

SBL 704 (Human Virology): Mid semester exam

February 23, 2024

Total: 30 marks

Time: 90 minutes

Part I: Choose the most appropriate answer (1 X 12 = 12 marks):

- 1) Most viruses could be visualized with light microscopy if they were _____.
 - a) 10X larger
 - b) 25-50X larger
 - c) 50-100X larger
 - d) 1000X larger
 - e) none of the above

- 2) Which of the following organisms do NOT have a mRNA synthesis (or formation) step during their replication?
 - a) Most viruses
 - b) Retroviruses
 - c) Bacteria
 - d) ss-positive sense RNA viruses
 - e) none of the above

- 3) Which of the following statements is NOT true about picornaviruses?
 - a) Most picornaviruses resist (or survive) the acid pH in the stomach
 - b) Some of them can cause exanthems
 - c) All picornaviruses do not grow in cell culture
 - d) All picornaviruses cause detectable pathological lesions when injected into suckling mice
 - e) None of the above

- 4) OPV (live attenuated poliovirus vaccine) leads to better herd immunity than IPV (killed poliovirus vaccine) because _____.
 - a) it is well adapted in non-neuronal cells
 - b) it can result in the production of IgA antibodies against poliovirus
 - c) it is shed in the faeces of vaccinated individuals
 - d) the risk of reversion to wild-type is low
 - e) none of the above

- 5) Every individual infected with a virus is likely to produce _____.
 - a) quasi species
 - b) a new genotype with additional beneficial mutations
 - c) a new serotype
 - d) all of the above
 - e) none of the above

- 6) Rotavirus was first discovered in patients with diarrhoea using _____.
 - a) PCR and sequencing

- b) next-generation sequencing
 - c) Immunofluorescence
 - d) electron microscopy
 - e) antigen-antibody reactions
- 7) Which of the following statements about rotavirus is **NOT** true?
- a) Antibodies against VP6 and VP7 are neutralizing antibodies
 - b) Rotavirus is a non-enveloped virus
 - c) Rotavirus predominantly causes disease in newborns after a few months of birth and up to the age of 2 years.
 - d) There is a live attenuated vaccine available against rotavirus
 - e) None of the above
- 8) Virus mRNA splicing occurs in a newly discovered single-stranded positive sense RNA virus (virus X) that has been associated with cancer. Which of the statements is **NOT** true about splicing in virus X?
- a) Splicing may lead to the synthesis of new proteins by virus X
 - b) Splicing may lead to the synthesis of a defective protein by virus X
 - c) Splicing may lead to the production of defective genomes of virus X
 - d) Splicing may alter the risk of developing cancer among patients infected with virus X
 - e) None of the above
- 9) Influenza virus H1N1 and H7N9 are replicating in the same respiratory epithelial cell (cell A). The H1N1 genome gets packaged in H7N9 proteins and is released from the cell and goes on to infect a new respiratory epithelial cell (cell B) – which of the following will best describe the viruses produced from cell B?
- a) H1N1 genome with H1N1 proteins
 - b) H1N1 genome with H7N9 proteins
 - c) H7N9 genome with H1N1 proteins
 - d) H7N9 genome with H7N9 proteins
- 10) For a given virus X, 80% of the capsids secreted outside the infected cell were found to be empty (containing no nucleic acids). Which of the following is likely to represent the nucleocapsid symmetry of the virus:
- a) Helical
 - b) Icosahedral
 - c) Icosahedral or helical
 - d) Icosahedral or helical or complex
- 11) Which of the following is **NOT** true about virus classification?
- a) Viruses neither belong to the animal kingdom nor the plant kingdom
 - b) Binomial nomenclature is used for viruses
 - c) The highest level (broadest) of classification for viruses is families
 - d) None of the above
- 12) Shellfish-associated gastroenteritis is frequently linked to infection with _____.
- a) adenoviruses types 40 or 41
 - b) noroviruses

- c) toroviruses
- d) astroviruses
- e) None of the above

Part II: Write short notes on ANY four of the following (4 X 2.5 = 10 marks)

- a) Virus replication cycle ✓
- b) Rotavirus pathogenesis
- c) Role of interferons in virus infections ✓
- d) Spinal form of poliomyelitis
- e) Principle of the three real-time PCR chemistries ✓

Part III: Case studies (3+3+2 = 8 marks)

1. A scientist performs real-time PCRs to detect influenza virus with three chemistries: SYBR green Taqman probes and molecular beacons. She optimized the real-time PCR with all chemistries. For all chemistries, the real-time PCR was performed for 45 cycles. The positive control has a Ct (threshold cycle) of around 30 cycles, and the negative control never gave a signal; this was true for all three chemistries. She set up runs using all three chemistries; in each run, she tested positive and negative controls. But she programmed the real-time PCR cyclers so that the optics for all three chemistries is switched on (i.e. the signal is captured) at the denaturation step (i.e. at 94°C). What do you think she will find out in each of the three chemistries for the positive control and the negative control? Explain. (3 marks)
2. You are a scientist in the influenza virus surveillance programme. There is a sudden increase in H5N1 cases across multiple continents. The WHO indicates that at least 5 months will be needed to produce a vaccine against the H5N1 influenza virus. A large pharmaceutical company suggests exploring mass vaccination with the current influenza virus vaccine (i.e., H1N1 and H3N2), as it can be readily produced in large quantities. What is your opinion are the pros and cons of mass vaccinating in terms of protection against the H5N1 strain if we use the currently configuration of the Influenza A virus vaccine (3 marks).
3. The United States of America had used IPV for several decades and continues to use IPV. However, in India we used OPV for several years. In 2012 India was declared a polio-free country and in 2015 India has gradually started switching to IPV. Explain why in India we did not use IPV as the primary vaccine in our fight against polio but now we are switching to IPV. (2 marks)

SBL 704 (Human Virology): Major examination

May 3,

2023

Total: 45 marks

Time: 2 hour

Part I: Choose the most appropriate answer: (1 x ¹⁷~~16~~ = 17 marks)

- 1) Which of the following vaccines is NOT suitable for use among pregnant women?
 - a) Subunit vaccines
 - b) Killed vaccines
 - c) DNA vaccines
 - d) Viral vector vaccines
 - e) None of the above

- 2) Which of the following statements is NOT true?
 - a) Killed vaccines often require adjuvants ✓
 - b) There are no DNA vaccines licensed for human use
 - c) Subunit vaccines are likely to be more stable than DNA vaccines
 - d) Live attenuated vaccines confer mucosal immunity
 - e) None of the above

- 3) Which of the following is likely to be a good candidate for a subunit viral vaccine?
 - a) Virus polymerase
 - b) Virus integrase
 - c) Virus protease
 - d) Virus reverse transcriptase
 - e) Virus capsid protein

- 4) Which of the following statements is NOT true about HIV?
 - a) Resting memory T cells with HIV provirus DNA (in integrated form) represent long-term reservoirs of the virus ✓
 - b) HIV actively replicates during clinical latency ✓
 - c) The glycosylation of gp120 enhances neutralization by specific antibodies
 - d) Recombination occurs in HIV genomes
 - e) None of the above

- 5) Which of the following statements is NOT true?
 - a) Chronicity rates in adults are higher for HCV infection than for HBV infection ✓
 - b) HDV co-infection with HBV almost always results in chronic HDV infection among adults
 - c) Differences in response to antiviral therapy exists among HCV genotypes
 - d) Both HBV and HCV can cause liver cancer
 - e) None of the above

- 6) Which of the following statements is TRUE?
 - a) HBV is a DNA virus that replicates with an RNA intermediate

- b) HDV uses HBV capsid protein to make HDV virions ✓
 - c) HDV and HEV are transmitted by the faeco-oral route ✓
 - d) HAV always causes symptomatic infection among children and adults ✓
 - e) None of the above
- 7) Which of the following statements is NOT true?
- a) Endogenous retroviruses make up a significant portion of the human genome
 - b) Endogenous retroviruses are passed on from 1 generation (parents) to the next generation (offspring)
 - c) Exogenous retroviruses are RNA viruses that replicate with a DNA intermediate step
 - d) Exogenous retroviruses are found only in germ cells and not in somatic cells
 - e) None of the above
- 8) In which of the following human vaccine types do you expect post-translational modifications to be different from those in the vaccinated hosts?
- a) Live attenuated vaccines
 - b) Subunit vaccines
 - c) Viral vector vaccines
 - d) DNA vaccines
 - e) None of the above
- 9) Which of the following statements is NOT true about HPV?
- a) Most HPV genotypes (or types) do not cause cancer ✓
 - b) The HPV E2 protein is often expressed from integrated HPV sequences ✓
 - c) HPV E6/E7 proteins have oncogenic properties ✓
 - d) A HPV-encoded protein induces DNMT expression ✓
 - e) None of the above
- 10) Which of the following DOES NOT represent an underlying mechanism in HCV-induced liver cancer?
- a) Inhibition or down regulation of p53
 - b) Inhibition or down regulation of pRb
 - c) Insertional mutagenesis
 - d) None of the above
- 11) Which of the following statements is NOT true about HIV?
- a) Neonates with HIV infection progress rapidly to AIDS ✓
 - b) Western blots are routinely used to confirm HIV-positive results obtained in ELISA ✓
 - c) A sizable proportion of HIV-1-infected individuals develop neurological complications ✓
 - d) Reassortment occurs in HIV genomes
 - e) None of the above
- 12) Which of the following is NOT linked to measles virus infection?
- a) Koplik spots ✓
 - b) Reactivation of *Mycobacterium tuberculosis* infection possible ✓
 - c) Secondary bacterial infection of the lungs ✓
 - d) Blindness ✓

- e) None of the above

- 13) Which of the following is TRUE about rubella virus?
- a) Rubella virus is associated with a vesicular rash ✓
 - b) Rubella virus IgM is used to assess if the individual has adequate immunity against the virus ✓
 - c) Exposure to rubella virus always confer lifelong immunity ✓
 - d) Rubella virus spreads through the respiratory route
 - e) None of the above
- 14) Influenza virus types (eg. H1N1, H3N2 etc.) represent
- a) genetically distinct viruses
 - b) serologically distinct viruses
 - c) both genetically and serologically distinct viruses
 - d) virus quasispecies
 - e) none of the above
- 15) Virus genome reassortment can occur only in
- a) DNA viruses
 - b) RNA viruses
 - c) enveloped viruses
 - d) viruses infecting both animal and human hosts
 - e) all of the above
- 16) A M-tropic strain of HIV-1 can NOT infect
- a) CD4+ T cells
 - b) CD4+ T-cell lines
 - c) monocytes
 - d) any of the above
 - e) none of the above
- 17) Which of the following virus-related cancers is NOT vaccine preventable?
- a) Hepatitis B virus-related liver cancer
 - b) Human papillomavirus-related cervical cancer
 - c) Hepatitis D virus-related liver cancer
 - d) HTLV-1-related Adult T cell leukemias
 - e) None of the above

Part II: Write short notes on any ~~THREE~~ ^{FOUR} of the following: (4 x 4 = 16 marks):

- 1) Viral vectors in vaccination ✓
- 2) Congenital Rubella Syndrome ✓
- 3) Underlying mechanisms of HPV-related cervical cancer ✓
- 4) The discovery of HCV and its public health implications
- 5) Post-exposure prophylaxis for rabies

Part III: Case studies (2 x 6 = 12 marks)

- 1) You are using a SYBR green-based chemistry followed by a melt curve analysis to identify a G to A point mutation that results in anti-viral resistance in HIV. The melting temperature of the wild-type (drug-sensitive with a "G") is 1°C higher than that of the mutant (drug-resistant with an "A"). A PhD student in your lab is curious to know what will happen if he/she does the same assay with a TaqMan probe. The PhD student tries it out. Assuming that the TaqMan probe used can bind to both the wild-type and the mutant with equal efficiency – what do you expect the student to find out when he/she does the melt curve analysis. Explain. (2 marks)
- 2) A 40-year-old man is positive for anti-HCV antibodies but is negative for HCV RNA. He is re-tested after 6 months and was positive for both anti-HCV antibodies and for HCV RNA. Explain what is happening and why? (2 marks)
- 3) The correlates of protective immune response are not fully understood in HIV-1 infections. Nonetheless, it is widely accepted that gp120 of HIV-1 is highly immunogenic and containing virus neutralizing epitopes (i.e. antibodies produced by the host can bind to gp120 epitopes and prevent HIV-1 infection of the host cell). You are an expert in HIV-1 biology. A young researcher asks you about the potential evolution rates of the HIV-1 gp120 encoding region of HIV-1 as compared to that of the rest of the HIV-1 genome.
- a) Given your expertise in the area what would you predict? (1 mark)
- b) How would an immunocompromised state of the infected host affect the evolution rates of the HIV-1 gp120 encoding region of HIV-1 and the rest of the HIV-1 genome? (1 mark)
- 4) A scientist is in possession of two cold adapted strains of measles virus. Protein A is mutated in the first cold adapted strain (Strain A); while protein K is mutated in the second cold-adapted strain (Strain B) and neither of the strains can grow at temperatures more than 32°C. He tries to infect cells with both strains simultaneously and he incubates the cells at 37°C. To his surprise, he finds that both viruses were able to replicate at 37°C. He then purifies strain A that he grew at 37°C (in the presence of strain B) and tries to infect cells and incubates at 37°C; this time without strain B. Will strain A be able to replicate in this experiment? Explain. (2 marks) *Copy & mutation*
- 5) You are a virologist who donated blood during a NSS blood donation camp. Your blood was screened for HBsAg, anti-HCV antibodies and HIV antigens and antibodies against HIV. You were negative for all assays tested. Your blood / blood components were given to three recipients. After a week, you developed jaundice, and you were HBsAg positive. Can you explain what had happened? What tests/intervention would you suggest for the recipients? (2 marks)
- 6) The paper linking MMR vaccination to developmental disorders reduced the proportion of children receiving this vaccine in the USA from about 98% to 88%. What are the public health implications (no need to discuss a specific disease or the expected outcomes; please provide a broad overview) of a reduction in the coverage of the MMR vaccine? (2 marks)