Microbiology 200 Mazes

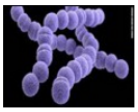
Bio101, Chem101 & MEDscience Physiology Collections are FREE

Review and/or Quiz yourself on topics that span a *General Microbiology* course. Pak includes Microbial Growth and Genetics, Viruses, Prokaryotes, Protozoans & Parasites, Virulence & Pathogenicity, Diseases and Epidemics, Antibiotics and Immunology. We recommend first completing Bio101 Semester Pak (free) and MEDscience 06 - Immune System (free).

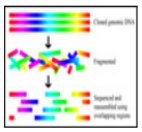
Author: MazeFire

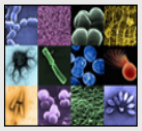
Make sure to use the TIPS! - and if sent back to a question you probably got it right the first time: *try it again* and it may turn GREEN!

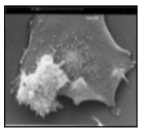
Microbiology 200

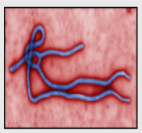
1. 
   Microbiology 200.1 - The Microbial World
   This is a deeper introduction than Microbiology101. It includes bacterial shapes, stains, metabolism and behaviors. Perhaps try Biology 101 Semester Pak first and/or try two immuno games: MEDscience 06 and A&P 2.6

2. 
   Microbiology 200.2 - Microbial Life & Death
   Review growth rates and conditions as well as human countermeasures! As background, maybe try Bio101.1 (cells), Bio101.2 (biochem) and Bio101.7 (bioenergetics) first.

3. 
   Microbiology 200.3 - Genetics & Biotechnology
   Basics of Microbial Genetics are covered along with some Biotech questions. You might try some Biology 101 Series Mazes as Prep and the A&PII 2.6 and 2.10 Games to complement this maze.

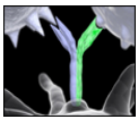
4. 
   Microbiology 200.4 - Rise of the Prokaryotes
   Phylogeny is quite the challenge when we start dealing with these little critters! Test your knowledge of bacterial identification and attributes.

5. 
   Microbiology 200.5 - Protozoans & Parasites
   Review your knowledge of Eukaryotic Microbes including yeasts, algae, protozoans and parasites.

6. 
   Microbiology 200.6 - Viruses101
   This maze tests mainly your understanding of viruses, although you'll find a bit about prions and antibiotics.

7. 
   Microbiology 200.7 - Diseases & Epidemics
   Diseases and Epidemics explores *interactions* between Humans and Microbes, including both "normal" co-existence and more vigorous interactions .

8. 
   Microbiology 200.8 - Virulence & Pathogenicity
   Covers mechanisms of pathogenicity. You might first review some of our Physiology Games (MEDscience, A&P II) and also Bio101 since these are the underpinnings of pathology.

9. 
   Microbiology 200.9 - Playing Defense: Immunology
   MazeFire has two BASIC Immuno games: MEDscience06 (easiest) and A&P 2.6 (more detailed). It might be best to try those first! Micro200.9 is more challenging!

10. 
    Microbiology 200.10 - Playing Offense: Antibiotics
    Focuses on Antibiotics including mechanisms, antifungals and new developments. This is the final Microbiology 200 Maze. Authors welcome for other advanced Microbio Mazes, such as Medical and Industrial Microbiology!

Q1. Virus is from the Latin word for

A. tiny
B. poison
C. infectious
D. hidden
E. harmful

INCORRECT responses shown in **RED**
CORRECT responses shown in **GREEN**

Between 1890 and 1930, it became clear that there was an infectious agent that was too small to be a bacterium because it was "filterable", i.e. passed through a mesh that was too fine for bacteria to pass. This placed the agent in the realm of chemicals and so the Latin word for poison "virus" was used. Adolph Mayer had shown that tobacco mosaic disease was transmissible and in 1892, Russian bacteriologist Dmitri Ivanovsky discovered that it was filterable. American chemist Wendell Stanley isolated tobacco mosaic virus in 1935, and soon after, with the advent of the electron microscope, we saw viruses for the first time. And soon thereafter, no doubt, began the debate of are they living things or not? [see Answer #19].

Q2. A capsid is

A. an envelope that surrounds most animal viruses
B. a protein subunit of a viral protein coat
C. the protein coat that surrounds a viral genome
D. a protein cap that is added to the end of an assembled virus
E. a viral extension that sprays hydrolytic enzymes to help penetrate into the host cell

*Viruses are generally surrounded by a protein coat or *capsid*. The capsid itself is comprised of protein subunits called capsomeres. The actual form of the capsid can take on a great variety of shapes, ranging from the spiky Adenovirus balls, to rod shaped TMV virus and M13 bacteriophage, to polyhedral and brick shapes. Most viruses enter cells by binding to receptors, as opposed to spraying hydrolytic enzymes, which we do not think any viruses can do. But bacteriophage can release lysozymes that aid the penetration of bacterial cell walls. Hint: These are especially useful if your virus gets cold.*

Q3. The viral eclipse period is

A. the final stage of viral activity before its constituent components break down
B. the time between a virus disappearing inside a cell and then reforming (as progeny)
C. the period during which viral proteins block or eclipse host DNA polymerases
D. when viral nucleotides in a cell outnumber host cell nucleotides
E. a theoretical moment at which viruses have consumed most of Earth's organic materials ending life as we know it

After an adding an aliquot of virus to a Petri dish, the number of virions first falls as they enter cells and disassemble. This begins the eclipse period, during which few or no viral particles can be detected. After some time has passed, during which viral DNA and proteins are synthesized, the eclipse period ends. This is signaled by a rapid increase in virion number as virus particles are assembled, which can exceed the starting number by many fold, if the viruses effectively enter and replicate within the cells in the Petri dish. Eventually there is a plateau and finally a fall in virion production, as the cells in the dish are lysed and can no longer make new virions. While eclipse does not specifically concern virion effects on host cell gene expression, many viruses do in fact degrade the host cell DNA and recycle the free nucleotides into new viral DNA. We do not actually believe (E) can happen, but it would make a nice SciFi story!

Q4. Which statement about lysogeny is INCORRECT?

A. lysogeny entails integration of viral DNA into the host genome
B. the integrated virus is termed a prophage
C. viruses are replicated in the course of normal host cell replication
D. after perhaps thousands of cell divisions, the prophage exits the genome, replicates and lyses (kills) the host cell
E. phages capable of lysogeny are called virulent phages

Like a scene out of the movie Alien, but on a smaller scale, some phages enter cells and then integrate into the host cell genome by means of complementary DNA sequences between phage and host DNA. These phages are called "temperate" because they do not hijack the cell's machinery upon entry. Viruses that immediately start replicating upon penetration are called "virulent". Temperate might not seem like such a good term, since the virus is still aiming at some point, perhaps after 10,000 cell divisions, to exit the genome and THEN replicate and lyse the cell. In the meantime, it has used the bacterium's reproductive capabilities to make many more copies of itself. But this is not necessarily 100% bad for the bacterium because (1) the phage makes repressors of phage gene expression so as to remain as prophage, and this hinders infection by additional viruses and (2) the bacterium may gain some new genes in the integration event that make it more capable of reproducing by providing new exotoxins and exoenzymes, a process termed lysogenic conversion.

Q5. WHO declared H1N1 a pandemic in 2009?

A. Centers for Disease Control
B. National Academy of Sciences
C. Red Cross
D. World Health Organization
E. Doctors without Borders

The 2009 strain of the H1N1 flu virus, aka swine flu, was declared a pandemic by the World Health Organization (WHO). WHO is the disease preparedness / health systems arm of the United Nations and is assisted by groups such as the Red Cross, Doctors without Borders and the CDC (amongst others). H1N1/09 was a new Influenza-A virus that emerged in 2009 and contained swine genes. Seasonal flu vaccines are said to have offered "no" protection, although some older adults had limited immunity. It is said to have killed 17,000 worldwide, including 3,900 in the US, but ~36,000 die annually in the US from seasonal flu, which puts the threat from Ebola (1 US death, total) and terrorism (about 10 fatalities per year since 9-11) in perspective! The Wikipedia article "Pandemic H1N1/09 virus" summarizes efforts to analyze and track this virus along with conflicting views on its makeup and spread. Hint: Already gave you a hint!

Q6. Which fraction of cancers in the US are virus-induced?

A. 0.1 %
B. 1%
C. 10% to 20%
D. 50% to 70%
E. >90%

Oncogenic viruses are believed to induce at least 10% of all cancers in the US. In 1908, Danish researchers showed that chicken leukemia could be induced by cell-free filtrates (i.e. viruses, although viruses would not be seen for another 30 years using EM). This was subsequently shown for sarcoma and adenocarcinoma, but it was not until 1972 that Sarah Stewart first isolated a cancer-causing virus. While random insertions into the genome can potentially cause cancers (via dysregulation of cell cycle control), it turns out that many viruses insert viral forms of endogenous genes. For example, c-myc is a normal gene that regulates cell cycle in mammals. The viral, v-myc, version which recombines into the genome, results in excess cell proliferation and immortalization, aka cancer. The 10% to 20% range might be an underestimate given that virtually all cervical cancers are associated with HPV virus infection, while liver cancer seems to be caused by hepatitis B virus in a great majority of liver cancer patients. While University of Cambridge researchers (J. Gen. Virology, 2010) suggested that up to 25% of cancers are caused by viruses, an MD Anderson paper (J. Virology, 2013) estimate was about 10%.

Q7. The discovery of Prions (proteinaceous infectious agents) came about because of

A. theoretical work demonstrating that proteins could mimic nucleic acids
B. the inadvertent release of developmental bioweapons
C. a rash of unexplained infections in several research laboratories
D. unexplained infections in cows and humans
E. ALL of the above

There is no indication that events like (B) or (C) ever happened in the Prion domain, nor that proteins could transmit infectious information in the way a virus or bacteria can. But there were unexplained, radiation-resistant bovine and human encephalopathies that led Alper and Griffith to propose in the 1960's that a protein might be responsible. UCSF Medical Resident Stanley Prusiner, having lost a patient to Creutzfeldt-Jakob Disease in 1972, began a 10 year effort to discover the cause and in 1982 published a paper in Science reporting that a proteinaceous particle was responsible for these and other illnesses such as Kuru. This disruption of the most central dogma of infectious disease led to years of controversy, but progress over the years (not to mention the 1997 Nobel Prize) weigh in favor of this hypothesis. Challenges to the Prion hypothesis persist today on Wikipedia and ResearchGate, but one wonders if this is akin to arguments against vesicular neurotransmitter release and HIV as the cause of AIDS. Bioweapons in general are (today) of little tactical or strategic value, although it is still prudent for military organizations to protect their soldiers from such attacks.

Q8. Which kind of virus infects bacteria?

A. phage viruses
B. rabies virus
C. picornaviruses
D. pox viruses
E. adenovirus

Phage virus, aka bacteriophage, is a generic name for the wonderfully diverse viruses that infect bacteria and that have been used since ancient times (as filtered waters) as antibiotics. Seas are rife with them and a large percentage of bacteria may be naturally infected with viruses. Phage-lambda and the T-even viruses are useful research tools and have shed great light on molecular, cellular and genetic processes. The other viruses are all animal viruses with rabies obviously infecting dogs and other mammals; pox including the lethal small pox virus; and adenovirus names for its affinity for respiratory tracts. Picornaviruses are tiny RNA viruses and yet cause lots of problems for vertebrate animals like us.

Q9. Viruses are classified based upon

A. their morphology
B. whether they are DNA or RNA viruses
C. whether they use single-stranded vs. double-stranded nucleic acids
D. based upon the presence or absence of an envelope
E. ALL of the above

Viruses are classified based upon a constellation of traits, including those above. Additional factors include number of protein subunits in the capsid, host species and any immunological characteristics. Viruses do not have a phylogenetic lineage in the sense that different clades of living organisms do, at least in part because viruses make their "living" shuffling genetic materials between living organisms. Absent a deducible phylogeny, viral classification is aimed more towards the practical goal of grouping related strains so as to better understand them, treat them and create vaccines to protect against them.

Q10. The Herpesviridae viruses family includes

A. Simplexvirus, which causes cold sores
B. Roseolovirus, which infects most infants
C. HHV-8, which causes Kaposi's sarcoma in AIDS patients
D. viruses that infect mammals, birds, fish, reptiles, amphibians, and molluscs
E. ALL of the above

There are more than 100 different viruses in the Herpesviridae (or Herpesvirus) grouping, and a number are extremely widespread in human. While HHV-7 is a fairly benign Roseolovirus causing a mild rash in infants, HHV-8 has more serious consequences (Kaposi's sarcoma) in the immunocompromised. HHV-3, varicellovirus, causes chicken pox, which in turn can become a latent neural infection that produces shingles (despite its name, chicken pox is not part of the poxviruses family). Latent infections are also common with Simplexvirus where heat and stress increase the likelihood of Herpes outbreaks. Epstein-Barr virus, which causes mononucleosis, and Cytomegalovirus are also part of the Herpesvirus family. Epstein-Barr also causes several cancers and increased risk of autoimmune disease, so you get the sense that this family is a pretty big deal.

Q11. This animal virus is unusual in that it replicates in the cytoplasm

A. herpes
B. picornaviruses
C. poxviruses
D. retroviruses
E. rhabdoviruses

Most viruses that infect eukaryotes, including animals, replicate in the nucleus, which makes sense given the location of the cell's DNA replication machinery. One notable exception is the poxviruses, which includes small pox, perhaps the deadliest virus in history, killing about 400 million in the 20th century (smallpox has since been eradicated, although samples remain in the hands of military organizations). The poxviruses, which are amongst the largest and most complex viruses known, initiate viral genome replication in the cytoplasm perhaps to more efficiently generate mature viruses. They are enveloped by endoplasmic reticulum and assume an oval-brick shape. If you are not familiar with the other viruses, you should know that polio is a picornavirus, HIV a retrovirus, and rabies a rhabdovirus. Hint: This virus family includes the deadliest virus in human history.

Q12. Ebola virus is most commonly spread via

A. the ventilation systems of aircraft cabins
B. non-sterile medical instruments
C. coughing and sneezing
D. contact with bodily fluids
E. amorous activities

Recurrent outbreaks of Ebola virus in Africa are normally well-contained, but the 2014-2015 West African epidemic wreaked havoc in Guinea, Sierra Leone, and Liberia with 25,000 cases and about 10,000 fatalities, including many health-care workers both local and international (e.g. Doctors without Borders). It is spread by living in close quarters and by traditional rites, but less so by coughing/sneezing (fortunately). It can potentially be spread by medical instruments and certainly by intimate contact, but these are not the main routes of transmission. To our knowledge, no one has ever contracted Ebola on an airplane but Ebola is, to be sure, a frightening virus with a fatality rate of 50% in Africa. The cable-news fueled hysteria sparked fears of a pandemic, leading to calls in the US to cancel international flights and a panic in NYC over a Bowling Alley (not to mention the imprisonment of Texas health-care worker Kaci Hickox by the Governor of NJ). On the plus side, the hysteria may have helped spur better detection, management and treatment of the illness and in 2015 there has been progress on creating an Ebola vaccine. Better procedures could come in handy if something much worse comes down the pike, e.g. a virus with the virulence of Ebola and the contagiousness of the flu. Here is Kaci's story: http://www.cbsnews.com/news/ebola-in-the-u-s-nurse-kaci-hickox-quarantined-in-n-j-criticizes-way-she-has-been-treated/

Q13. An anti-sense strand (- strand) virus is

A. a DNA single-strand virus
B. a DNA double-strand virus
C. an RNA virus that is first copied by reverse transcriptase
D. an RNA virus that is "copied" to create translateable mRNA
E. a viral nucleic acid strand with more negative than positive charges

While viral classification is a messy business, a useful, primary criterion is the nature of the viral genome which can be single- or double-stranded DNA or RNA. In the case of RNA viruses, they can be double-stranded, single sense strands or single antisense strands. Sometimes the sense strand is called positive and the antisense strand negative. Positive or Sense strand RNA is the same as mRNA in the sense that you can directly translate it into protein (assuming you have the correct start and stop sequences present). Negative or antisense RNA must first be copied (from antisense to sense) to make usable mRNA. This might seem like an extra step, but upon entering the cell the virus can immediately make many copies of mRNA and quickly hijack the host cell's machinery. But this is just one option and there are indeed pros and cons to all the different coding choices and, in any case, the viral world is trying out all of them. This blog post adds a bit more on virus classification: http://www.virology.ws/2009/08/07/how-viruses-are-classified/

Q14. In regards to the idea of using bacteriophage as antibiotics

A. the idea of injecting viruses is so frightening that no patients will accept this
B. there have been too many deaths from sub-standard efforts in this arena
C. researchers are unable to obtain phage viruses in sufficient quantities to test the idea
D. there has been a good deal of research in this area and significant clinical efforts
E. phage-therapy is now a primary treatment for most bacterial infections now a mainstay

The problem of antibiotic resistance is akin to a global pandemic in that humans have decreasing means to fight bacterial infections. Because bacteriophage naturally kill bacteria, this provides a biological means of attack to complement chemical antibiotics. There are many hurdles to this with costs probably near the top. Mass producing viruses has its challenges and meeting FDA standards is an even bigger challenge. Moreover, phage viruses have a narrow host range, and so a very specific virus is needed for each virulent bacterial infection. As such, this could be a useful means of last resort (highest cost), but specificity is also a benefit in that one does not wipe out commensal or beneficial bacteria in the process. A recent ingenious paper (PNAS, 2015) uses the gene-editing tool CRISPR to remove antibiotic-resistance from harmful bacteria. A link is also provided to ongoing phage work in Eastern Europe, which is perhaps a less litigious climate to develop this. One clinic in Europe has been advertising phage treatment for a very wide range of conditions, but this seems impossible given the current state of the art. Here are some resources on phage therapy: 1. CRISPR paper: http://bit.ly/1B2xXpF 2. News Report: http://bit.ly/1pDBZgx

Q15. The plaque method for growing and identifying viruses

A. uses bacteria grown on a Petri dish
B. uses bacteria grown in suspension
C. is tailored for animal viruses that cannot be grown in culture
D. is an intermediate stage between *in vitro* and *in vivo* culture
E. uses dental plaque from less-astute tooth brushers to boost viral growth

Viral culture is not so common and widespread as bacterial cell culture, yet is quite important for biomedical research, vaccine development, patient diagnosis and public health measures. With the plaque method, an aliquot of viral solution (containing bacteriophage) is spread over a bacterial lawn (in a Petri dish) and the number of holes (plaques) that appear in the lawn indicate the viral titre (concentration, given as plaque-forming units). Perhaps more important is the more basic observation: do plaques form? If none form, this indicates that either there are no viruses in the sample OR the cells on the plate are NOT a host to that virus. Being a host sounds like such a nice thing! One can also grow viruses in a bacterial suspension and use other means to assess growth and titre. Similar plaque and suspension methods can be done using animal cells and animal viruses: these are all considered in vitro (in glass) methods, i.e. in a Petri dish. Some animal viruses can only be grown inside animals (in vivo). If one wishes to use phage viruses as antibiotics, they need to be grown in large quantity and be free of harmful contaminants. Answer (E) is just gross, sorry. Here is a methods chapter on Viral Culture: http://bit.ly/1IZG3Ri.

Q16. Viruses can have which effect on infected cells?

A. they can destroy the host cell's DNA
B. they can integrate into the host cell's DNA
C. they can add non-viral genes into the host cell's DNA
D. they can work with other viruses to co-opt the cell's machinery
E. ANY of the above, depending upon the specific virus

The classical viral action: infect, replicate quickly, kill (lyse) the host cell, is perhaps the simplest of viral patterns and the modus operandi of virulent phages/viruses. But many viruses can integrate into the viral genome (lysogeny) and bring with them "non-viral" genes (transformation). If the host cell experiences damage, the integrated prophage can exit the host cell chromosome and begin a lytic cycle (induction). Because viruses can both gain and lose genes as they enter and exit host cell genomes, some viruses are defective, i.e. carry insufficient genetic information for replication. But if other viruses of the same species infect a cell, the viruses as a group can overcome one another's deficits. Moreover, this allows for the creation of new viruses, e.g. new flu viruses that combine bird and swine genes and then infect humans that are ill-prepared for the new strain (see H1N1 question). Hint: Non-viral means genes that do not code for viral proteins, e.g. oncogenes or toxin genes.

Q17. If an animal is injected with a monoclonal antibody against a virus-receptor on a host-cell membrane, this

A. should recruit large numbers of viruses to the tagged sites
B. can block the viral receptors preventing infection
C. can trigger a massive immune response, often leading to an auto-immune disorder
D. should increase the efficiency of virus binding and host-cell penetration
E. should not have any effect

Biomedical researchers are increasingly using monoclonal antibodies (MABs) as therapies for diverse medical illnesses. If MABs can be efficiently produced and delivered so as to prevent viral infections from attaching to cells, by e.g. blocking the binding sites that viruses normally use, this could be an effective anti-viral therapy (of which there are few good ones today--witness the Ebola virus debacle). One problem is that one needs a very specific antibody AND one needs it produced in time to be beneficial, which is an issue because new strains of viruses are appearing all the time. While MAB binding should not recruit viruses to their target neurons, it is possible but unlikely that the MAB-receptor protein complex could trigger an auto-immune disorder: this should at least be monitored. It is even less likely that a MAB will improve viral binding and penetration, but that is theoretically possible-- and hopefully you will never be injected with a MAB that does that!

Q18. For a given virus, the term *host range* refers to

A. the geographic range of hosts that it can infect
B. how far a host can travel once infected
C. the range of species that a virus is able to infect
D. the range of species for which it offers net benefits
E. the specific *range receptors* with which it interacts

Viruses generally infect a relatively narrow range of species, in a phylogenetic sense. While we are familiar with bird and swine flu affecting humans (not to mention rabies viruses), mammals are closely related and we need not worry about infection by bacteriophage. Indeed, we might be able to use bacteriophage as antibiotics one day, but as of 2015 this is not your antibiotic of choice! The specificity of infection stems from the fact that all viruses invade cells through specific "receptors" on the outside of cells. These are not receptors in the traditional sense of proteins that evolved to bind the virus and produce an appropriate cellular response, but the term is more generally used here to refer to any biochemical structure on the outside of a cell to which a virus can attach for its own nefarious purposes! While the term "range receptor" makes sense or at least sounds nice, it is not a term used by microbiologists.

Q19. Which trait distinguishes viruses from all metabolically-active forms of life?

A. the presence of proteins
B. the presence of nucleotides
C. the presence of either DNA or RNA (but not both)
D. the ability to pack proteins around nucleic acids
E. the ability to catalyze chemical reactions

Whether one prefers to consider viruses as non-living things (a reasonable choice) or inert biological entities (i.e. metabolically sterile) is perhaps a matter of semantics. What is clear is that viruses are metabolically inert--they carry out no significant biological activity on their own (decomposing does not count). They also fail the central dogma of biology (DNA => RNA => protein), because any given virus has either DNA or RNA, but not both (all truly living things have both). While viruses can catalyze chemical reactions (to enter a cell or hijack its genetic machinery), so can enzymes, but few would grant enzymes the status of living entities. Of course, it is also true that viruses do replicate and evolve, so our preference to exclude viruses from the Domain of the Living, will be VERY far from the last word on the subject.

Make sure to use the TIPS! - and if sent back to a question you probably got it right the first time: *try it again* **and it may turn GREEN!**