to genus and phylum

a)	_____	_____
b)	_____	_____

(6) 52. The organisms shown here are all classified within the kingdom _____ and are unique in that they have layers containing _____ outside their cell membranes. Provide the common names and phyla of these organisms.

a)	_____	_____
b)	_____	_____

(6) 53. Identify the following as to genus and phylum.

	Genus name	Phylum name
a.	_____	_____
b.	_____	_____
c.	_____	_____

(3) 54. These organisms belong to the phylum _____, to the class _____, and to the genus _____

(5) 55. These organisms belong to the phylum _____. Identify them as to genus and class.

	Genus	Class
a.	_____	_____
b.	_____	_____

(3) 56. These organisms belong to the phylum _____. Identify them as to genus
(a.) _____ and (b.) _____

(2) 57. The organisms shown here belong to the Genus _____. According to the film "Conquest of the Parasites", how do these organisms gain access to their definitive host?
_____

(5) 58. These organisms belong to the Kingdom _____ and to the phylum _____. Identify each of them as to genus.
a) _____
b) _____
c) _____

(1) 59. All fungi, algae, protozoa and multicellular organisms including parasites, hydra, earthworms, and humans belong to the domain _____.

Sierra College Name: _____
Microbiology December 10-11, 2003

Laboratory Exam II

Directions: Read each question carefully and completely before you write your answer. Note that some of the questions require you to observe materials on the desk tops. Those questions are marked with an (*) in the margin. Please make your answers as complete as possible, DO NOT BE VAGUE!

(3) 1. Define:

Cultured food

Acetoin

Beta hemolysis (□-hemolysis)

(4) 2. This beaker contains Sauerkraut, a food material made by placing finely chopped cabbage and salt into a clean beaker and applying a weight (beaker full of water). Certain bacteria in the genera _____ and _____ are associated with cabbage, and will grow under anaerobic conditions using a _____ type of metabolism (one that involves an organic compound as the final electron acceptor). Although these bacteria can produce ATP under anaerobic conditions, they will eventually produce so much _____ (metabolic end product) that they die. The pH within the beaker drops from 6.5 to around 4, and the food value of sauerkraut is preserved.

(3) 3. This flask contains a poor quality apple wine that was produced by adding a live culture of fungi classified as _____ _____ to a mixture of apple juice and sucrose. The metabolic activity of the fungi present caused the sugars in the juice mixture to be converted into _____ (a gaseous end-product that was allowed to escape from the flask), and _____ a liquid end-product that was collected. This second product is one of the primary flavor components of wine.

(2) 4. The cheese made during our food microbiology laboratory was a finished product at the end of the initial processing steps, so was an example of a/an _____ cheese. Although the water content of our cheese was similar to that of Brie, our cheese was unlike Brie in that it was not aged, and did not have a _____ _____ added to it.

(3) 5. The bacteria most commonly used in the production of cheddar cheese are Gram-positive cocci identified as _____. These bacteria are added to milk, the milk is warmed slightly, and then proteolytic enzymes are added to coagulate the casein (milk protein) present. After that, the _____ (solid portion) is collected and pressed to remove excess moisture (whey). If the cheese is allowed to age for a long period of time, the bacteria present will produce more _____ and the cheese will become a sharp or extra-sharp cheddar. If not, the flavor of the cheese will be mild.

(3) 6. The bacteria usually associated with fresh yogurt include Gram-positive cocci in the genus _____ and Gram-positive bacilli in the genus _____. Although these bacteria produce acidic end products when fermenting lactose, they also form _____, a neutral end product that gives yogurt a somewhat nut-like flavor.

(1) 7. According to the laboratory syllabus, the consumption of fresh yogurt can add microbial flora to the gut and may reduce the risk of _____.

(2) 8. The materials presented here were used to carry out a technique/procedure referred to as _____ and allowed students to transfer a pattern of bacterial colonies (many colonies) from one plate to several other plates. This technique is easy to use and requires less _____ than would be needed if each colony was transferred individually and streaked onto a separate plate.

(3) 9. The mannitol salt agar (MSA) in this plate contains 7.5% NaCl and is selective for halophiles such as *Micrococcus* and _____. This medium also contains phenol red and allows for the differentiation of bacteria on the basis of their ability to ferment _____. Can these bacteria ferment the carbohydrate present? _____

(4) 10. Tergitol-7 and Mac Conkey's agar are _____ media because they promote the growth of Gram-negative bacteria while inhibiting the growth of other organisms. These media are also _____ because they cause fermentative organisms to form colonies that look distinctly different than those of non-fermentative organisms. The carbohydrate contained in these media is _____. Which of the plates contains organisms capable of fermenting the carbohydrate? _____

(1) 11. The quantitative plating method or viable cell count allows us to determine the number of viable cells present within a broth culture of bacteria or yeast, but cannot be used to determine total cell number. Why is this so, i.e., why are viable cells the only ones that can be counted?

(2) 12. The bottles shown here were used to prepare a _____ of a bacterial culture, and then samples of water from two of the bottles were used to inoculate the plates shown. How many bacteria were present in one ml of the original culture? _____.

(2) 13. Microorganisms that require oxygen in order to grow are referred to as obligately aerobic organisms and use a _____ type metabolism. Which of the tube sets shown here contains organisms that have this characteristic? _____

(2) 14. Which of these tubes was inoculated with organisms that were able to ferment the carbohydrate present? _____ How do you know, i.e., what evidence is visible within the tube? _____
_

(3) 15. These tubes contain glucose and a buffer that tends to inhibit pH change. The pH indicator used to complete this test is called _____ and is added to the culture after 48 hours of incubation. Organisms that are capable of producing large amounts of

_____ (enough to overcome the effects of the buffer) are said to test positive. Which of the tubes present represents a (+) test result? _____.

(4) 16. This medium is called TSI and can be used to demonstrate the ability of certain bacteria to catabolize _____ molecules that contain sulfur. Organisms able to do this will produce a gaseous end product called _____ that will bind with iron in the media to form a precipitate called _____, Which of the tubes shown contains organisms that can form this substance? _____

(2) 17. This medium is called SIM and can be used to determine if or not bacteria are capable of H_2S production, indole production and _____. The medium in this tube was inoculated 24 hours ago, and then Kovac's reagent was added to determine if or not the bacteria present could catabolize _____ to form indole.

(3) 18. Name the pH indicators present in each of the tubes shown:
a) _____ b) _____
c) _____

(3) 19. These tubes were used to determine if or not bacteria could _____ (remove a $COOH^-$ group from) the amino acid lysine. Bacteria that can do this will form carbon dioxide and an alkaline substance called an _____ (cadaverine to be exact). Are the bacteria present here capable of producing cadaverine? _____ and Note – Culture medium containing the amino acid ornithine will look just like one containing lysine prior to inoculation, and the results of the two would be analyzed in the same manner, i.e., the color change expected would be the same in either case.

(2) 20. Amino acid tubes containing lysine or ornithine, and tubes containing the amino acid control medium are all sealed with vaspar (vasoline/paraffin) following inoculation. Why is this seal necessary? (two reasons)

(3) 21. The medium originally present in these tubes contained an organic acid called _____ as the only carbon source. The pH of the original medium was 6.8, but the culture added to tube _____ was able to take in and catabolize the carbon source, so the medium became _____ as indicated by the color change in the pH indicator present.

(2) 22. This medium is used to determine if or not bacteria form urease, an enzyme that can be used to convert urea into _____ (a highly alkaline substance). The tube showing a positive (+) hydrolysis reaction is tube _____ and will have a pH of 8.1 or greater.

(5) 23. Using the data provided, identify the bacteria indicated (genus and species). Note - the bacteria present in these tubes will match exactly with one of the names on the chart.
The bacteria present are identified as: _____

(2) 24. These materials are used to conduct a test called the _____ test and allow us to determine if or not bacteria are able to form an enzyme called _____. This enzyme is associated with the electron transport chain.

(2) 25. These tubes were used to determine if or not bacteria could produce _____, and enzyme formed by pathogenic members of the genus *Staphylococcus*. Which of the tubes present contains organisms that are able to form this enzyme? _____

(2) 26. The catalase test was used in the laboratory to distinguish between various types of Gram-positive cocci. Which of these reagents would be used to conduct a catalase test? _____ What type of reaction would be expected of bacteria that tested catalase positive?

(3) 27. Define:

Genomics

Bacteriophage

Taq polymerase

(2) 28. The PCR or _____ is a method or procedure that can be used to amplify (increase the concentration of) segments of _____ in vitro.

(2) 29. The enzymes most commonly used in PCR reactions today are thermostable, ie, are not denatured by heat. Why is this characteristic important? _____ _____. Where were the bacteria that produce thermostable DNA polymerase enzymes originally found? _____

(2) 30. Small segments of DNA (19-20 bases in length) that are used for PCRs, and bind to single-stranded DNA molecules are called oligonucleotide _____. Why are these short nucleotide segments necessary?

(2) 31. During our "miniscreen" exercise, we extracted small, extrachromosomal, loops of DNA known as _____ from our host cells (JM83 and JM101). These DNA loops are genetically engineered, and contain genes referred to as "marker genes" that code for resistance to _____.

(4) 32. Enzymes that can cut double stranded DNA molecules (break phosphodiester bonds) are called _____ and are most valuable if they cut the DNA in a site specific manner, i.e., always cut in the same place. For our digestion exercise we used an enzyme called _____ that was initially produced by bacteria identified as *Escherichia coli* strain RY13. This enzyme recognizes the nucleotide sequence 5'-GAATTC-3', will bind to this sequence and will "cut" double-stranded DNA between the G and A bearing

nucleotides. This action results in the formation of _____ or sticky ends that are _____ (#) bases in length.

(1) 33. Enzymes that prevent the digestion of DNA by adding methyl groups to certain bases are called _____ enzymes and protect cellular DNA from the activity of restriction enzymes.

(1) 34. According to the naming procedure described in this class, the second enzyme isolated from bacteria identified as *Desulfovibrio africanus* strain E would be called _____.

(3) 35. The banding patterns visible in this photograph represent RFLP patterns. What does RFLP stand for? _____ How are RFLPs created? _____. Assuming the patterns that are labeled represent DNA samples taken from specific bacteria as indicated, what type of bacteria is represented by the unlabeled pattern? _____.

(3) 36. These pieces of equipment were used to carry out a procedure known as gel _____ _____. Because DNA molecules carry a slight negative charge, they will tend to migrate toward the anode when the power is turned on. Is the simulated gel present in this chamber positioned correctly for data collection? _____. What would happen to the DNA samples if a gel was placed into the chamber backward and the power was turned on?

(1) 37. In this laboratory we added a mixture of brom phenol blue, xylene cyanol and sucrose to our DNA samples before we loaded them into the agarose gels. The sucrose was added to make the samples heavy so they would sink into the wells. The dye was added so we could see where we were putting the DNA in the gels, and to _____.

(2) 38. Use the data provided to answer the following questions:
a) Which lane or lanes contain(s) the lambda standard? _____
b) Which lane(s) _____ (may be more than one) contain(s) pBR322?

(2) 39. Students in this class were asked to copy a nucleotide sequence from the microbiology web page and then access an Internet site called NCBI. What do the letters NCBI stand for? _____ _____. The nucleotide sequence was transferred into a BLAST program and was compared to other sequences in the gene banks in order to do what? _____

(2) 40. The data shown here was obtained by accessing NCBI and using a nucleotide-nucleotide BLAST to search the gene banks. Nucleotide sequences from what type of organisms show significant alignment with the query sequence used? _____.
What is the lineage (taxonomic information) listed for this genus?
_____.

(3) 41. All of the plates shown here were inoculated with 50 □l of *E. coli* culture. Colonies growing on the TSA-AMP plates represent cells which have undergone _____.
There are no colonies growing on the TSA-AMP plate inoculated with cultures labeled (Y) because the host cells, *E. coli* strains JM83 and JM101, were not given any _____.

Since all of the plates received the same volume of cells, why is there far more growth on the TSA plates than on the TSA-AMP plates? (Please be specific!)

(3) 42. In this laboratory, cultures of *E. coli* strains JM83 and JM101 were allowed to grow until they had reached the _____ phase of their growth curve, in order to produce cells that were _____ (able to take up DNA from the environment). After these cultures were taken from the incubator, 10 ml samples were centrifuged to pellet the cells, the residual TSB was poured off, and then a solution of ice cold _____ was added. This treatment was designed to give the surface of each cell a slight positive charge.

(2) 43. A type of biochemical testing that involves the use of known viruses to identify bacteria is called _____. Of the plates shown here, A and B were inoculated with *E. coli* plus ☐ X-174, while plates C and D were inoculated with *E. coli* plus ☐ T2. *E. coli* strain C is the optimum host for ☐ X-174 but can also be infected by ☐ T2. *E coli* strain B is the optimum host for ☐ T2, and cannot be infected by ☐ X-174. All of the *E. coli* cultures were exposed to phage at the same concentration. Which two plates contain *E. coli* strain C? _____

(2) 44. The clear areas present on this plates are called _____ and indicate areas where phage particles have caused the lysis of bacteria cells. How many pfu were present in one ml. of the original phage suspension? _____

(2) 45. Assuming the data presented here represent the results we obtained during our bacteriophage exercise; determine 1) the latent period for this virus and 2) the burst size for this virus. Latent period = approximately _____ minutes. Burst size = _____ virions per infected cell.

(2) 46. The bacteria growing on these plates are identified as *Serratia marcescens* and are able to produce a bright red-orange colored pigment called _____ when grown at certain temperatures. Which of these plates was grown at room temperature? _____

(4) 47. These plates contain bacteria that have been subjected to a physical factor called _____ radiation. Use the data shown to answer the following:

1) What is the overall effect of this type of radiation on bacteria?

2) Would this type of radiation be an effective method for controlling bacteria inside plastic or cardboard containers? _____ Explain why or why not.

(1) 48. Chemicals used to control pathogenic bacteria on non-living surfaces are called _____ and often include halogens, alcohols and/or surfactants.

(3) 49. This plate was used to conduct an antimicrobial sensitivity test known as an agar diffusion method or Kirby Bauer test. The cleared areas around the paper discs are called _____ and represent areas where the bacteria have either been killed or have been prevented from growing (inhibited).

Is the organism being tested resistant, intermediate, or sensitive to Bacitracin (B-10) _____, to Tetracycline (TE-30)? _____.

(1) 50. Where on a Kirby Bauer test plate would you expect to find the MICs for the drugs being tested?

_____
_

(4) 51. The Standard Methods tests used in the bacteriological examination of water are designed to test for _____ as an indicators of water borne pathogens due to fecal contamination. Why are these organisms used as indicators?
a. _____ b. _____
c. _____

(2) 52. The first step in the Standard methods test for the bacteriological examination of water is called the _____ test, and is sometimes conducted in phenol red lactose broth. Which of the tubes shown here represents a positive test? _____

(2) 53. This plate represents the second step used in the bacteriological examination of water and is called a _____ test. Is this a positive or a negative result? _____

(1) 54. The science or study of antibody and antigen interactions in vitro is called _____.

(2) 55. In this laboratory we used an immunodiffusion method known as the _____ test to determine if antibodies were binding to soluble antigens and causing them to form an insoluble precipitate that appears as a line in the agar. If the middle well of the plate shown here contains antigens from *Coccidioides immitis*, and the outer wells contain serum samples from patients, which of the patients are producing antibodies against the fungus? _____

(2) 56. Human blood type is determined genetically, and is partially influenced by alternate forms of a gene, or _____ identified as A, B, and O. If a person's genotype is AA, BB, or OO, they are said to be _____ for the genes controlling blood type.

(2) 57. Human RBCs have on their surfaces, antigenic determinant groups or epitopes that are referred to as _____. These epitopes will cause the blood cells to clump together when they are exposed to the appropriate antibodies (IgM) called agglutinins. This clumping reaction is referred to as _____ and is the basis for blood typing.

(3) 58. The blood type indicated here would be identified as _____ (include both ABO and Rh). Could this individual safely receive blood from an individual that had type A Rh positive blood? _____ Explain why or why not?

(1) 59. A person with type O, Rh-negative blood is sometimes referred to as a universal donor. Why would packed blood cells form a person with this blood type be unlikely to cause damage when transfused into other individuals even if their blood type was different?

(2) 60. The letters ELISA stand for _____ and form the name of a very sensitive technique used to detect and assay small amounts of antigen or antibody. What factor makes the ELISA a more sensitive test than is a precipitation or agglutination reaction? _____

(2) 61. The liquid portion of blood is called _____ and contains water, electrolytes and proteins. If the clotting factors are removed, most of the proteins remaining will be complement factors and _____.

(3) 62. Identify the blood cell types indicated at the pointer tips: A) _____ B) _____ C) _____

(1) 63. According to the film <u>And the Band Played On</u>, the virus that causes AIDS was initially discovered by researchers working in what country? _____

(2) 64. Prior to the identification of the AIDS virus, researchers working for the CDC suspected that some of the _____ supply being used to treat patients in hospitals and clinics in the US had become contaminated with the AIDS virus. Since no test was available for the AIDS virus, the CDC proposed that an alternate test be used; one that would detect antibodies against the core of the _____ B virus.

Extra Credit Option: Please observe the extra credit questions available on the front counter.

Sierra College Name: _____
Microbiology May 19-20, 2004

Laboratory Exam II

Directions: Read each question carefully and completely before you write your answer. Note that some of the questions require you to observe materials on the desk tops. Those questions are marked with an (*) in the margin. Please make your answers as complete as possible, DO NOT BE VAGUE!

(3) 1. Define:

Fermentation

Decarboxylation

Catalase

(3) 2. This food material was made by placing finely chopped cabbage and salt into a clean beaker and applying a weight (beaker full of water). The cabbage supplied nutrient and populations of bacteria in the genera _____ and _____. These organisms grew under anaerobic conditions and formed _____, a metabolic end-product that lowered the pH and flavored the food material.

(3) 3. This flask contains a poor quality apple wine that was produced by adding a live culture of fungi classified as _____ _____ to a mixture of apple juice and sucrose. The metabolic activity of the fungi present caused the sugars in the juice mixture to be converted into _____ (a gaseous end-product that was allowed to escape from the flask), and _____ a liquid end-product that was collected. This second product is one of the primary flavor components of wine.

(2) 4. In this laboratory we used buttermilk as a source of microorganisms for making cheese. According to the cheese table provided in the laboratory syllabus, the bacteria most commonly used in cheese production are _____ (Gram-positive, catalase negative cocci). Like other Homofermentative organisms, these bacteria produce _____ as their only fermentation product, so this is one of the primary flavor components in cheese.

(1) 5. A ripened cheese is one that has been aged or has a _____ added to it, while an unripened cheese is a finished product at the end of its initial processing steps.

(3) 6. During the initial steps of cheese making, milk is inoculated with a starter culture, it is warmed, and then a proteolytic enzyme called _____ is added to coagulate the milk protein (casein). After that, the _____ (solid portion) is collected and pressed to remove excess moisture or _____ (liquid portion). The amount of liquid allowed to remain in the cheese will influence its consistency (will make it soft or hard).

(3) 7. The bacteria usually associated with fresh yogurt include Gram-positive cocci in the genus _____ and Gram-positive bacilli in the genus _____. Although these bacteria produce acidic end products when fermenting lactose, they also form _____, a neutral end product that gives yogurt a somewhat nut-like flavor.

(2) 8. These materials were used to carry out a technique or procedure referred to as _____. When properly applied, this technique can save time and media because it allows for _____ _____.

(4) 9. Tergitol-7, eosine methylene blue and Mac Conkey's agar are all _____ media because they promote the growth of Gram-negative bacteria while inhibiting the growth of other organisms. These media are also _____ because they cause fermentative organisms to form colonies that look distinctly different from those of non-fermentative organisms. The carbohydrate contained in these media is _____. Which of the plates shown here contains organisms able to ferment the carbohydrate? _____

(2) 10. Organisms that grow on mannitol salt agar (MSA) can often be distinguished from one another based on their ability to ferment _____. Those that can will cause the pH indicator _____ to change from red-pink to yellow.

(3) 11. During the viable cell count conducted in this laboratory, bottles such as these were used to prepare a _____ of a bacterial culture, and then samples of water from two of the bottles were used to inoculate agar plates. Assuming the plates shown here were inoculated according to this technique, how many viable cells were present within 1 ml of the original culture? _____ Why were viable cells the only ones that could be counted?
_____

(2) 12. Microorganisms that require oxygen in order to grow are referred to as obligately aerobic organisms and use a _____ type metabolism. Which of the tube sets shown here contains organisms that have this characteristic? _____

(3) 13. Which of these tubes was inoculated with organisms that were able to ferment the carbohydrate present? _____ How do you know, i.e., what evidence is visible within the tube?
_____
_

(3) 14. These tubes contain glucose and a buffer that tends to inhibit pH change. The pH indicator used to complete this test is called _____ and is added to the culture after 48 hours of incubation. Organisms that are capable of producing large amounts of _____ (enough to overcome the effects of the buffer) are said to test positive. Which of the tubes present represents a (+) test result? _____.

(2) 15. Organisms that test positive in a Voges-Proskauer test are able to produce a neutral fermentation product called _____ by breaking down glucose. Which of the tubes shown contains positive test results? _____

(2) 16. The black color present within this tube is due to the presence of a black precipitate called iron sulfide that is formed when bacteria catabolize sulfur-containing _____ molecules and release _____. This gaseous substance binds with iron in the medium to form the iron sulfide.

(3) 17. Which of the reagents shown here would be used to test for the presence of indole? _____ How is indole produced, i.e., where does it come from? _____ _____ How is motility indicated in an SIM tube? _____ _

(3) 18. These tubes were used to determine if or not bacteria could remove $COOH^-$ groups from lysine molecules. Bacteria that can do this will form carbon dioxide and alkaline substances known as _____ (cadaverine to be exact). What is the pH indicator used in these tubes? _____ Are the bacteria present here capable of producing cadaverine? _____ Note – Culture medium containing the amino acid ornithine will look just like one containing lysine prior to inoculation, and the results of the two would be analyzed in the same manner, i.e., the color change expected would be the same in either case.

(2) 19. Amino acid tubes containing lysine or ornithine, and tubes containing the amino acid control medium are all sealed with vaspar (vasoline/paraffin) following inoculation. Why is this seal necessary? (two reasons)

(4) 20. These tubes were used to determine if or not bacteria could take in and catabolize an organic acid called _____. What is the pH indicator present? _____ _____. Which of the tubes shown contains a culture capable of using this material as a carbon source? _____. What change in pH has occurred within this tube? _____

(3) 21. This medium is used to determine if or not bacteria form _____, an enzyme that can be used to convert urea into _____ (a highly alkaline substance). The tube showing a positive (+) hydrolysis reaction is tube _____ and will have a pH of 8.1 or greater.

(4) 22. Using the data provided, identify the bacteria indicated (genus and species). Note - the bacteria present in these tubes will match exactly with one of the names on the chart. The bacteria present are identified as: _____

(1) 23. The oxidase test is used to detect the presence of _____, an enzyme involved in oxidative phosphorylation.

(1) 24. These tubes were used to determine if or not bacteria could produce _____, and enzyme formed by pathogenic members of the genus *Staphylococcus*. Which of the tubes present contained organisms that tested positive for the enzyme? _____

(1) 25. Students seeking to identify Gram-positive cocci were advised to perform a _____ test by adding hydrogen peroxide to a small sample of bacteria placed on a glass slide.

(3) 26. Define:

Polymerase chain reaction

Electropherogram

Coliphage

(3) 27. The enzyme used in our PCR is called _____ and was mixed with dNTPs and buffer solution in a master mix. This enzyme is thermostable, ie, is not denatured by heat. Why is this characteristic important? _____ _____. Where were the bacteria that produce this thermostable enzyme originally found? _____

(3) 28. Small segments of DNA (19-20 bases in length) that are used for PCRs, and bind to single-stranded DNA molecules are called oligonucleotide _____. Why are these short nucleotide segments necessary?

What region of DNA were we attempting to amplify using the PCR? _____

(2) 29. During our "miniscreen" exercise, we extracted small, extrachromosomal, loops of DNA known as _____ from our host cells (JM83 and JM101). Each of these DNA loops contains an origin of replication, so can reproduce itself when placed into a host cell. For this reason, these structures are often used as _____ or replicons. Any fragment of DNA inserted into them will be reproduced when transferred into a host cell.

(1) 30. Enzymes that can cut double-stranded DNA molecules (break phosphodiester bonds) are called _____ and are most valuable if they cut the DNA in a site-specific manner, i.e., always cut in the same place.

(3) 31. In this laboratory we digested pUC19 and pBR322 with an enzyme called _____ that was initially produced by bacteria identified as *Escherichia coli* strain RY13. We also digested our PCR product with an enzyme called _____ that was initially produced by bacteria identified as *Arthrobacter luteus*. The first enzyme recognizes and binds

to the nucleotide sequence 5'-GAATTC-3', and will "cut" between the G and A bearing nucleotides to produce 4-base _____ or sticky ends. The second enzyme recognizes and binds to the nucleotide sequence 5'-AGCT-3' and cuts between G and C bearing nucleotides to produce blunt ends.

(1) 32. Enzymes that prevent the digestion of DNA by adding methyl groups to certain bases are called _____ enzymes and protect cellular DNA from the activity of restriction enzymes.

(1) 33. According to the naming procedure described in this class, the first enzyme isolated from bacteria identified as *Nocardia asteroides* strain T would be called _____.

(3) 34. These pieces of equipment were used to carry out a procedure known as gel _____. Because DNA molecules carry a slight negative charge, they will tend to migrate toward the anode when the power is turned on. Is the simulated gel present in this chamber positioned correctly for data collection? _____. What would happen to the DNA samples if a gel was placed into the chamber backward and the power was turned on?

(1) 35. In this laboratory students mixed loading dye (brom phenol blue & xylene cyanol) with their DNA samples before placing these into the wells of agarose gels. In addition to making the DNA samples visible during loading, what function does this dye mixture serve?

(3) 36. Use the data provided to answer the following questions:
a) Which lane or lanes contain(s) the lambda standard? _____
b) Which lane or lanes contain(s) _____ pUC19?
c) Which lane contains the PCR product generated from physiological unknown #2 _____

(3) 37. The light-colored bands represented here are called RFLP patterns, what does RFLP stand for? _____ __ Assuming these patterns were generated by cutting PCR product DNA from different organisms using the same restriction enzyme (which they were), which of the lanes appear to contain organisms that are very closely related? _____. RFLP patterns are also commonly referred to as _____ and are used extensively in the identification of people (in criminal investigations, forensics, paternity suits, etc.).

(3) 38. A relatively new science called _____ involves the study of genomes from multiple organisms all at the same time (as a single unit), and requires the use of computers. In this laboratory, students were asked to copy nucleotide sequences from the microbiology web page and then access an Internet site identified as the _____ or NCBI. Students were then able to compare their nucleotide sequences to those recorded in the gene banks using the _____ algorithm. This tool searches the gene bank data and determines the extent to which local nucleotide sequences align with recorded sequences.

(2) 39. The data shown here was obtained by using the technique described above. Nucleotide sequences from what type of organisms show significant alignment with the query sequence

used? _____. What is the lineage (taxonomic information) listed for this genus? _____.

(3) 40. Gram-negative bacteria that have been made capable of taking up DNA from their environment are referred to as _____ cells. In this laboratory we prepared such cells from *E. coli* cultures by growing the cells until they had reached the _____ phase of their growth curve and then treating them with ice-cold calcium chloride. What function did the calcium chloride serve? _____ _____.

(3) 41. All of the plates shown here were inoculated with 50 □l of *E. coli* culture. Colonies growing on the TSA-AMP plates represent cells that have undergone _____, i.e., they have picked up plasmid DNA that contains genes coding for _____ _____. There are no colonies growing on the TSA-AMP plate inoculated with cultures labeled (Y) because the host cells, *E. coli* strains JM83 and JM101, do not carry any plasmids. Since all of the plates received the same volume of cells, why is there far more growth on the TSA plates than on the TSA-AMP plates?

(2) 42. A type of biochemical testing that involves the use of known viruses to identify bacteria is called _____. Of the plates shown here, A and B were inoculated with *E. coli* plus □ X-174, while plates C and D were inoculated with *E. coli* plus □ T2. *E. coli* strain C is the optimum host for □ X-174 but can also be infected by □ T2. *E coli* strain B is the optimum host for □ T2, and cannot be infected by □ X-174. All of the *E. coli* cultures were exposed to phage at the same concentration. Which two plates contain *E. coli* strain C? _____

(2) 43. The clear areas present on this plates are called _____ and indicate areas where phage particles have caused the lysis of bacteria cells. How many pfu were present in one ml. of the original phage suspension? _____

(2) 44. Assuming the data presented here represent the results we obtained during our bacteriophage exercise; determine 1) the latent period for this virus and 2) the burst size for this virus. Latent period = approximately _____ minutes. Burst size = _____ virions per infected cell.

(2) 45. The bacteria growing on these plates are identified as *Serratia marcescens* and are able to produce a bright red-orange colored pigment called _____ when grown at certain temperatures. Which of these plates was grown in the 37° C incubator? _____

(3) 46. These four plates were inoculated with lawn cultures of bacteria and were then subjected to _____ radiation. Direct exposure for as little as one minute caused most of the bacteria present to _____ but exposure blocked by a plastic Petri plate lid or a 3x5 card had no effect. This is because this form of radiation has _____ ability.

(1) 47. Chemicals used to control pathogenic bacteria on living surfaces are called _____ and often include halogens, alcohols and/or metal ions.

According to the data shown here, which general type of bacteria (Gram-positive or Gram-negative) is most sensitive to the chemicals being used?
_____

(3) 48. This plate was used to conduct an antimicrobial sensitivity test known as an agar diffusion method or Kirby Bauer test. The cleared areas around the paper discs are called _____ and represent areas where the bacteria have either been killed or have been prevented from growing (inhibited). Is the organism being tested resistant, intermediate, or sensitive to Bacitracin (B-10) _____, to Tetracycline (TE-30)? _____.

(2) 49. The lowest concentration of an antimicrobial drug required to gain clinical control of a pathogen is referred to as the _____ concentration of MIC. Where on a Kirby Bauer test plate would you expect to find the MICs for the drugs being tested?
_____

(2) 50. According to the data shown here, which of the antimicrobial drugs tested are broad-spectrum antibiotics? _____

(3) 51. The Standard Methods tests used in the bacteriological examination of water are designed to test for bacteria identified as _____ as indicators of water-borne pathogens due to fecal contamination. Why are these organisms used as indicators?

(2) 52. The first step in the Standard methods test for the bacteriological examination of water is called the _____ test, and is sometimes conducted in phenol red lactose broth. Which of the tubes shown here represents a positive test? _____

(2) 53. This plate represents the second step used in the bacteriological examination of water and is called a _____ test. Is this a positive or a negative result? _____

(1) 54. Chemical reactions that involve the binding of antibody and antigen in vitro are called _____ reactions and involve the formation of hydrogen bonds.

(2) 55. This data was obtained from an immunodiffusion plate that involved the binding of antibodies with soluble antigens. When the antibodies were bound with the antigens the complex became insoluble and fell out of solution forming the white lines. This type of reaction is known as a _____ reaction and is often used in diagnostic testing. If the middle well of the plate shown here contains antigens from *Coccidioides immitis*, and the outer wells contain serum samples from patients, which of the patients are producing antibodies against the fungus? _____

(3) 56. Human RBCs have on their surfaces, antigenic determinant groups or epitopes referred to as _____. These epitopes will cause the blood cells to clump together when they are exposed to the appropriate antibodies (IgM) called _____. This clumping reaction is referred to as _____ and is the basis for blood typing.

(2) 57. Human blood type is determined genetically, and is partially influenced by alternate forms of a gene, or _____ identified as A, B, and O. If a person's genotype is AB, AO, or BO, they are said to be _____ for the genes controlling blood type.

(3) 58. The blood type indicated here would be identified as _____ (include both ABO and Rh). Could this individual safely receive blood from an individual that had type A Rh positive blood? _____ Explain why or why not?

(1) 59. A person with type O, Rh-negative blood is sometimes referred to as a universal donor. Why would packed blood cells form a person with this blood type be unlikely to cause damage when transfused into other individuals even if their blood type was different?

(2) 60. The letters ELISA stand for _____ and form the name of a very sensitive technique used to detect and assay small amounts of antigen or antibody. What factor makes the ELISA a more sensitive test than is a precipitation or agglutination reaction? _____

(1) 61. The liquid portion of blood is called _____ and contains water, electrolytes and proteins.

(4) 62. Identify the blood cell types indicated at the pointer tips:
A) _____ B) _____
C) _____ D) _____

(2) 63. According to the film <u>And the Band Played On</u>, the virus that causes AIDS was initially discovered by researchers working in what country? _____ Did they call the virus HIV? _____

(2) 64. Prior to the identification of the AIDS virus, researchers working for the CDC suspected that some of the _____ supply being used to treat patients in hospitals and clinics in the US had become contaminated with the AIDS virus. Since no test was available for the AIDS virus, the CDC proposed that an alternate test be used; one that would detect antibodies against the core of the _____ virus.

Extra Credit Option: Please observe the extra credit questions available on the front counter.

SUGGESTED STUDY TECHNIQUES

The conscientious use of proven study methods can help students to improve their mastery of subject materials and to improve their grades. In a physiological sense, although LEARNING involves understanding, it is mostly a matter of REPETITION: The more exposure students have to their subject materials, the greater their chances of retaining that information. The more times a neuronal circuit (pathway) is excited (used) in the central nervous system (brain and spinal cord) the more that circuit is facilitated (remembers).

When students begin to study Microbiology they must recognize that: 1) most of the information presented will be "new" to them, and 2) much of the vocabulary used to present this information will be unfamiliar. Studying a new course "in a different language" is more difficult than taking a "more conventional class". It is somewhat similar to studying the history of Czarist Russia with the instructor lecturing on the history in Russian. You would obviously need to master the language before you can master the history. Therefore, when studying Microbiology (as well as many other academic subjects) you must learn the language in order to master the information. The following techniques can be useful in **any class** where there is a large volume of information being presented and much of the vocabulary is new.

1. Establish a schedule (similar to your class schedule) and extend it for a full 24 hour day, 7 days a week. Know when you have free time to study and **use** it. Don't waste time sitting in the campus center, lounging on the lawn or watching mediocre TV. When you need to play, do so energetically, and when its time to study, do so intensely. Don't try to play while studying.

2. Understand your physiology. Recognize when you are really alert and when you are sluggish mentally (like after meals). STUDY ACCORDINGLY!

3. Complete all reading assignments **before** the lecture and/or lab. on that topic. You will find this makes the lecture and lab. material easier to understand.

4. Make sure your notes are complete and accurately represent the information being presented. (Most students write down less than half of the material they receive orally, and this is often not adequate.) If necessary, share notes with another student and/or invest in a small tape recorder and record lecture and lab. presentations. Taped information can be reviewed before the next class session, and will allow you to fill in any gaps present in your notes. Reviewing taped lectures increases accuracy, and allows for REPETITION of the subject material.

5. Use flash cards for vocabulary. REPETITION IS LEARNING , whether it is in college or in the second grade. Write each new term on one side of a 3X5 card along with the word **define** . On the other side of the card write out a complete definition for the term in the form of a question, leaving a blank space for the term being studied. This method will allow you to study for both definition and fill in the blank type questions. You will find that flash cards take time to make up, but are highly effective if used properly. For best results, do not attempt to put too much information (more than two new terms) on a single card, and remember that there is a difference between recognition and recall. When studying for “fill-in-the-blank” type tests, do not be fooled by recognition. If you must turn the 3X5 card over and look at the information before you can “recall” it, you DO NOT know it, and will not be able to recall it on a test.

6. Review is repetition; REPETITION IS LEARNING. Review each night before the next day's class. Pick up points on quizzes. KNOW WHAT TO STUDY, and if the instructor tests from lecture materials, don't waste time excessively studying other sources of information. Review several weeks ahead for finals. Get ahead of the crowd. Try simply reading and re-reading your notes from beginning to end at least three or four times a week (It will take less time each time you read them, and is more REPETITION.) If you have reviewed ahead of time you can come to the instructor and get questions answered while others are feebly cramming.

7. Rewrite your lecture notes. It is time consuming but it is repetition. REPETITION IS LEARNING. Look up unclear portions. Write a second set of notes which contains only that information you could not immediately remember from your original notes.

8. Set small, attainable study goals. If you are successful in attaining your initial goals, you will be encouraged to formulate and accomplish additional goals. Success feels good!

9. Review some school work each evening before going to sleep. This is usually a very efficient learning technique as there is little or no interference with the formation of memory. This method is particularly valuable when trying to comprehend difficult subjects.

These techniques, when used properly, yield a high degree of success. If you force yourself to use them (over and over again), establish a regular pattern and follow it, you will be successful. "Hit and miss" study habits result in "hit and miss" learning and yield "hit and miss" grades. Consider your role as a student analogous to a sharp-shooter; with practice you can be one of the best, but without it you're just average.

USE THIS STUDY GUIDE !