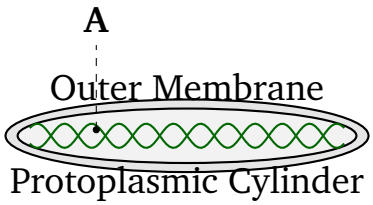
NEET PG Microbiology Sample Paper-6

Duration: 15 Minutes **Maximum Marks: 80**

Instructions

- This paper contains **20** Multiple Choice Questions.
- Each correct answer carries **+4** mark. Incorrect answer: **−1** marks. Only **one** correct option.
- Unattempted questions carry **0** marks.
- Use of mobile phones, smartwatches, or any electronic gadgets is strictly prohibited.

Q1. A 48-year-old patient presents with a painless indurated ulcer (chancre) on the genitalia. Dark-field microscopy confirms the presence of spirochetes. The structural organization of this causative organism's motile apparatus is schematically represented below. Identify the region labeled 'A' which allows its characteristic twisting motility.



(A) Periplasmic flagella (Endoflagella)

(B) Lipopolysaccharide spikes

(C) Outer membrane porin channels

(D) Sex pilus assembly complex

Q2. A patient presenting with acute dysentery is suspected of having Bacillary Dysentery. The causative organism produces a toxin that inhibits protein synthesis by targeting the 28S rRNA of the 60S ribosomal subunit. Which of the following features is true regarding this organism?

(A) It is motile by peritrichous flagella at 22°C but non-motile at 37°C

(B) It forms pink colonies on MacConkey agar due to rapid lactose fermentation

(C) It is catalase positive, oxidase negative, and fails to produce gas from glucose

(D) It uses swarming motility to cover the entire agar surface within 24 hours

Q3. An intensive care unit patient on mechanical ventilation develops pneumonia with thick, green-pigmented, sweet-smelling sputum. The isolated organism is a Gram-negative bacillus. Which group of virulence factors plays the primary role in preventing phagocytosis and mediating structural adherence for this specific pathogen?

(A) Alginate capsule and Pili

(B) Protein A and Coagulase

(C) Cord factor and Sulfatides

(D) Erythrogenic toxin and M-protein

Q4. During a routine inspection of a hospital sterilization unit, the efficiency of an autoclave cycle run at 121°C for 15 minutes needs validation. Which biological indicator should be processed alongside the load to verify successful sterilization?

(A) Spores of *Bacillus atrophaeus*

(B) Spores of *Geobacillus stearothermophilus*

(C) Vegetative cells of *Clostridium tetani*

(D) Non-pathogenic strains of *Coxiella burnetii*

Q5. A 45-year-old male from a rural community presents with a chronic, painless swelling over his right foot with multiple discharging sinuses. The discharge contains yellowish grains. Microscopic evaluation reveals a filamentous Gram-positive organism that is modified acid-fast positive (using 1% H_2SO_4). What is the most likely diagnosis?

(A) Eumycetic Mycetoma

(B) Actinomycotic Mycetoma due to *Actinomyces israelii*

(C) Actinomycotic Mycetoma due to *Nocardia* species

(D) Cutaneous Anthrax

Q6. A 5-year-old child presents with high fever, sore throat, and difficulty swallowing. On examination, a thick, leathery grey exudate is seen covering the tonsils and pharynx. This membrane bleeds upon attempts to dislodge it. The lethal action of the toxin produced by this organism is achieved through which biochemical pathway?

(A) ADP-riboxylation of Elongation Factor 2 (EF-2)

(B) Cleavage of SNARE proteins inhibiting neurotransmitter release

(C) Adenylate cyclase activation leading to hypersecretion of fluids

(D) Direct degradation of cell membrane phospholipids via lecithinase

Q7. A 29-year-old female presents with burning micturition and increased urinary frequency. The urine culture on CLED agar grows lactose-fermenting colonies. Biochemically, the organism is Indole positive, Methyl Red positive, Voges-Proskauer negative, and Citrate negative. Which of the following statements best characterizes this pathogen?

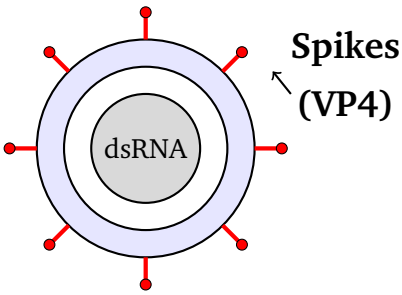
(A) It utilizes urease production to form staghorn calculi

(B) It is the leading cause of uncomplicated community-acquired urinary tract infections

(C) It causes hemolytic uremic syndrome via production of Heat-Labile enterotoxin

(D) It is an obligate intracellular pathogen requiring cell culture for growth

Q8. An infant presents with severe diarrhea, vomiting, and dehydration during winter. The causative viral agent is double-stranded and segmented. The structural layout of this virus's wheel-like capsid layout is modeled below. Which structural protein forms the outer layer spikes responsible for cell attachment and target neutralization?



(A) VP6 (Inner capsid core)

(B) VP4 (Hemagglutinin cleaved protein)

(C) VP7 (Glycoprotein outer layer)

(D) NSP4 (Enterotoxigenic peptide)

Q9. A 40-year-old chronic hepatitis patient undergoes a serological evaluation. The results show: HBsAg positive, HBeAg positive, Anti-HBs negative, and Anti-HBc IgM positive. How should this clinical profile be accurately interpreted?

(A) Acute Hepatitis B infection with high viral replication/infectivity

(B) Chronic Hepatitis B infection with low risk of transmission

(C) Recovery phase of Hepatitis B following successful vaccination

(D) Late window period presentation with resolved acute infection

Q10. A 24-year-old medical student sustains a needle-stick injury while drawing blood from a patient confirmed to be HIV-positive with a high viral load. According to current operational guidelines, Post-Exposure Prophylaxis (PEP) should be initiated within how many hours, and what is the standard recommended duration?

(A) Within 72 hours, for 28 days

(B) Within 24 hours, for 7 days

(C) Within 48 hours, for 14 days

(D) Within 12 hours, for 42 days

Q11. A 65-year-old male presents with painful vesicular lesions clustered unilaterally along a single dermatomal band on his lower thorax. He recalls

having a severe generalized itchy rash during childhood. What is the primary underlying pathogenetic mechanism of this current disease?

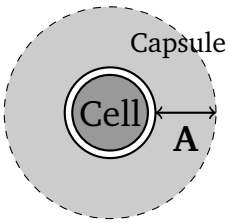
(A) Exogenous reinfection with a mutated variant of Variola virus

(B) Reactivation of latent Varicella-Zoster Virus residing within the dorsal root ganglia

(C) Hematogenous dissemination of Epstein-Barr virus following immunosuppression

(D) Hypersensitivity reaction to primary Herpes Simplex Virus Type 1 exposure

Q12. An HIV-positive patient with a CD4 count of 80/μL presents with a subacute onset of headache, low-grade fever, and neck stiffness. India ink preparation of the cerebrospinal fluid reveals encapsulated yeast cells. The unique capsular structure of this pathogen, which serves as its primary virulence factor, is shown diagrammatically below. Which biochemical component constitutes this protective shield?



(A) Glucan and Chitin wall Matrix

(B) Glucuronoxylomannan (GXM)

(C) Ergosterol lipid bilayer

(D) Lipophosphoglycan outer coat

Q13. A 32-year-old male presents with an irregular fever, profound weight loss, marked splenomegaly, and hyperpigmentation of the skin. A bone marrow biopsy is performed. The demonstration of which morphological stage of the causative parasite inside the macrophages confirms the diagnosis of Kala-azar?

(A) Flagellated promastigote stage

(B) Elongated trypomastigote stage with a free flagellum

(C) Non-flagellated amastigote stage (Leishman-Donovan bodies)

(D) Quadrinucleate cyst stage with chromatoid bars

Q14. A patient presents with abdominal pain, blood-stained mucus diarrhea, and tenesmus. Stool microscopy reveals actively motile trophozoites containing ingested erythrocytes. Which statement regarding the lifecycle or characteristics of this pathogen is true?

(A) The infective stage is the motile trophozoite shed in fresh liquid stool

(B) Extraintestinal dissemination predominantly manifests as a 'anchovy sauce' liver abscess

(C) It multiplies inside the lumen of the small intestine via multiple fission (schizogony)

(D) The organism is an obligate aerobe requiring elevated oxygen tensions to colonize tissue

Q15. A 35-year-old female presents with an intensely pruritic, foul-smelling, yellowish-green vaginal discharge. Speculum examination reveals a characteristic "strawberry cervix." A wet-mount preparation of the vaginal fluid displays actively motile, flagellated protozoa with an undulating membrane. What feature distinguishes this organism?

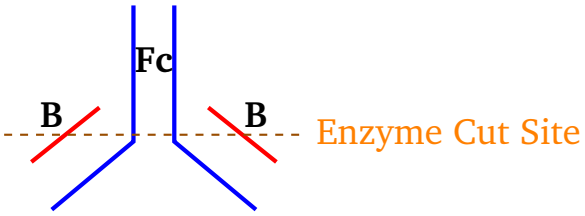
(A) It forms highly resistant octanucleate cysts in adverse environmental conditions

(B) It requires an intermediate arthropod vector for mechanical transmission

(C) It is acid-fast positive when stained with modified Ziehl-Neelsen stain

(D) It possesses no true cyst stage in its life cycle and is transmitted primarily via sexual contact

Q16. An antibody molecule is subjected to enzymatic digestion to analyze its functional fragments. The structural cleavage pattern using a specific proteolytic enzyme is shown below. Identify the structural fragments produced at 'B' and the specific enzyme used to achieve this cleavage configuration.



(A) Two independent monovalent Fab fragments; cut by Papain

(B) Four separate variable domains; cut by Chymotrypsin

(C) One bivalent $F(ab')_2$ fragment; cut by Pepsin

(D) Two intact light chain monomers; cut by Trypsin

Q17. A 22-year-old male develops generalized urticaria, wheezing, and laryngeal edema within minutes of receiving an intramuscular injection of penicillin. This life-threatening reaction is driven by the cross-linking of which antibody class bound to the surface of mast cells and basophils?

(A) IgG1 and IgG3 via Fc-γ receptors

(B) Secretory IgA dimers via secretory component interaction

(C) IgE via high-affinity Fc-ϵRI receptors

(D) Pentameric IgM via J-chain complex activation

Q18. The classical pathway of the complement system plays a critical role in innate immunity and immune complex clearance. Which of the following components acts as the crucial operational C3 convertase within this specific branch of the cascade?

(A) C3bBb

(B) C4b2a

(C) C5b6789

(D) C4b2a3b

Q19. A newborn infant with recurrent, severe pyogenic bacterial infections is found to have normal B-cell and T-cell counts, but a complete absence of functional complement-mediated opsonization. A genetic defect preventing the assembly of which molecule is the most likely cause?

(A) C1q

(B) C3b

(C) C5a

(D) C9

Q20. An experiment evaluates the primary versus secondary immune responses following antigen exposure. Which statement correctly characterizes the humoral shift observed during a secondary immune response compared to the primary immune response?

(A) A longer latent/lag period with predominant production of low-affinity IgM antibodies

(B) A shorter lag period, a rapid exponential rise in antibody titer, and a predominant shift to high-affinity IgG antibodies

(C) Complete independent reliance on T-cell independent antigens with no memory cell activation

(D) Suppression of isotype switching resulting in exclusive IgA production

Detailed Solutions

Q1.

Solution

Concept:

Spirochetes, such as *Treponema pallidum* (the causative agent of syphilis), exhibit a unique morphology and a characteristic corkscrew-like twisting motility. Unlike most flagellated bacteria, their motile apparatus is entirely internal and contained within the periplasmic space between the peptidoglycan-containing protoplasmic cylinder and the outer membrane sheath.

Solution:

(a) The structure labeled 'A' represents the periplasmic flagella, also known as endoflagella or axial filaments. These flagella arise from subterminal basal bodies located at each pole of the cell and extend toward the center along the length of the protoplasmic cylinder.

(b) The rotation of these endoflagella within the rigid periplasmic space exerts torque against the inner core and outer membrane, causing the entire organism to rotate.

(c) This unique internal motor allows the spirochete to move efficiently through highly viscous environments like mucus membranes, connective tissues, and extracellular matrix, which normally inhibit or stop standard externally flagellated bacteria.

(d) Lipopolysaccharide spikes and outer membrane porins are associated with structural integrity and outer membrane transport but do not play a mechanical role in cell locomotion.

(e) Sex pili are specialized appendages involved in bacterial conjugation and horizontal gene transfer rather than structural twisting motility.

Final Answer: Periplasmic flagella (Endoflagella)

Answer: (A)

Go Back to Question 1

Q2.

Solution

Concept:

Bacillary dysentery is primarily caused by *Shigella* species, notably *Shigella dysenteriae*. The major virulence factor is the Shiga toxin, an AB-5 cytotoxin that cleaves a specific adenine residue from the 28S ribosomal RNA of the 60S eukaryotic ribosomal subunit, arresting protein synthesis and leading to cell death.

Solution:

(a) *Shigella* species belong to the family Enterobacteriaceae. Characteristically, they are Gram-negative bacilli that are biochemically catalase-positive, oxidase-negative, non-motile, and non-lactose fermenting.

(b) Unlike other enterics, *Shigella* ferments glucose with the production of acid but specifically fails to produce gas, distinguishing it from gas-producing organisms.

(c) *Shigella* is completely non-motile at all environmental and physiological temperatures. The temperature-dependent motility pattern described in the options is typical of *Listeria monocytogenes* or *Yersinia enterocolitica*.

(d) On MacConkey agar, *Shigella* produces pale, colorless, or transparent colonies because it cannot ferment lactose, unlike rapid lactose fermenters like *Escherichia coli* which form pink colonies.

(e) Swarming motility is an characteristic phenotypic feature of the genus *Proteus*, not *Shigella*.

Final Answer: It is catalase positive, oxidase negative, and fails to produce gas from glucose

Answer: (C)

Go Back to Question 2

Q3.

Solution

Concept:

Pseudomonas aeruginosa is a notorious opportunistic pathogen frequently isolated from intensive care unit patients on mechanical ventilation. It classically produces a thick, sweet-smelling, green-pigmented biofilm or sputum, mediated by pigments like pyocyanin and pyoverdine, alongside structural factors facilitating colonization.

Solution:

(a) *Pseudomonas aeruginosa* produces an exopolysaccharide polymer called alginate, which forms a prominent, viscous mucoid capsule layer around the bacterial cells.

(b) This alginate capsule provides exceptional protection by physically shielding the bacterium from phagocytosis by host neutrophils and macrophages, and protecting the community within a structural biofilm matrix.

(c) Pili (fimbriae) are hair-like surface extensions that mediate initial structural adherence to mucosal surfaces and epithelial tissue of the respiratory tract.

(d) Protein A and coagulase are major virulence factors specific to Gram-positive *Staphylococcus aureus*.

(e) Cord factor and sulfatides are lipid-based virulence factors linked to the cell wall of *Mycobacterium tuberculosis* that prevent phagolysosome fusion.

(f) Erythrogenic toxin and M-protein are associated with *Streptococcus pyogenes* infections.

Final Answer: Alginate capsule and Pili

Answer: (A)

Go Back to Question 3

Q4.

Solution

Concept:

Sterilization monitoring relies on physical, chemical, and biological indicators to ensure that parameters achieve microbial destruction. Biological indicators provide the highest level of assurance because they directly test the destruction of highly resilient bacterial endospores.

Solution:

(a) For steam sterilization (autoclaving) operating at 121°C for 15 minutes, the standard biological indicator choice is the endospores of *Geobacillus stearothermophilus*.

(b) These endospores are exceptionally thermophilic and possess extreme resistance to moist heat, making them the ideal benchmark organism to validate that all microbial life has been eradicated during the cycle.

(c) Spores of *Bacillus atrophaeus* are instead utilized for validating dry heat sterilizers and ethylene oxide gas sterilization processes.

(d) Vegetative bacterial cells, such as those of *Clostridium tetani*, are easily killed by boiling or low-level heat and are completely unsuitable for checking high-temperature autoclave parameters.

(e) *Coxiella burnetii* is a fastidious, highly infectious zoonotic pathogen responsible for Q fever; it is never safely used as a biological indicator for routine hospital quality control.

Final Answer: Spores of *Geobacillus stearothermophilus*

Answer: (B)

Go Back to Question 4

Q5.

Solution

Concept:

Mycetoma is a chronic, progressive, granulomatous infection of the subcutaneous tissues and skin, typically affecting the lower extremities. It is clinically characterized by a triad of painless swelling, multiple interconnecting subcutaneous sinuses, and the discharge of purulent fluid containing granules or grains.

Solution:

(a) Mycetoma can be classified based on etiology into two distinct types: eumycetic mycetoma (caused by true fungi) and actinomycotic mycetoma (caused by filamentous, branching bacteria).

(b) Direct microscopic examination showing Gram-positive branching filaments that are modified acid-fast positive (resisting decolorization with weak 1% sulfuric acid) confirms the presence of *Nocardia* species.

(c) True fungi involved in eumycetic mycetoma are eukaryotic structures containing thick septate hyphae and chlamydospores, which are not acid-fast.

(d) *Actinomyces israelii* is also a branching, filamentous Gram-positive bacterium that causes actinomycosis; however, it is strictly anaerobic and is consistently modified acid-fast negative.

(e) Cutaneous anthrax, caused by *Bacillus anthracis*, presents as an acute lesion forming a painless black eschar surrounded by extensive edema, rather than a chronic sinus-forming mycetoma.

Final Answer: Actinomycotic Mycetoma due to *Nocardia* species

Answer: (C)

Go Back to Question 5

Q6.

Solution

Concept:

Diphtheria, caused by the Gram-positive rod *Corynebacterium diphtheriae*, is characterized by severe pharyngitis and the development of a dense, adherent, leathery pseudomembrane over the tonsils and pharynx. This membrane consists of dead epithelial cells, fibrin, red blood cells, and bacteria.

Solution:

(a) The systemic lethality and tissue destruction of *Corynebacterium diphtheriae* are mediated by the production of diphtheria toxin, an exotoxin encoded by a lysogenic corynebacteriophage (tox gene).

(b) The biochemical mechanism of action of diphtheria toxin involves the irreversible ADP-ribose transfer from NAD+ to Elongation Factor 2 (EF-2) inside host cells.

(c) This specific ribosylation inactivates EF-2, halting ribosomal polypeptide chain elongation, completely blocking host cellular protein synthesis, and causing rapid cell necrosis.

(d) Cleavage of SNARE proteins to block neurotransmitter release is the mechanism utilized by neurotoxins like tetanus toxin and botulinum toxin.

(e) Adenylate cyclase activation leading to fluid hypersecretion is the hallmark mechanism of cholera toxin and *E. coli* heat-labile enterotoxin.

(f) Direct degradation of cell membrane phospholipids via lecithinase is typical of the alpha toxin produced by *Clostridium perfringens*.

Final Answer: ADP-riboxylation of Elongation Factor 2 (EF-2)

Answer: (A)

Go Back to Question 6

Q7.

Solution

Concept:

Urinary tract infections are frequently encountered in clinical practice. Identification of the causative Gram-negative enteric rods relies heavily on a standard battery of biochemical screening tests, including the classic IMViC series (Indole, Methyl Red, Voges-Proskauer, Citrate).

Solution:

(a) The biochemical pattern described (Indole positive, Methyl Red positive, Voges-Proskauer negative, Citrate negative) corresponds to a classic ++– IMViC signature, which is diagnostic for *Escherichia coli*.

(b) *Escherichia coli* is a lactose-fermenting coliform on CLED or MacConkey agar and is recognized globally as the leading cause of uncomplicated community-acquired urinary tract infections.

(c) Organisms like *Proteus mirabilis* utilize prominent urease production to hydrolyze urea, increase urinary pH, and promote the crystallization of struvite or staghorn calculi; however, *Proteus* is indole negative and citrate positive.

(d) Hemolytic uremic syndrome is caused by enterohemorrhagic *E. coli* (EHEC) strains via Shiga-like toxins (verotoxins), not via Heat-Labile enterotoxins.

(e) *E. coli* is a facultative anaerobe that grows readily on standard cell-free agar media, unlike obligate intracellular organisms.

Final Answer: It is the leading cause of uncomplicated community-acquired urinary tract infections

Answer: (B)

Go Back to Question 7

Q8.

Solution

Concept:

Rotavirus is the most common cause of severe, dehydrating diarrhea in infants and young children worldwide, particularly during winter. It is a non-enveloped, double-shelled member of the Reoviridae family containing a segmented double-stranded RNA (dsRNA) genome.

Solution:

(a) The rotavirus capsid exhibits a characteristic wheel-like appearance under electron microscopy. The outer capsid shell is composed of two major structural proteins: VP7 and VP4.

(b) The protein VP4 forms the prominent, surface-exposed spikes that project outwards from the viral capsid surface.

(c) These VP4 spikes act as the primary viral attachment protein, binding to sialic acid receptors on host enterocytes to initiate viral entry, and serving as a key target for neutralizing antibodies.

(d) VP6 is the highly conserved major inner capsid protein that forms the middle layer of the virus and determines the group specificity (Groups A–G).

(e) VP7 is a glycoprotein that forms the smooth outer capsid surface layer from which the VP4 spikes project.

(f) NSP4 is a non-structural protein that functions as a viral enterotoxin, inducing secretory diarrhea by disrupting intracellular calcium homeostasis.

Final Answer: VP4 (Hemagglutinin cleaved protein)

Answer: (B)

Go Back to Question 8

Q9.

Solution

Concept:

Serological markers are critical for staging Hepatitis B virus (HBV) infection, determining infectivity, monitoring chronicity, and evaluating immune status or recovery. Interpretation depends on analyzing combinations of antigens and antibodies.

Solution:

(a) The presence of Hepatitis B surface antigen (HBsAg) indicates active infection, either acute or chronic.

(b) The presence of Hepatitis B e-antigen (HBeAg) is a marker of active viral replication, indicating high viral load in the serum and highly elevated infectivity or transmission risk.

(c) The presence of IgM antibodies against Hepatitis B core antigen (Anti-HBc IgM) is a specific marker for acute or recently acquired HBV infection, as it appears during early infection and wanes within six months.

(d) Taken together, an HBsAg positive, HBeAg positive, and Anti-HBc IgM positive status demonstrates an acute phase Hepatitis B infection with high viral replication.

(e) Chronic infections would be characterized by Anti-HBc IgG antibodies rather than IgM.

(f) A vaccinated individual would display isolated Anti-HBs antibodies without core markers or surface antigens.

Final Answer: Acute Hepatitis B infection with high viral replication/infectivity

Answer: (A)

Go Back to Question 9

Q10.

Solution

Concept:

Post-Exposure Prophylaxis (PEP) for Human Immunodeficiency Virus (HIV) is an emergency intervention designed to prevent viral replication and systemic integration following potential occupational or non-occupational exposure.

Solution:

(a) Following a high-risk exposure like a needle-stick injury with blood from an HIV-positive source, timing is critical. PEP should be initiated as soon as possible, ideally within the first few hours.

(b) Operational guidelines state that PEP must be initiated within a strict maximum window of 72 hours post-exposure; efficacy drops if started later.

(c) Once initiated, the full antiretroviral prophylaxis regimen must be maintained continuously for a standard duration of 28 days (4 weeks).

(d) A 7-day or 14-day duration is insufficient to ensure complete viral clearance and prevent the establishment of latent viral reservoirs.

(e) Initiating treatment past 72 hours is generally not recommended unless specific clinical exceptions apply, as the probability of preventing infection is drastically minimized.

Final Answer: Within 72 hours, for 28 days

Answer: (A)

Go Back to Question 10

Q11.

Solution

Concept:

Shingles, or Herpes Zoster, presents as a localized, painful vesicular eruption distributed along a specific dermatomal pathway. This clinical condition does not result from primary exposure to an infectious individual but rather stems from the secondary re-emergence of an endogenous viral pathogen that has remained dormant inside the host's nervous tissue since childhood.

Solution:

(a) The patient's childhood presentation described as a generalized itchy rash is highly characteristic of chickenpox, which is the primary infection caused by the Varicella-Zoster Virus (VZV), a human alphaherpesvirus.

(b) Following the resolution of chickenpox, the viral particles travel retrogradely along sensory nerve axons from the cutaneous lesions to establish a lifelong latent infection inside the sensory ganglia, specifically the dorsal root ganglia or cranial nerve ganglia.

(c) In later life, a decline in cellular immunity—frequently brought on by advanced age, psychological stress, systemic illness, or immunosuppressive therapy—permits the latent virus to reactivate and replicate once more.

(d) The reactivated virus travels anterogradely down the sensory nerve fibers to the skin, causing severe localized neuralgic pain followed by a cluster of cutaneous vesicles restricted to that nerve's dermatome.

(e) Variola virus is the causative agent of smallpox, an entirely distinct, eradicated orthopoxvirus that does not cause latent, dermatomal recurrences.

Final Answer: Reactivation of latent Varicella-Zoster Virus residing within the dorsal root ganglia

Answer: (B)

Go Back to Question 11

Q12.

Solution

Concept:

Cryptococcus neoformans is an opportunistic, encapsulated yeast that shows a strong tropism for the central nervous system, particularly in immunocompromised individuals. Direct microscopic visualization of cerebrospinal fluid utilizing negative staining techniques like India ink highlights its prominent, non-staining halo.

Solution:

(a) The halo observed around the yeast cell under India ink microscopy is an exceptionally thick, specialized polysaccharide capsule that acts as the principal virulence factor protecting the fungus from the host immune response.

(b) The main biochemical constituent of this defensive capsular matrix is glucuronoxylomannan (GXM), which accounts for approximately ninety percent of the total capsular mass, alongside smaller amounts of galactoxylomannan.

(c) This GXM capsule functions dynamically by inhibiting phagocytosis by macrophages, blocking leukocyte migration into the site of infection, promoting immune evasion, and downregulating the production of pro-inflammatory cytokines.

(d) Glucans and chitin are structural carbohydrates that comprise the inner cell wall layer beneath the capsule, providing mechanical strength but not forming the outer capsule shield.

(e) Ergosterol is a critical sterol lipid component found exclusively within the fungal cell membrane bilayer, acting as the primary pharmacodynamic target for polyene and azole antifungal medications.

Final Answer: Glucuronoxylomannan (GXM)

Answer: (B)

Go Back to Question 12

Q13.

Solution

Concept:

Visceral leishmaniasis, clinically designated as Kala-azar, is a systemic protozoan disease transmitted by the bite of infected female sandflies. It is characterized by persistent irregular fever, massive splenomegaly, hepatomegaly, pancytopenia, and progressive cachexia linked with dark skin hyperpigmentation.

Solution:

(a) The life cycle of *Leishmania donovani* alternates between two primary structural forms: the flagellated promastigote found in the sandfly vector and the non-flagellated amastigote found in the mammalian host.

(b) When an infected sandfly feeds on a human, it injects the promastigote stage into the skin, where they are rapidly engulfed by mononuclear phagocytes.

(c) Inside the phagolysosomes of host macrophages, the parasites shed their flagella and transform into the amastigote stage, also historically known as Leishman-Donovan (LD) bodies.

(d) Definitively diagnosing Kala-azar via bone marrow or splenic aspirate microscopy relies on demonstrating these intracellular, round-to-oval amastigotes containing a clear nucleus and a distinct rod-shaped kinetoplast.

(e) Trypomastigotes represent the highly motile, extracellular circulating blood stage typical of *Trypanosoma* species, the causative agents of sleeping sickness and Chagas disease.

Final Answer: Non-flagellated amastigote stage (Leishman-Donovan bodies)

Answer: (C)

Go Back to Question 13

Q14.

Solution

Concept:

Amebiasis, caused by the protozoan parasite *Entamoeba histolytica*, primarily targets the large intestine, leading to tissue destruction and dysentery. Distinguishing it from bacterial causes of dysentery involves identifying specific cytological phenotypes via fresh stool microscopy.

Solution:

(a) The pathognomonic microscopic finding in acute amebic dysentery is the presence of motile *Entamoeba histolytica* trophozoites displaying erythrophagocytosis, meaning they contain ingested host red blood cells within their cytoplasm.

(b) When these invasive trophozoites breach the mucosal epithelium of the colon, they can gain access to the mesenteric venules and migrate via the portal venous system to extraintestinal organs.

(c) The primary site for extraintestinal dissemination is the liver, where the trophozoites cause focal liquefactive necrosis, forming an amebic liver abscess filled with a characteristic odorless, reddish-brown chocolate-colored fluid traditionally described as "anchovy sauce."

(d) The infective stage of the parasite is the mature, hardy quadrinucleate cyst passed in feces, whereas the fragile trophozoites passed in fresh liquid stool cannot survive gastric acidity and do not transmit infection.

(e) *Entamoeba histolytica* multiplies inside the large intestine via binary fission, and it is an aerotolerant anaerobe that thrives in low-oxygen tissue environments.

Final Answer: Extraintestinal dissemination predominantly manifests as a 'anchovy sauce' liver abscess

Answer: (B)

Go Back to Question 14

Q15.

Solution

Concept:

Trichomoniasis is a highly prevalent non-viral sexually transmitted infection caused by the flagellated protozoan *Trichomonas vaginalis*. It characteristically induces vaginitis in women, presenting with diffuse vulvovaginal erythema and a frothy, malodorous vaginal discharge.

Solution:

(a) The physical examination finding of a "strawberry cervix" refers to punctate, focal mucosal hemorrhages on the ectocervix caused by the local inflammatory response and mechanical irritation induced by the parasite.

(b) A defining biological attribute of *Trichomonas vaginalis* is that its life cycle completely lacks a morphologically distinct cyst stage, existing exclusively as a motile, pear-shaped trophozoite.

(c) Because the trophozoite is fragile and cannot survive long-term exposure to the external environment, transmission relies on direct, close mucosal contact, making it almost exclusively a sexually transmitted disease.

(d) The protozoan features four anterior flagella and a short undulating membrane that produces a unique, jerky, twisting motility visible on fresh saline wet-mount preparations.

(e) Since it lacks a cyst stage, it does not form octanucleate cysts, nor does it require an intermediate insect vector or display acid-fast staining characteristics.

Final Answer: It possesses no true cyst stage in its life cycle and is transmitted primarily via sexual contact

Answer: (D)

Go Back to Question 15

Q16.

Solution

Concept:

Enzymatic cleavage of immunoglobulin G (IgG) molecules is a foundational biochemical method used to isolate structural fragments and analyze their discrete functional properties, distinguishing the antigen-binding arms from the immune-interactive stem.

Solution:

(a) The provided diagram displays an enzyme cleavage site situated just below the inter-chain disulfide bonds linking the two heavy chains together in the hinge region.

(b) Treatment of an antibody with the proteolytic enzyme pepsin results in cleavage at this specific sub-hinge position, separating the molecule into two primary fragments.

(c) The antigen-binding portion remains held together by the intact disulfide bonds, producing a single, bivalent fragment designated as $F(ab')_2$, which possesses two functional antigen-binding sites capable of cross-linking antigens.

(d) The remaining constant region of the heavy chains is extensively degraded by pepsin into small, non-functional peptide fragments, leaving no intact Fc piece.

(e) In contrast, digestion with the enzyme papain cuts precisely above the hinge disulfide bonds, yielding three distinct pieces: two separate, monovalent Fab fragments and one intact, crystallizable Fc fragment.

Final Answer: One bivalent F(ab')2 fragment; cut by Pepsin

Answer: (C)

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Q17.

Solution

Concept:

Anaphylaxis is a severe, systemic, immediate Type I hypersensitivity reaction occurring within minutes of antigen exposure in a previously sensitized individual. It is triggered by the rapid, massive degranulation of immune effector cells following specific immunological cross-linking.

Solution:

(a) When an individual is initially exposed to an immunogenic drug like penicillin, the immune system undergoes class-switching to produce allergen-specific Immunoglobulin E (IgE) antibodies.

(b) These circulating IgE antibodies quickly bind with extremely high affinity to specialized $Fc\epsilon RI$ receptors constitutively expressed on the surface of tissue mast cells and circulating basophils.

(c) Upon subsequent re-exposure, the penicillin molecules act as bivalent or multivalent antigens, directly binding to and cross-linking adjacent, membrane-bound IgE molecules on these sensitized cells.

(d) This cross-linking activates an intracellular signaling cascade that induces immediate cellular degranulation, releasing preformed vasoactive mediators such as histamine, tryptase, and leukotrienes into the surrounding tissues.

(e) These chemical mediators cause acute systemic vasodilation, increased capillary permeability, and smooth muscle contraction, presenting clinically as generalized urticaria, bronchospasm, and life-threatening laryngeal edema.

Final Answer: IgE via high-affinity FceRI receptors

Answer: (C)

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Q18.

Solution

Concept:

The complement system is a tightly regulated biochemical cascade comprising numerous plasma proteins that cooperate to eliminate pathogens, promote inflammation, and clear circulating immune complexes via three distinct activation pathways.

Solution:

(a) The classical pathway is typically initiated when the C1 complex ($C1qr_2s_2$) binds directly to the Fc portion of antigen-bound IgG or IgM antibody complexes.

(b) Activated C1s functions as a specific protease that sequentially cleaves serum complement component C4 into C4a and C4b, and component C2 into C2a and C2b.

(c) The major fragments C4b and C2a physically associate on the microbial surface to assemble a stable, active bimolecular enzymatic complex designated as C4b2a.

(d) This C4b2a complex is the functional classical pathway C3 convertase, whose specific operational role is to rapidly cleave thousands of molecules of native C3 into C3a and C3b.

(e) The alternative pathway utilizes a distinct C3 convertase, written as C3bBb, which is activated independently of antibodies.

(f) The addition of a C3b fragment to the C3 convertase creates a C5 convertase ($C4b2a3b$), while components C5b through C9 assemble to form the membrane attack complex.

Final Answer: C4b2a

Answer: (B)

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Q19.

Solution

Concept:

Opsonization is an essential immunological mechanism whereby pathogens are chemically coated with specialized proteins to facilitate their rapid recognition and engulfment by phagocytic cells expressing corresponding surface receptors.

Solution:

(a) When the complement cascade is activated via any of the primary pathways, the large fragment C3b is generated via the enzymatic action of C3 convertases.

(b) C3b contains a highly reactive internal thioester bond that allows it to covalently attach directly to hydroxyl or amino groups present on the surface proteins and carbohydrates of invading microbes.

(c) Professional phagocytic cells, such as neutrophils and macrophages, possess specific surface-bound complement receptors, notably CR1, which bind with high affinity to the attached C3b molecules.

(d) This strong physical bridge between the opsonized microbe and the phagocyte membrane triggers actin polymerization, leading to rapid pseudopod extension and internal engulfment of the pathogen.

(e) A genetic deficiency preventing the synthesis or assembly of functional C3b completely halts this vital mechanism, rendering the host highly susceptible to recurrent infections by pyogenic encapsulated bacteria.

(f) C1q is involved in initiating the classical pathway, C5a acts as a potent anaphylatoxin, and C9 forms the lytic cylinder of the membrane attack complex.

Final Answer: C3b

Answer: (B)

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Q20.

Solution

Concept:

Humoral immunity demonstrates dynamic kinetic modifications when encountering an antigen for the first time compared to subsequent exposures, reflecting the establishment of specialized immunological memory.

Solution:

(a) During a primary immune response, naive B cells are activated for the first time, leading to a prolonged lag phase of several days before detectable antibodies appear in the serum, with low-affinity IgM serving as the initial predominant isotype.

(b) In contrast, a secondary immune response occurs when the immune system re-encounters the same specific antigen, rapidly engaging the pool of pre-existing memory B cells created during primary exposure.

(c) This secondary anamnestic response is characterized by a significantly shortened lag phase, a steep exponential rise in serum antibody concentrations, and a significantly higher peak antibody titer that persists for a longer duration.

(d) Due to helper T-cell-derived cytokine signaling and somatic hypermutation occurring within germinal centers, the responding cells undergo robust isotype switching and affinity maturation.

(e) This shifts the predominant antibody population from low-affinity IgM to highly specialized, high-affinity Immunoglobulin G (IgG) molecules that bind the target antigen with enhanced avidity.

Final Answer: A shorter lag period, a rapid exponential rise in antibody titer, and a predominant shift to high-affinity IgG antibodies

Answer: (B)

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Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	A	2	C	3	A	4	B	5	C
6	A	7	B	8	B	9	A	10	A
11	B	12	B	13	C	14	B	15	D
16	C	17	C	18	B	19	B	20	B