

PTS x MedSoc 2a Questions - Immunology / Microbiology / Pathology

Questions

- 1) Pattern recognition receptors (PRRs) are the mechanism by which the innate immune system detects harmful material. There are multiple kinds of PRRs.

Which of the follow is true regarding Toll-Like Receptors (TLRs)

- a. TLR2 detects LPS
- b. TLR4 detects lipoteichoic acid
- c. TLR5 is expressed on B-cells
- d. TLR 3 is an intracellular receptor
- e. TLRs all contain lysine-rich repeats

- 2) Antibiotics target specific structures or functional units of bacteria.

Which of the following features make *mycoplasma* resistant to β -lactam antibiotics?

- a. They have a 70S type ribosome
- b. They lack a cell wall
- c. They contain polymyxins
- d. They do not require folate synthesis
- e. They have 50S type ribosome

- 3) A 65 year old man is brought into A&E due to increasing confusion. On investigation he is cold and clammy, with a low BP, tachycardia, and a weak, thready pulse. He is found to have cardiogenic shock. One of the medications he is given is dobutamine.

What is the mechanism of dobutamine?

- a. β 1-agonist
- b. β 2-antagonist
- c. α 1-agonist
- d. Vasopressin analogue
- e. Na⁺/K⁺ ATPase Inhibitor

- 4) Jacob is a 1 year old who has multiple bacterial infections since his neonatal period. He is referred to an immunologist who diagnoses him with leukocyte adhesion deficiency.

Which of the following is the ligand for Toll-Like receptor 4 (TLR4)?

- a. Lipoteichoic acid
- b. Flagellin
- c. Unmethylated nucleotide motifs (CpG)
- d. Lipopolysaccharide (LPS)
- e. Single stranded RNA

- 5) A 34-year old man, previously diagnosed with severe combined immunodeficiency (SCID), is admitted following a high grade fever, cough, tachypnoea. His blood cultures later grow pneumococcal.

Which toll-like receptor (TLR) detects Gram positive bacteria?

- a. TLR-4
- b. TLR-7
- c. TLR-2
- d. TLR-10
- e. TLR-11

- 6) A 3 year old girl is brought into A&E with a high grade fever and purpuric rash. She is suspected to have bacterial meningitis and a lumbar puncture was performed.

Given the likely diagnosis, which cell type would you expect to predominate in the CSF?

- a. B cells
- b. T cells
- c. Astrocytes
- d. Red Blood Cells
- e. Neutrophils

- 7) A 67 year old woman is admitted to the cardiology ward with congestive heart failure. She is breathless at rest and has pitting oedema bilaterally to the level of the shins. You prescribe a furosemide infusion.

Which of the following mechanisms best describe the way furosemide acts as a diuretic?

- a. $\text{Na}^+/\text{K}^+/\text{2Cl}^-$ inhibitor
- b. NaCl transport inhibitor
- c. Aldosterone antagonist
- d. Carbonic anhydrase inhibitor
- e. Angiotensin-converting enzyme inhibitor

- 8) A medical student is reading about hypersensitive reactions and finds that systemic lupus erythematosus is classed as a type of hypersensitivity involving damage to tissues to tissues mediated by the deposition of antibody-antibody complexes, resulting in activation of complement.

Which of the following hypersensitivity reactions does this describe?

- a. Type I
- b. Type II
- c. Type III
- d. Type IV
- e. Type V

- 9) A 20 year old student has a persistent cough. He smokes cannabis daily and his lungs have high numbers of pulmonary macrophages, that phagocytose foreign material.

Which leukocyte in this man's peripheral blood can become pulmonary macrophages?

- a. Neutrophils
- b. Basophils
- c. Mast Cells
- d. Platelets
- e. Monocytes

10) *Escherichia coli* is a Gram-negative rod-shaped coliform. Some strains are motile and have peritrichous arrangement of flagella.

Which TLR is responsible for detecting flagellated bacteria?

- a. TLR-6
- b. TLR-9
- c. TLR-12
- d. TLR-5
- e. TLR-4

11) A 26 year old man has recently had a reaction to his nose ring. He recalled a similar reaction on his wrist when he was wearing a nickel bracelet.

Which of the following investigations is used to confirm a nickel allergy?

- a. Flow cytometry
- b. Human leukocyte antigen (HLA) typing
- c. Patch test
- d. Skin prick testing
- e. Polymerase chain reaction.

12) A 34-year-old intravenous drug user presents with acute jaundice, nausea, and vomiting. He has been passing very dark urine and his stools are pale in colour. On examination he is itchy and has right upper quadrant tenderness. His serology comes back positive for Hepatitis B.

Which antibody response is the initial response to the virus?

- a. IgA
- b. IgD
- c. IgE
- d. IgG
- e. IgM

13) Antibody transfer from a mother to infant during breastfeeding is most likely an example of which of the following types of immunity?

- a. Naturally acquired; active
- b. Artificially acquired; active
- c. Naturally acquired; passive
- d. Artificially acquired; passive
- e. None of these

14) Which of the following is secreted by virally infected cells as part of a signalling mechanism?

- a. Secretory IgA
- b. Membrane attack complex
- c. Interferon- α
- d. Tumour necrosis factor α
- e. Histamine

15) Which cell in the normal lymph node is a specialised, highly efficient antigen-presenting cell (APC) found mostly in areas of T-cell concentration?

- a. Reticular cell
- b. Dendritic cell
- c. Macrophage
- d. Follicular dendritic cell (FDC)
- e. B cell

16) A 35-year-old heterosexual woman with known human immunodeficiency virus (HIV) presents to her GP two weeks after her last clinic check-up. Results from her last clinic attendance showed her viral load to have increased and her CD4 count to have dropped below 200 units. The GP examines the patient and is concerned that she is showing signs of an acquired immune deficiency syndrome (AIDS)-defining illness.

Which of the following is the most common opportunistic infection and presentation of AIDS?

- a. Kaposi's sarcoma
- b. *Pneumocystis jirovecii* pneumonia
- c. Extrapulmonary *Cryptococcus*
- d. *Mycobacterium avium* complex
- e. Oesophageal candidiasis

17) A 33-year-old man returns to his GP for the results of a human immunodeficiency virus test; the result is positive.

Which of the following investigations will be most useful in estimating his risk of developing an opportunistic infection?

- a. Blood cultures
- b. CD4 count
- c. Chest X—ray
- d. Full blood count (FBC) with differential and blood film
- e. Tuberculin skin test (TST)

18) A 20-year old student returns from a 12-month trip around Africa, South and East Asia, suffering from diarrhoea. He has had loose watery stools for 3 days and appears markedly dehydrated. A diagnosis of traveller's diarrhoea is made.

Which is the most common causative organism of traveller's diarrhoea?

- a. Shigella
- b. Enterotoxigenic Escherichia coli (ETEC)
- c. Campylobacter
- d. Giardia intestinalis
- e. Salmonella

19) A 25-year-old woman comes to you after her honeymoon, complaining of dysuria, right flank pain and suprapubic discomfort.

Which of the following is the most likely organism causing her symptoms?

- a. *Serratia marcescens*
- b. *Staphylococcus saprophyticus*
- c. *Enterobacter cloacae*
- d. *Proteus mirabilis*
- e. *Escherichia coli*

20) A 31-year-old HIV+ man is taken by his wife to A&E and is admitted with dehydration due to chronic diarrhoea.

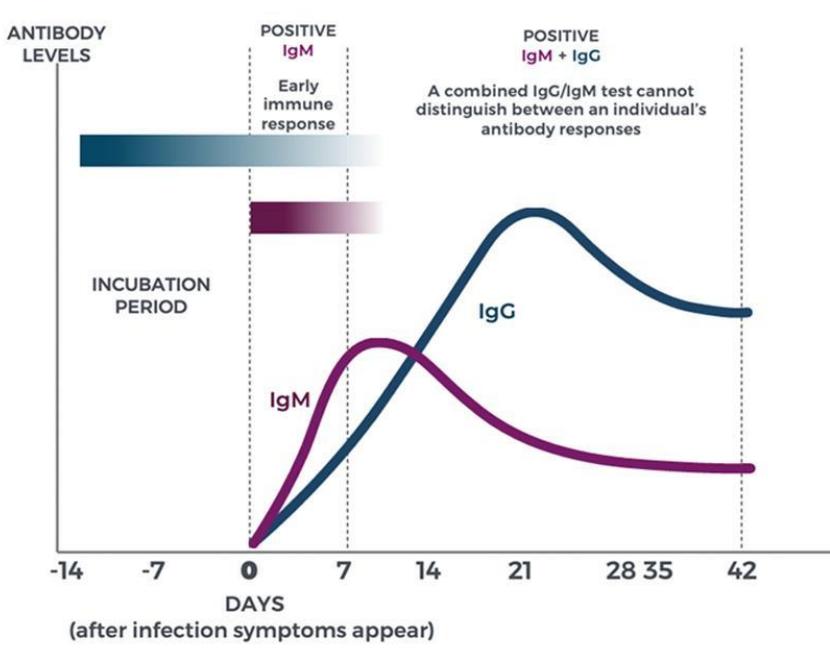
Which pathogen is most commonly isolated in cases of chronic diarrhoea associated with HIV?

- a. *Cryptosporidium*
- b. *Isospora belli*
- c. *Salmonella*
- d. *Campylobacter*
- e. *Shigella*

Answers

Answer	Explanations
1. D	<p>TLR-3 is an intracellular receptor. The way to remember is that TLRs 3, 7,8,9 are intracellular so it can work to remember 7 is then the two after that and then 3 is a multiple of 9. TLR-2 does not detect LPS and detects lipoteichoic acid. TLR2 also detects TB and other mycobacteria, Two begins with T □ TB. TLR-4 conversely does detect LPS and not lipoteichoic acid. TLRs are expressed on innate immune cells, whereas a B-cell is a part of the adaptive response and has antibody as it's cell surface receptor. All TLRs contain leucine-rich repeats not lysine.</p>
2. B	<p>They lack a cell wall. Whilst on the face of it this might seem like a microbiology question it is actually testing pharmacology knowledge. β-lactam antibiotics act by inhibiting the synthesis of the peptidoglycan layer of bacterial cell walls, which incidentally mycoplasma lack. 70S ribosome is the combination of 50S and 30S ribosomal subunits (S refers to Svedbergs unit. This unit depicts how fast a cell organelle sediments during the ultracentrifugation, which is why it's not 50+30) and is not a target of β-lactams. Polymyxins are antibiotics themselves that target the cell membrane of Gram negative bacteria. Folate synthesis is the target of Sulfonamides and trimethoprim antibiotics, not β-lactams. 50S ribosomal subunits are targeted by macrolide antibiotics.</p>
3. A	<p>Dobutamine is a β1-agonist that acts as a positive inotrope that increases heart muscle contractility and tries to increase cardiac output. β2-antagonists block the action of β2-receptors either selectively or non-selectively and have negative chronotropic and inotropic affects. α-1 agonists, such as doxazosin, inhibit the activation of post-synaptic alpha-1 receptors by norepinephrine thus opposing blood vessel contraction. They are first line treatment in benign prostatic hypertrophy and as an additional treatment of resistant hypertension. Vasopressin analogues, like desmopressin, mimic the action of ADH and is used in conditions where ADH is not produced such as neurogenic diabetes insipidus. Desmopressin also causes endothelial cells to produce von Willebrand factor in von Willebrand disease. Na⁺/K⁺ ATPase inhibitors such as digoxin, block the enzymes activity in the heart and thus are negative chronotropes.</p>
4. D	<p>TLR4 detects LPS on the surface of Gram negative bacteria. TLR2 detects lipoteichoic acid on the surface of Gram positive bacteria. Flagellin is detected by TLR5, 5 begins with F as does flagellin is a good way to remember. Unmethylated nucleotide motifs are targets of TLR9, 9</p>

	begins with an N □ Non-methylated is a way of remembering. Single stranded RNA is detected by TLR7, Seven □ Singles stranded RNA.
5. C	TLR2 Detects lipoteichoic acid on Gram positive bacteria. TLR4 detects LPS on the surface of Gram negative bacteria. TLR7 detects single stranded RNA intracellularly. TLR10 specifically detects listeria and influenza A via a yet unknown target. TLR11 is a protein that only exists in rats and mice
6. E	Neutrophils (a polymorphonuclear cell) are one of the main combatants to bacteria in the human body. Neutrophilia is a key finding in blood during bacterial infection and in CSF during CNS infection with bacteria. Both B and T cells are lymphocytes and are increased in response to viral infection. Astrocytes are a glial cell that provides biochemical support tot endothelial cells that form the blood brain barrier and provide nutrients to nervous tissues. You would not find these in CSF in any scenario. RBCs in the CSF is usually a sign of an intracranial or spinal bleed, or damage to a blood vessel during lumbar puncture, in this scenario this would not be the predominate cell.
7. A	Na⁺/K⁺/2Cl⁻ inhibitor. Furosemide does this at the thick ascending loop of Henle leading to massive sodium and chloride concentrations in the filtrate, causing massive diuresis. Thiazide diuretics inhibit NaCl transport at the distal convoluted tubules. Spironolactone act as aldosterone antagonists, causing Na ⁺ excretion and a decrease in K ⁺ and H ⁺ excretion in the collecting tubules. Note other K ⁺ sparing diuretics act on ENaCs on principle cells of the collecting tubules. Carbonic anhydrase inhibitors are not used as a diuretic , they act on the proximal convoluted tubule where they increase bicarbonate excretion. ACE inhibitors are not diuretics instead they decrease angiotensin II production.
8. C	Type III reactions involve antibody-antigen complexes (immune-complexes) deposit into tissues. Type I involve mass cell degranulation mediated by Antigen-IgE linkage on their surface. E.g. atopy and anaphylaxis. Type II involved IgM and IgG linkage to antigens on the surface of cells or tissue components, e.g. Goodpasture syndrome, autoimmune haemolytic anaemia. Type IV is cell mediated by T-cells. There is granulomatous inflammation or direct cytotoxicity, e.g. contact dermatitis and is a delayed reaction. Type V are stimulatory autoantibodies e.g. in Grave's Disease.
9. E	Chronic irritation of the airways will recruit monocytes from the blood to cross the blood-air interface and enter the alveoli where they will differentiate into macrophages. None of the other cell types have the propensity to transform after egressing into tissues.

10. D	<p>TLR-5 detects flagellin. One way to remember this is that 5 begins with an F, as does Flagellin and ergo TLR-5 detects flagellated bacteria.</p>
11. C	<p>Patch test diagnoses delayed Type IV hypersensitivity reactions. Flow cytometry differentiates populations of cells in a given sample and would not be useful here. HLA typing is used to match donors for cord blood or bone marrow transplants. Skin prick testing is used to diagnose Type I hypersensitivity, which are IgE mediated. Polymerase chain reaction amplifies DNA segments. It is used for functional analysis of genes, diagnosis of inherited diseases, and diagnoses of some infectious diseases.</p>
12. E	<p>The initial humoral response is IgM mediated, which are low affinity but can bind multiple different antigen sites due to their pentameric structure. IgA is found in the highest concentrations at mucosal surfaces and in secretory fluids and would not interact with Hep B. IgD's function is unclear. IgE is found in low levels in serum and is important in parasitic/helminth infections, and allergy via IgE bound on mast cells. IgG has the overall highest serum concentration and is a high affinity antibody and comes later in an infection after class switching.</p> 
13. C	<p>Naturally acquired passive immunity occurs when antibody (in this case IgA) is transferred from the mother to infant (in colostrum here). Passive because the antibody is the molecules that's transferred. Naturally acquired active immunity occurs when a person is infected with a pathogen. Artificially acquired active is the deliberate introduction of an antigen to the immune system to it produces antibody e.g. during vaccination. Artificially acquired passive immunity is when an</p>

	antibody therapy is administered to a patient during a treatment strategy. E.g. intravenous immunoglobulin therapy.
14. C	INF-α is the principle molecule in viral responses, they bind target innate cells such as macrophages and NK cells and induce an antiviral state. Secretory IgA is found in saliva and through the GI tract and mucosa secretion. It is not a signalling mechanism. Membrane attack complex is a set of complement proteins that perforate pathogen membranes. TNF- α is a cytokine released in systemic inflammation. It has a role in signalling by it induces fever and suppresses appetite at the hypothalamus, causes the liver to release C—reactive protein, increases insulin resistance and stimulates macrophage phagocytosis. It is not secreted by virally infected cells. Histamine is released from mast cells following IgE cross-linkage.
15. B	Dendritic cells monitor lymph nodes for antigen. They present antigen to T cells and are the most efficient and powerful antigen presenting Cell. Reticular cells make reticular fibres containing type III collagen. Macrophages are phagocytic and are antigen presenting cells but have lower levels of MHC II compared to dendritic cells, and are therefore less efficient, and tend to bind immune complexes and endocytose them. Follicular dendritic cells are specialised APCs that contact B cells in germinal centres of a lymph node. They bind and hold immune complexes but do not endocytose them. B-cells are fundamentally responsible for humoral responses.
16. B	<i>Pneumocystis jirovecii</i> pneumonia. This infection is the most common presentation of AIS and comprises ~40% of all AIDS-Defining illnesses. Ix includes CXR, showing bilateral mid and lower-zone interstitial shadowing. Tx with Co-Trimoxazole or IV pentamidine for 21d. Kaposi Sarcoma is a HIV related cancer and is associated with human herpes virus 8. It is perceptually common due to the due to the characteristic skin masses but is less common than <i>P. jirovecii</i> at around 35%. Extrapulmonary cryptococcosis and mycobacterium avium complex infections both can occur in AIDS but at a much lower incidence as they require much lower CD4 counts at around <50. Oesophageal candidiasis is not as common in AIDS and occurs in >10% of patients.
17. B	CD4 (T-helper cell) count is a reliable indicator for HIV-related immunodeficiency as CD4 is the cell tropism for HIV via it's gp120 glycoprotein. Without antiretroviral therapy (ART) HIV patients experience a gradual CD4 decline. The key figure to remember is <200 cells/μL incurs a 80% risk of opportunistic infections over the next 3 years. WHO recommends starting ART in every HIV+ patient regardless of CD4 count. Blood cultures would help in diagnosing an infection but not in determining risk. CXR would only show an acute chest infection, most HIV+ patients without a history of chronic

	<p>respiratory disease will have a normal CXR. FBC with differential and film would show possible anaemia, lymphopenia, and thrombocytopenia in these patients, but this could be for a variety of reason and would not help with risk assessment for opportunistic infections. The tuberculin skin test (TST) tests immunity to TB and diagnosis of latent TB. HIV+ patients have both a higher risk of TB but may have a muted response to TST due to compromised immunity. This test is not useful in assessing disease stage or risk of opportunistic infections in general.</p>
18. B	<p>ETEC. Traveller's diarrhoea usually lasts 3-4 days and is the commonly a result of infection due to ingestion of contaminated food. The most common organism is ETEC. Shigella presents with bloody diarrhoea 48-72 hours after ingesting the toxin, so would not fit this clinical picture. Campylobacter also presents 48-72 hours after eating contaminated foods. Here there is flu like prodrome and in severe cases bloody diarrhoea. Tx is with quinolones and one should be wary of development of neurological symptoms due to Guillain-Barré syndrome. Giardia infection causes abdo pain, bloating and non-bloody diarrhoea. Giardia is a parasite incubate for >7 days so would not fit this clinical picture. Salmonella is a GI infection that presents 12-24 hours after eating uncooked foods so likewise would not fit the picture.</p>
19. E	<p>Escherichia coli. This patient has a UTI and pyelonephritis. <i>E. coli</i> is by far the most common cause of UTI and pyelonephritis. In general, UTIs are caused by GI bacteria migrating from the anus up the urethra. Tx is with a fluoroquinolone or sulfamethoxazole mixture with trimethoprim. <i>Serratia marcescens</i> does cause UTIs but this is less likely as it is associated with hospital-acquired infections. <i>Staphylococcus saprophyticus</i> is the second most common causative agent of acute UTI. <i>Enterobacter cloacae</i> is a much less common cause of UTI. <i>Proteus mirabilis</i> produces urease that breaks down urea to form ammonia and hydroxide. If the bacteria chronically colonise the urinary tract this leads to the formation of staghorn calculi (stones containing ammonium sulphate). This is more a picture for chronic infection rather than acute infection.</p>
20. D	<p>Chronic diarrhoea is common in HIV infection and <i>Cryptosporidium</i> is most commonly isolated. It is a protozoan parasite that causes self-limiting diarrhoea in immunocompetent individuals. In HIV+ patients highly active antiviral therapy (HAART) is used to constitute immunity. <i>Isospora belli</i> can cause diarrhoea in immunosuppressed persons but is quite uncommon. <i>Salmonella</i> presents acutely 12-24 hours after eating uncooked meats. <i>Campylobacter</i> also presents acutely. Shigella likewise presents acutely.</p>