Microbiology and Immunology 2500 A/B: Virology Solutions

Introduction

Dear student,

This document contains content derived from the Microbiology & Immunology 2500A/B course and it focuses specifically on the **virology unit** by providing practice questions and answers to help students follow along with the content presented in lectures. This resource has been created by the Education Team at Webstraw. The Education Team consists of students that have previously taken and/or students that are currently taking Microbiology 2500A/B.

Purpose

This resource focuses on key concepts that are important for students to understand to succeed within this course. This resource was created by students for other students. Our goal is to help students (1) further develop their understanding of course content and (2) achieve greater academic success. (3) Our resource is also open access meaning there are no financial or legal barriers to students who wish to access and use our resource.

Instructions

Before the exam, we recommend that you attempt to familiarize yourself with all the content covered in the bacteriology unit. This document is a supplementary resource used to help organize all the species of viruses in the virology unit, separated by lecture.

This document is accompanied by a **question document**.

Disclaimer: This resource is supplementary to your course content and is not meant to (1) replace any of the resources provided to you by your instructor nor is it meant to (2) be used as a tool to learn the course material from scratch. We assume that students who use this resource will have a basic understanding of the course content. This resource does not contain everything you need to know for your evaluations. Please refer to the course material provided by your instructors if there are any discrepancies between our resource and your course content.

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We wish you the best of luck on your exams!

- The WebStraw Team

Note to Instructors:
If this resource has been created for your course and you would like to collaborate with us, please email us at team@webstraw.ca

Answers

1. E

All of the above are true regarding the measles virus.

2. C

The cell filtrate (which contains TMV) is able to infect new plants once it comes into contact with them. However, because it is a virus, fundamentally, it requires a host to replicate and survive. Therefore, it is unable to replicate on its own (without coming in contact with a plant).

Learning Strategy #1: Study the experiment in depth and try to distinguish between the cell debris and cell filtrate - don't get the two mixed up!

3. A

Viruses are typically much smaller than bacteria and are indeed 1/1000th their size. However, the Mimivirus is an exception and is very large - hence why it can be visualized under a light microscope and unable to be filtered, whereas many other viruses cannot be visualized and can be filtered.

4. D

Index case is defined as the first case to be diagnosed for a particular disease in a region.

5. B

Measles is highly contagious and is spread through aerosol droplets (coughing, sneezing, etc). Therefore, in a school setting with many students, it is very likely that the virus will spread and infect those that are unvaccinated with MMR.

6. D

The first animal virus (discovered by Loeffler and Frosch) was responsible for causing foot and mouth disease.

7. A

The wasp has a polydnavirus genome within its own wasp genome. As it lays its eggs into a caterpillar, the polydnavirus genome is also deposited. By suppressing the innate immune system of the caterpillar, the egg can survive and hatch.

8. D

The tulip breaking virus, the cause of the broken tulip petals, is a potyvirus. By interfering with pigment synthesis of the flower, it creates multi-coloured petals.

9. A

The viral genome is absolutely essential for replication in a host, since their genome is packaged into a viral particle and transferred to a host. Without their genome there is no material for the host replication machinery to replicate.

10. D

The curvularia thermal tolerance virus (CThTV) does indeed give the fungus in question (*Curvularia protuberata*) thermotolerance, allowing it to survive at the same temperature as *D. lanuginosum*. This process is essential for the fungus to survive, which in turn is responsible for keeping the plant alive. It is important to note that CThTV does not infect *D. lanuginosum* itself.

Learning Strategy #2: For questions 7 and 10, it is helpful to draw out a diagram of the scenarios and indicate what happens at each step. Visualizing it and reading it out loud to really understand the concept is much more beneficial than trying to memorize full sentences of material.

11. B

The host cell will provide the virus with all the necessary tools to replicate and spread their genome (aside from the viral genome itself). This includes energy, transport vehicles, and translation machinery to create viral proteins.

Learning Strategy #3: The lecture slides made it very clear that the genome is the most important factor when it comes to viral infection and replication. Take note of what is emphasized on each slide!

12. A

Susceptible cells have functional receptors for the virus, allowing uptake to occur. Permissive cells allow the virus to replicate inside the cell.

13. D

Rodents are preferred to monkeys due to the expensive cost of working with monkeys in the lab.

14. D

Transformation is a cytopathic effect, leading to uncontrolled division of infected cells leading to a formation of a large mound of cells.

15. C

Syncytia is a cytopathic effect from a viral infection, leading to fusion of adjacent plasma membranes.

16. A

A plaque assay measures the infectivity of a virus, rather than the resulting cytopathic effects from infection.

17. B

The live cells will be stained purple from the crystal violet stain; the dead cells will be seen as clear spots on the plate.

18. C

When viruses are present in the sample, it does indeed bind to red blood cells to form a lattice. However, rather than forming a red dot in the centre of the test tube, it would be dispersed and coat the sides of the tube.

19. A

Transformation assays are measurements of infectivity, and are performed to count foci to calculate foci forming units (ffu)/mL.

Learning Strategy #4: Pure memorization - this is the quickest and easiest way to memorize and distinguish measurements of infectivity and physical measurements.

20. B

The plaque assay was first used for bacteriophages (which are viruses that infect bacteria), not Herpes. Furthermore, plaques represent areas where the bacteria are infected with a virus, and the virus would be replicating at these plaques.

21. B

The original experiment utilized tagging the viral genome with radioactive phosphorus, exposing the phages to bacterial hosts, and blending the mixture to see where the radioactive signals came from. Tagging the capsid with radioactive sulfur proved that the capsid shell was not the heritable portion of viruses

Learning Strategy #5: Understand the differences between the modern and original versions of the Hershey Chase experiment (LIST THEM OUT)! Different strategies are used to track genome entry into the host, but both have the **same** conclusions.

22. C

GFP genes are spliced downstream of genes that encode the protein of interest, so that when the protein is expressed, so is the GFP. This shows researchers both the quantity and location of the protein of interest.

23. C

According to the RNA hypothesis, life on Earth originally depended on RNA to enable heredity and genome encoding, with DNA based lifeforms coming millenia later. Thus, viruses with RNA genomes are older than those with DNA genomes.

24. B

Rotavirus is a dsRNA virus, but remember that the original (+) RNA strand **cannot** be directly unwound and translated to protein. Instead, the (-) RNA strand acts as a template for a novel (+) RNA strand to be transcribed by viral RNA dependent RNA polymerases, which is then translated.
Ebola Virus is a (-) RNA virus, meaning that it must synthesize a (+) complementary strand via RNA dependent RNA polymerase before translation.

25. B

JC virus is a dsDNA virus, meaning its transcription/translation is dogmatic, and depends entirely on cellular mechanisms. Influenza is a ss (-) RNA virus, meaning it needs RNA dependent RNA polymerase to be translated. Retroviruses require reverse transcriptase to function, but a single virion outside of a host is not considered a cell, and does not have cytosol.

26. B

80% of Americans have a latent infection by JC virus, meaning that the virus lives at steady levels, and does not cause symptoms. Immunosuppression by the HIV virus will release this dormant infection, causing it to spread rapidly and cause neural degeneration.

27. B

As a ssDNA virus, the DNA cannot be directly transcribed into mRNA. It must be made into DNA using host DNA polymerase, and then transcribed into mRNA with host RNA polymerase.

Learning Strategy #6: Use the flowchart of how every viral classification of the Baltimore system gets to the (+) RNA endpoint that results in translation. Write down the enzymes involved in each arrow as they are all very different. Additionally, label specific examples of each of the numerical classes (ex Retroviruses are examples of #6) for ease during an open book exam. Make this flowchart **early** on in your study, and use it as a guide to organize your more specific learning later on.

28. A

No change since in a dsRNA virus, the (-)RNA strand serves as the template to a novel (+) strand that is translated. The original (+) strand is not utilized in the transcription process.

29. C

The L-protein is another name for the RNA dependent RNA virus that all (-)ssRNA viruses need to synthesize the (+) RNA strand for survival.

30. D

RNA dependent RNA polymerase is seen in (-)RNA viruses. Retroviruses turn (+)RNA into ssDNA, they are not (-) RNA. (+)RNA into protein is a process that is seen in all viral cycles.

31. B

Remember that the viral particles derive their envelopes from budding of the lipid bilayers of their host's membranes, but these envelopes also contain viral envelope glycoproteins! These are used for host recognition, and initiation of the invasion process.

32. A

There are 5 P1 precursor proteins that come together to form the protamer. 12 of these protamers complete the viral capsid of poliovirus (5 x 12 = 60 P1)

33. C

Remember that envelopes are created when the viral particle leaves the cell, and forces part of the host cell's lipid bilayer to bud off with it.

34. B

A major disadvantage of electron microscopy is the negative staining required to make it visible during imaging. This will destroy some of the finer, ultrastructural details of the specimen. The resolution of NMR Spectroscopy is also higher than electron microscopy.

Learning Strategy #7: Understand the differences between the different microscopy and imaging techniques (LIST THEM OUT)! They all have some sort of pros and cons, with different capabilities.

35. A

NMR spectroscopy DOES NOT image the whole specimen. Only individual proteins are visible using this process.

36. D

Capsids need to maintain a balance of stability and instability throughout the viral life cycle. Therefore, there cannot be irreversible, covalent bonds (e.g., ethers via dehydration) binding the protein shell together permanently

37. C

The major role of viral envelope glycoproteins is to bind to potential host receptors, and kick start the viral invasion of that targeted cell.

38. A

The two types of symmetry that were touched upon in class are the helical symmetry of rod shaped viruses and the polyhedral symmetry found in "round" virus shapes.

39. D

As a (-) sense RNA virus, there needs to be a process that converts this (-) RNA of the genome into (+) RNA that can then be transcribed into protein. This process is nondogmatic, and needs proteins that are encoded within the viral genome! The host cell cannot provide this RNA dependent RNA polymerase since it does not need this conversion machinery.

Learning Strategy #8: Keep reviewing the DNA genome types! Those are the hardest concepts to keep separate, and you might get confused under exam conditions.

40. B

Not all viruses are enveloped. The L protein is only found in ebola virus to make RNA from an RNA template

41. A

CD4P8 is not a receptor that allows a virus to enter a host cell.

42. B

Sialic acid is the receptor for the influenza virus. As a receptor for a virus, it is found on the membrane of the host cell.

Learning Strategy #9: This is a question where two of the options, A and B, are "opposites" of one another. So, the answer will be one of these two options.

43. D

SARS-COV2 enters the host cell via the ACE2 receptor.

44. B

The most acidic pH is found in the late endosome. The only virus here that releases its genome from the late endosome is the reovirus. The other viruses release their genome at the cell surface and late endosome which have a more basic pH.

45. B

Osmosis refers to the movement of water and viruses are too large to cross the membrane by passive diffusion.

46. D

The virion's stability varies depending on which stage of the viral infectious cycle it is in. Some viruses require more than one receptor to enter a host cell. These receptors are called co-receptors.

47. C

The receptors that viruses use to enter a cell have other functions. For example, SARS-COV2 enters via the ACE2 receptor which has other functions related to the kidneys and blood pressure.

48. C

The receptors of the avian influenza virus are mainly found in the lower respiratory tract. So for infection a deep breather must be taken.

49. A

The viral genome can be released at the cell surface, early endosome or late endosome.

Learning Strategy #10: The above two questions have answers with two parts. First determine the answer to the first part, then you can use the process of elimination to eliminate two options and decide between the final two options.

50. D

Some viruses have an envelope and others do not.

51. A

Horizontal, vertical and iatrogenic transmission are three possible modes of viral transmission.

52. B

Hepatitis A has a positive stranded RNA genome, enters humans through the alimentary tract, infects a large percentage of Puglia residents in February and causes jaundice via infection of the liver.

53. D

There is no such thing as extrinsic immunity.

54. B

In an inapparent infection, symptoms are invisible, both viral replication and transmission are likely, and the immune system is still activated by the infection of the virus.

55. D

Transmission can occur between different species, fomites are actually contaminated objects, and non-enveloped viruses are resistant to acidic pH.

Learning Strategy #11: For multiple-multiple choice questions, you only have to evaluate statement 1 or statement 3 and not both. Because if one is correct, the other is correct. And if one is incorrect, the other is also incorrect.

56. A

For viral pathogenesis to occur, the host cell must be susceptible and permissible, there must be an adequate amount of viral particles, and the virus must be resistant to the defense mechanism of the host. The virus can have an RNA or DNA genome.

57. C

Viral replication caused a skin rash.

58. C

Skin must be broken for viruses to enter and infect the host.

59. C

The lungs have a large surface area and viruses do not encounter acidity in the upper respiratory tract.

Learning Strategy #12: Read through questions carefully, this is a question where two of the options are true, and two of the options are false. Misreading the question can lead to easily losing marks even though you know the correct answer.

60. D

The skin is acidic which inactivates viruses.

61. B

AIDS is acquired immunodeficiency syndrome, often caused by HIV. Some of the common diseases caused by AIDS is Kaposi Sarcoma and serious lung infections as a result of depressed immune system function.

62. C

One of the hallmarks of HIV is that it has a reverse transcriptase enzyme that converts the + ssRNA genome to a ssDNA. However, to go from a ssDNA to a dsDNA, the virus uses the host's DNA polymerase. Remember, think of the virus as a suitcase. It carries what it needs to survive, and uses the host machinery as much as possible. Viruses are greedy!

63. A

The three main structural proteins are surface protein gp120, transmembrane protein gp41, and capsid protein p24.

64. D

SIV was non-pathogenic in old-world monkeys, but is pathogenic to chimpanzees. HIV is passed on from SIV and is very pathogenic.

65. A

Although it is common to think about sexual transmission between chimps and humans to be the reason for the transmission of HIV, it was in fact bushmeat hunting. While bushmeat hunting, blood-to-blood contact often occurred and infected chimps passed it onto the hunters.

Learning Strategy #13: The questions above just test your basic knowledge about HIV, and it's best to simply read over the notes multiple times to tackle memory type questions.

66. C

Reverse transcriptase does not have an exonuclease function. Thus, when it makes the DNA copy, it is prone to make errors. This allows the virus to mutate multiple times. So, it is likely that each individual HIV patient may have a different variant than another. This is why vaccines against HIV are hard to develop.

67. A

The point of no return is when integrase integrates the viral DNA copy into the host genome by making 3' cuts on both DNA copies. Ligation occurs between the free 3' OH groups leaving the permanently embedded viral genome.

68. B

HIV is differentiated by sequence homology. Although there may be more cases of one type of HIV in a specific geographical area, subtypes are not characterized using this method. Additionally, some subtypes may be more deadlier than others; like subtype D is quite deadly, while subtype B less deadly.

69. B

Bushmeat hunting was present before European colonization occurred, however through the development of urban centres after colonization, sex worker contact greatly increased. This accelerated the outbreak of HIV in sub-Saharan Africa.

70. D

Ebola is a zoonotic disease, and its original host is bats.

Learning Strategy #14: The next set of questions were some challenging questions that really tested your understanding and application of the concepts. To study for these types of questions, it is best to get the main points out of each concept and write a simple jot note after each slide/section about what the professor wants you to know. For example, it is important to know that reverse transcriptase has no exonuclease activity, and this would help you for question 7.

71. D

Endogenous viruses are remnants of genetic material present in our germ cell line. The germ cells are what allow us to pass on the virus to new generations, and are likely non-pathogenic. However, as it is likely non-pathogenic, it can still be pathogenic or become pathogenic through mutations.

72. B

Recently, the koala population has been declining as a result of high rates of lymphomas and leukemias in their population. Although it is not known whether an endogenous virus is the explanation for this rise, it is still a possibility to consider.

73. D

Recently, the koala population has been declining as a result of high rates of lymphomas and leukemias in their population. Although it is not known whether an endogenous virus is the explanation for this rise, it is still a possibility to consider.

74. C

KoRV-A and KoRV-B are two subtypes of the koala retrovirus. The difference between these two subtypes is that each use different receptors and that KoRV-B is more pathogenic than KoRV-A.

Learning Strategy #15: To study for concepts related to endogenous viruses, it is better to focus on the overall ideas and concepts rather than minute details. Making a summary sheet of the lectures will help you think of the big picture ideas and also involve some active learning from your part!