95%
Select the ONE lettered answer that is BEST in each question. Each question is worth 2 points.

1. A 16 year old male presents to your office with the complaint of a rash of three months duration. He has been otherwise healthy and uses over-the-counter medications for his mild to moderate acne. On exam, you notice a diffuse rash over his chest, back, and upper arms which is associated with a small amount of scale and decreased pigmentation. A Woods lamp examination causes the skin to fluoresce. Which of the following is the most appropriate next step in his management?

A. Take a detailed sexual history and refer for HIV testing.
B. Scrape the lesions and send for culture.
X. Make a diagnosis of tinea corporis and prescribe topical antifungal cream.
D. Make a diagnosis of pityriasis versicolor and prescribe an oral antifungal agent.
E. Treat empirically with topical steroid creams and follow up in 2 weeks.

2. Which of the following is a feature of fungal infections involving the hair follicle (Tinea capitis) and nail beds (Tinea unguium) that is unique among the dermatophytes that cause cutaneous infection?

A. They must be treated with a systemic rather than topical antifungal agent.
B. They have an increased likelihood to cause disseminated disease.
C. They are associated with more inflammation, leading to severe irritation and itch.
X. They are refractory to all known therapies.
E. They are more common in very young children.

3. A patient is diagnosed with Chromoblastomycosis. Her lesions had been present for several years when she sought medical attention. She is concerned about the possibility of spread to her family members. Which of the following is the best advice to give to this patient?

A. Since she likely acquired the infection from an airborne source, her family members should be screened for the disease as well.
B. This infection disseminates from the GI tract in affected individuals, so good hand washing practices should prevent colonization of family members.
C. Since this infection is generally acquired by direct inoculation through trauma with a contaminated object, the risk to her family is low.
D. She should keep the affected area covered, as person-to-person spread is common.
E. Since the lesion has been present for years, there is no longer any active infection and risk to family members is negligible.
4. Which of the following is an established risk factor for vaginal candidiasis?

A. Being prepubescent
B. Recent menstruation
C. Tampon use
D. Pregnancy (estrogen)
E. Group living arrangements (e.g. College dormitory)

5. A 36 year old female undergoes marrow-ablative irradiation followed by bone marrow transplant for leukemia. She is hospitalized in the medical ICU after transplant because she has difficulty stabilizing her blood pressure. Because she is unable to sit up, a urinary catheter is placed. She is maintained on immunosuppressive therapy to ensure successful engraftment and she is neutropenic. On day 4 following transplant, she develops fever and a rash. Her physicians are concerned about systemic candidiasis. Which of the following findings is NOT by itself diagnostic of this condition?

A. A blood culture positive for Candida species.
B. Culture of Candida species from urine collected from the urinary catheter.
C. Presence of “fungal balls” in the kidney detected by ultrasound.
D. Culture of Candida species from one of the skin lesions of the rash.
E. Culture of Candida species from cerebrospinal fluid after lumbar puncture.

6. The fungal cellular target that has provided the basis of selectivity for the vast majority of antifungal agents over the past several decades is which of the following?

A. Beta-glucan in the cell wall
B. DNA synthesis enzymes
C. Ribosomes
D. Electron transport chain in the mitochondria
E. Ergosterol in the plasma membrane
7. A 65 year old female patient is admitted to an intensive care unit because of a sudden swelling of the right side of the face and an episode of bleeding from the right nostril. According to her daughter, these signs were not apparent a few days ago. She has a long history of diabetes and high blood pressure. Her blood sugar level at the time of admission was severely elevated, and she had evidence of ketoacidosis. The facial lesion becomes partially necrotic and shows slight protrusion of the right eye and facial paralysis. The patient dies on the second day. Histopathologic examination of the lesions reveals occlusion of small vessels and the presence of non-septate hyphae. This is most probably caused by:

A. Candidiasis
B. Sporotrichosis
C. Zygomycosis
D. Cryptococcosis
E. Aspergillosis

8. A previously healthy 37 year old male presents to your office with a chief complaint of headache. The headache has been fairly constant over the past month and he has had a stiff neck for the past week. He has had intermittent low grade fevers and general malaise, interfering with his ability to go to work and concentrate. He also feels as if his memory is not as sharp. On examination, his neurologic exam is notable for weakness in the distribution of the facial nerve. He also has mild papilledema bilaterally. After obtaining a CT scan, which is negative for any mass or significant edema, you perform a lumbar puncture. Findings on the cerebrospinal fluid are notable for an elevated opening pressure (reflects increased intracranial pressure), an elevated protein, a decreased glucose, and a mildly increased white blood cell count. An India ink stain of the fluid reveals globose yeast cells. Which of the following is the most likely diagnosis?

A. Candidiasis
B. Sporotrichosis
C. Zygomycosis
D. Cryptococcosis
E. Aspergillosis

9. For the previous patient (question #8), which of the following studies would be most important for his ongoing management?

A. MRI of the brain
B. Blood culture
C. Chest X-Ray
D. Abdominal CT scan
E. HIV test
10. Which of the following statements regarding infections caused by *Aspergillus* is true?

A. Disseminated disease is very treatable and seldom results in mortality.
B. In patients with intact immunity, infection of the nasal sinuses generally remains localized and can be cured with surgical drainage.
C. Pulmonary aspergillomas generally occur in previously healthy lung tissue.
D. Hemoptysis (coughing up blood) is a rare complication of pulmonary aspergilloma.
E. Diagnosis is greatly facilitated by culture of clinical specimens, as the fungus grows rapidly on artificial media.

11. A child is walking around barefoot in an area where there may be sewage contamination. Which of the following may have resulted in hookworm infection?

A. Stepping on eggs and penetration through the foot
B. Larvae penetration through the foot
C. Ingestion of eggs
D. Ingestion of larvae

12. A 3 year old is sleepless and has perianal itching. The most rapid and efficient diagnosis of this likely pinworm infection (*Enterobius vermicularis*) is which of the following diagnostic tests?

A. stool specimens on 3 alternate days to look for eggs and worms
B. rectal swab for culture for larvae
C. blood smear looking for larvae
D. cellophane tape prep from perianal region to look for eggs

13. Which of the following factors should be addressed when drawing blood cultures for detection of bacteremia?

A. using proper disinfection of the site that will be cultured
B. drawing blood from at least 2 separate sites
C. drawing sufficient volume per stick (20 ml)
D. all of the above
14. Which of the following sputum specimens as reviewed on low power microscopic exam would be accepted for processing from a patient with suspected pneumonia in a patient presenting to the ER?

A. 4+ squamous epithelial cells and no polymorphonuclear cells
   4+ gram positive diplococci and 4+ normal respiratory flora

B. 4+ polymorphonuclear cells and 1+ bronchial epithelial cells
   4+ gram positive diplococci and 1+ normal respiratory flora

C. 2+ squamous epithelial cells and 2+ polymorphonuclear cells
   2+ normal respiratory flora

D. 1+ squamous epithelial cells and 2+ polymorphonuclear cells
   3+ normal respiratory flora and 1+ gram negative rods

15. In a synovial fluid specimen from a young sexually active female with arthritis, pain and swelling in her knee, gram negative organisms were identified by gram stain. The piece of information that would be most helpful in a presumptive identification and allow you to prescribe empiric therapy would be which of the following?

A. Morphology of the organisms seen in the gram stain
B. If there were white blood cells present in the fluid
C. If the patient presented with fever
D. Recent injury to her knee during a soccer game

16. In a urine specimen submitted for culture, processing includes using a calibrated loop that delivers a specific amount of urine to the culture plate and allows quantitation of the organisms. This is necessary because:

A. urinary tract infections only occur with counts equal to or greater than 100,000 colonies per ml of urine.
B. small numbers of organisms colonizing the urethra contaminate the specimen and quantitation helps distinguish colonization from a pathogen.
C. all the species of gram negative rods, and the likely pathogens, can be identified more easily.
D. allows Gram negative rods to be more easily seen and differentiated from gram positive organisms which never cause urinary tract infections.
17. An organism isolated from a stool specimen in a patient with diarrhea that is identified as a gram negative rod that is wavy in appearance and grows at 42 degrees would be most consistent with which of the following organisms?

A. Shigella
B. Salmonella
C. difficile
D. Campylobacter

18. A patient with gallbladder disease has a gram positive cocci isolated from multiple blood cultures. The organism has the following characteristics:

- Gram positive cocci in chains
- Gamma hemolytic on blood (no hemolysis noted)
- Catalase negative
- Grows in bile
- Grows in salt

What is the most likely pathogen:

A. Group A streptococcus
B. Staphylococcus aureus
C. Streptococcus pneumoniae
D. Enterococcus

19. A sternal wound infection was identified as having 4+ S. aureus. The most important piece of information for purposes of infection control and treatment is which of the following?

A. Presence of the mec A gene and methicillin resistance of the S. aureus isolate.
B. Whether there were white blood cells present in the specimen and it is of good quality.
C. If the patient also has sputum cultures that are positive for the same organism.
D. If the person also has a urinary tract infection with E. coli.
20. A gram negative rod that is a water and soil associated organism, a nonlactose fermenter, oxidase positive and is resistant to multiple antibiotics. The organism is commonly seen in ventilator-acquired pneumonia, cystic patients and wounds in burn patients. This organism is:

A. E. coli
B. Acinetobacter lwofii
C. S. aureus
D. Pseudomonas aeruginosa

Select the ONE lettered answer that is BEST in each question. Each question is worth 2 points.

1. Bacterial exotoxins have been found that owe their activity to the ability to facilitate ADP-ribosylation of proteins. Which one of the following toxins does not fall into this class?

- A. Cholera toxin
- B. Botulinum toxin
- C. Diphtheria toxin
- D. Shiga toxin
- E. Pseudomonas toxin

2. Endotoxin produced by Gram-negative bacteria can cause all of the following except:

- A. Fever
- B. Adult respiratory distress syndrome
- C. Hemolytic uremic syndrome
- D. Disseminated intravenous coagulation (DIC)
- E. Hypotension

3. With respect to Rocky Mountain spotted fever, which of the following is not correctly matched?

- A. Etiology—Rickettsia rickettsii
- B. Vectors—Dermacentor tick
- C. Diagnosis—rash on palms and soles
- D. Treatment—immediate administration of Rickettsial toxoid—Rickettsia doesn't make an exotoxin
4. Tuberculosis is:
   A. spread by contaminated food
   B. caused by a gram-negative rod
      C. spread by small droplets
      D. easily resolved by innate immune mechanisms

5. A 23-year-old woman presents to the emergency room with pelvic pain. A Gram stain of her cervical discharge finds multiple polymorphonuclear leukocytes, but none contain gram-negative diplococci. Which one of the following statements applies to both of the organisms that are the most likely causes of this woman’s symptoms?
   A. Both are unlikely to recur because of acquired cell mediated immunity.
   B. Both are unlikely to recur because of antibody-mediated immunity.
      C. Both induce endocytosis by epithelial cells.
   D. Both are obligate intracellular parasites
   E. Both respond to penicillin

6. The most common form of infection caused by Clostridium botulinum is:
   A. wound infection
      B. infant botulism
      C. food poisoning
   D. primary septicemia
      E. tetanus

7. A predisposing factor in pseudomembranous colitis is:
   A. old age
   B. bad diet
      C. clindamycin treatment
   D. gas gangrene

8. Which of the following may have enzymatic activity?
   A. Exotoxin
   B. Endotoxin
   C. Both
   D. Neither
9. Which of the following is required for definitive identification of *Streptococcus pyogenes*?
   A. Presence of lipoteichoic acid
   B. Presence of streptolysin O $\rightarrow SLO^{+}$
   C. Demonstration of group A-specific antigen
   D. Demonstration of M-protein

10. *Streptococcus pyogenes* is notorious for its production of a number and variety of biologically active extracellular proteins. With respect to this, which of the following does not belong in the list?
   A. Exfoliatin
   B. Fibrinolysin $\rightarrow$ streptokinase
   C. Hyaluronidase
   D. Erythrogenic toxin
   E. Deoxyribonuclease

11. A previously healthy 4-month-old male infant was admitted to a hospital with lethargy and loss of developmental milestones, constipation, and poor suck and feeding. He had been breast-fed and bottled foods were added at the age of 3 months. On examination, the child was generally hypotonic with flaccid extremities. He was alert, and had no oculomotor weakness. A stool specimen contained Gram-positive, sporulating, anaerobic bacilli and a filtrate of the stool killed a mouse. The best explanation of this combination of findings is: flopyp baby syndrome infant botulism
   A. The child has acute food poisoning caused by neurotoxins that bind to peripheral nerves at neuromuscular junction.
   B. The child has acute neurological consequences as a result of enterotoxin A.
   C. The child has early signs of a typical case of neonatal tetanus.
   D. The child has a botulism infection obtained by ingestion of bacterial spores.
   E. The culture report is meaningless because such bacteria are part of the normal intestinal flora.

   A or D
12. Each of the following statements concerning *Neisseria meningitides* is correct except:

A. It contains LOS in its cell wall
B. A capsular vaccine is available for certain serogroups
C. It contains a polysaccharide capsule
D. It produces an exotoxin that stimulates adenylate cyclase
E. None of the above are correct
F. All are correct

13. Which of the following is not an important characteristic of either *Neisseria gonorrhoeae* or *Neisseria meningitides*?

A. polysaccharide capsule
B. IgA protease
C. Pili
D. M protein

14. The pathogenesis of which of the following diseases does not involve an exotoxin?

A. Scarlet fever
B. Toxic Shock Syndrome
C. Tetanus
D. Typhoid fever $\rightarrow$ *Salmonella*
E. Cholera

15. The major determinant of gram positivity is:

A. membrane derived oligosaccharide
B. K antigen
C. peptidoglycan $\rightarrow$ retains crystal violet stain
D. porin
E. lipopolysachharide = LPS

16. Each of the following statements concerning the normal flora is true except:

A. The normal flora of the colon consists predominantly of anaerobic bacteria.
B. The presence of the normal flora prevents certain pathogens from colonizing the upper respiratory tract.
C. All normal flora are transient organisms
D. Organisms of the normal flora are permanent residents of the body surfaces.
17. Which of the following has an infectious dose that is less than 500?

A. *Shigella*  
B. Enterohemorrhagic *E. coli*  
C. *Yersinia pestis*  
D. All of the above  
E. None of the above

18. With respect to intestinal infections caused by *Escherichia coli*, which of the following types of *E. coli* produces stools which contain blood and pus (WBCs)?

A. Enterotoxigenic (ETEC) - watery  
B. Enteropathogenic (EPEC) - watery  
C. Enterohemorrhagic (EHEC)  
D. All of the above  
E. None of the above

19. With respect to intestinal infections caused by *Escherichia coli*, which of the following types of *E. coli* produces a copious watery diarrhea without showing any marked mucosal pathology?

A. Enterotoxigenic (ETEC)  
B. Enteroinvasive (EIEC)  
C. Enterohemorrhagic (EHEC)  
D. All of the above  
E. None of the above

20. Which of the following obligate intracellular bacteria has a cell wall containing peptidoglycan?

A. Rickettsia  
B. Chlamydia - definitely no cell wall  
C. Both  
D. Neither

21. In which of the following obligate intracellular bacteria is the requirement for intracellular growth related to their requirement for ATP?

A. Rickettsia  
B. Chlamydia  
C. Both  
D. Neither
22. An outbreak of gastrointestinal disease occurred following a visit by 60 first-grade students and 3 teachers to a dairy farm. Cookies and small cups of raw milk were served to all. Thirty-one of the visitors became ill. Symptoms included fever (84%), abdominal pain (81%), vomiting (65%), diarrhea (55%), headache (13%), bloody stool (12%), and myalgia (7%). Onset of the disease ranged from 1 to 8 days and illness lasted from 5 hours to 12 days. Phase contrast microscopy of 10 different stools showed curved bacilli that were S- or "seagull"-shaped. A Gram-negative organism was eventually isolated using special media and microaerophilic incubation. Which of the following organisms is the most likely cause?

A. Shigella sonnei
B. Salmonella enteritidis
C. Campylobacter jejuni
D. Listeria monocytogenes

23. Purulent bacterial meningitis in children and adults is primarily caused by three microorganisms: Neisseria meningitidis, Haemophilus influenzae, and Streptococcus pneumoniae. Which of the following virulence factors is common to all of these?

A. LPS endotoxin
B. Polysaccharide capsule
C. Pili
D. Exotoxins
E. Heat labile toxin
F. All of the above

24. S. aureus differs from S. epidermidis in which of the following:

A. catalase activity
B. microscopic appearance
C. ability to ferment glucose
D. ability to clot plasma = coagulase test
E. ability to colonize the skin
25. A culture of skin lesions from a patient with impetigo shows numerous colonies surrounded by a zone of beta hemolysis on a blood agar plate. A Gram-stained smear shows gram-positive cocci. If you found the catalase test to be negative, which one of the following organisms would you MOST probably have isolated?

A. Streptococcus pyogenes
B. Staphylococcus aureus
C. Staphylococcus epidermidis
D. Streptococcus pneumoniae α-hemolytic

26. The most common cause of septic arthritis in most age groups is *Staphylococcus aureus*. An exception to this is that most cases of septic arthritis in young adults is caused by:

A. *Streptococcus pyogenes*
B. *Neisseria gonorrhoeae*
C. *Pseudomonas aeruginosa*
D. *Chlamydia trachomatis*
E. *Borrelia burgdorferi*

27. Which of the following is not an intracellular bacterial parasite that lives in a phagosome:

A. *Legionella pneumophila*
B. *Chlamydia trachoma*
C. *Listeria monocytogenes* → LLO is used to escape the phagolysosome
D. *Mycobacterium tuberculosis*
E. None of the above

28. Syphilis and Lyme disease are strikingly similar in which of the following aspects?

A. Their modes of transmission.
B. Both display three similar stages of chronic infection.
C. Both causative agents share similar antigenic markers.
D. Both causative agents can be easily cultured but only observed using dark field microscopy.

*L. spirochete*
*L. T. pallidum*
cannot be cultured
29. Secondary syphilis is characterized by all of the following except:

A. Cutaneous lesions
B. Mucous membrane lesions
C. Onset several weeks after the chancre
D. Absence of spirochetes in the lesions
E. Condylomas

30. An exotoxin produced by which organism prevents protein synthesis and leads to cell lysis?

A. Helicobacter pylori
B. Escherichia coli (ETEC) - ST, LT
C. Salmonella typhimurium
D. Shigella dysenteriae
E. Vibrio cholerae
F. All of the above

Case 1

A 60-year-old woman with a history of a gastric ulcer had recently noted symptoms of dyspepsia (gastric indigestion). She characterized her discomfort as a pressure in the upper abdominal area that radiated to her chest and neck. She underwent an upper gastrointestinal series that showed radiologic findings compatible with a thickened fold within the stomach. A biopsy of the antral portion of the stomach was consistent with a moderate gastritis.

31. Which of the following organisms would most likely be associated with gastritis?

A. Enterohemorrhagic E. coli (EHEC)
B. Campylobacter jejuni
C. Helicobacter pylori
D. Shigella sonnei
E. Enteroinvasive E. coli (EIEC)

32. What additional clinical syndromes have been linked to this organism?

A. dysentery
B. stomach cancer
C. bloody diarrhea
D. Guillain-Barre syndrome - Campylobacter
E. hemolytic uremic syndrome - EHEC
33. What properties of this organism allow it to survive in the rather inhospitable environment of the human stomach?

A. M protein
B. Peritrichous flagella → has polar flagella, E. coli has peritrichous flagella
C. Urease enzyme
D. Heat labile toxin (LT toxin)
E. Heat stable toxin (ST toxin)
F. All of the above

Case 2
A 45-year-old male was in his usual state of good health when he awoke at 3 a.m. with pain in the lateral aspect of his left calf. He looked at his calf and thought that the pain was due to an ingrown hair and went back to sleep. At 10 a.m., he expressed a small amount of pus from the ingrown hair. Over the next 8 hours, the patient developed an area of cellulitis on the lateral aspect of the calf of approximately 5 by 10 cm. The next morning, the area of cellulitis extended from just below the knee to just above the ankle. He visited his physician. His vital signs were all normal. Physical exam was significant for an area of cellulitis as described that was red and warm to the touch but with no area of obvious fluctuance. No lymphoadenopathy was observed. The patient was referred to the surgery service where he was given intramuscular and oral antibiotics. He returned to the surgery clinic 48 hours later with an obvious area of fluctuance in the center of the area of cellulitis. He exhibited low-grade fevers and aspirated pus revealed gram-positive cocci in clusters. When pus was aspirated from the lesion, the surgeon decided to excise and drain the lesion. S. aureus

34. Which of the following would be the most likely source of this organism?

A. Colonization of the skin from the nose
B. Tick bite on his calf
C. Acquired from a previous bout of bacterial pharyngitis
D. Acquired from bathing in a hot tub that was improperly chlorinated

35. Why were incision and drainage necessary to treat this infection?

A. It was required to completely eliminate the crepitus, indicating gas in the skin lesion.
B. Intramuscular and oral antibiotics would have been sufficient to treat this patient, thus drainage was not necessary.
C. It was required to allow penetration of antimicrobial agents to center of infected tissue.
D. To prevent the spread of myonecrosis.
36. What other types of infection does this organism frequently cause?  
   S. aureus  
   A. nosocomial bacteremia  
   B. septic arthritis  
   C. food poisoning  
   D. All of the above  
   E. None of the above  

37. What properties of this organism allow it to cause a variety of diseases?  
   A. Superantigen exotoxins  
   B. Lipopolysaccharide (LPS)  
   C. M proteins  
   D. Opa proteins  
   E. All of the above  

Case 3  
The patient is an 8-year-old male with a 2-day history of diarrhea. He presented with worsening diarrhea that had become bloody. He also complained of pain on defecation. He had vomited once. He had attended a cookout 6 days previously and claimed that his mother made him eat a hamburger that was “pink inside” even though “he did not like it.” His physical examination was benign except for obvious dehydration. His laboratory findings were significant for a high white blood cell count with excess neutrophils. He was treated with antibiotics and intravenous fluid therapy for dehydration and was released within 24 hours.  

38. What is the most likely etiological agent of his infection?  
   A. O157:H7  
   B. Shigella dysenteriae  
   C. Salmonella enterica  
   D. Helicobacter pylori  
   E. Staphylococcus aureus
39. Which of the following virulence factors play a role in the diarrheal disease process?

   A. Shiga-like toxin and intimin
   B. Shiga-like toxin and enterotoxin
   C. Heat labile toxin and heat stable toxin
   D. Shiga-like toxin and vacuolating cytotoxin (VacA)
   E. Exotoxin A and Exotoxin S - Pseudomonas
   F. None of the above

   EHEC

40. What other organ is specifically targeted by this organism?

   A. heart
   B. kidney ⇒ hemolytic uremic syndrome
   C. gallbladder
   D. All of the above
   E. None of the above

   E. coli
   ↓
   neonatal meningitis
cystitis
pyelonephritis
diarrhea
   ⇒ HUS

Match the numbered pathogen at the top with the correct lettered pathogenic factor on the bottom. Note: Some letters may be used more than once. Each response is worth 2 points.

   D. 1. Rickettsia
   A. 2. Streptococcus pyogenes
   D. 3. Listeria monocytogenes
   E. 4. Neisseriae gonorrhoeae
   C. 5. Escherichia coli
   B. 6. Neisseriae meningitidis
   A. 7. Staphylococcus aureus
   A. 8. Clostridium perfringens − α-toxin, β-toxin
   E. 9. Borrelia burgdorferi
   E. 10. Mycobacterium tuberculosis

A. pore-forming exotoxin
B. polysaccharide capsule, IgA1 protease, LOS
C. type III secretion mechanisms
D. actin polymerization
E. host response to infection (i.e. chronic inflammation)
Match the numbered pathogen at the top with the correct lettered description on the bottom. Each response is worth 2 points.

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<th>1. Salmonella typhimurium</th>
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<td>9. Staphylococcus epidermidis</td>
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<td>J</td>
<td>10. Clostridium perfringens</td>
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A. beta hemolytic, macular rash, pyogenic, cardiac valvular damage

B. anaerobic lung abscess, normal enteric flora, opportunistic

C. clustered gram positive cocci, infects prosthetic heart valves and venous catheters, coagulase negative

D. no peptidoglycan, cytoplasmic inclusion body, ocular and respiratory infections

E. urease enzyme, slow bacterial infection, polar flagella, stomach cancer

F. Lactose negative on MacConkey agar, H antigen negative, low ID$_{50}$, bloody diarrhea, leukocytosis

G. nosocomial pathogen, minimal nutritional requirements, causes eczema

H. endoflagella, maculopapular rash, ataxic gait, no endotoxins

I. invasive, non-bloody diarrhea, H antigen positive, can colonize gallbladder

J. normal flora of vagina and GI tract, crepitation, associated with trauma, double zone

of hemolysis on blood agar plate, myonecrosis
The following questions are optional. You may choose to answer one or both of the questions. Each question is worth 2 bonus points. Please note that partial credit will not be given for either question. Complete the question on this page and on the back. No additional paper should be needed.

1. Describe, in as much specific detail as possible, the main pathogenic mechanism of any organism that fulfills the following criteria: *gram-negative rod* that does not form spores, is facultative anaerobic, contains a single-polar flagellum, is not part of the normal flora, and is highly motile but *not invasive*. Make certain the organism is first identified.

   ![Helicobacter pylori](image)

   Helicobacter pylori is a *gram-negative rod* that is not invasive but rather lives in the mucus layer near the epithelial cells of the stomach. It uses its single polar flagellum to burrow into the gastric mucus layer, one way in which it protects itself from the low pH of the stomach. A second mechanism is by secreting urease, an enzyme that breaks urea into ammonia and CO₂. This also functions to raise the local pH around Helicobacter and promote its survival. Although *H. pylori* does not invade the stomach lining, it causes the secretion of IL-8, a chemokine which then recruits neutrophils (which secrete more IL-8 and recruit even more neutrophils) and underlies the intense inflammatory reaction associated with this infection and clinically, produces gastritis, atrophic gastritis (loss of gastric glands due to intense inflammation) as well as gastric and duodenal ulcers. *H. pylori* also produces VacA, an enzyme that can digest intracellular organelles leading to vacuolization and Coga, which has the ability to alter the cytoskeleton. The role of both of these in pathogenesis is unclear, but there is a strong association of Coga⁺ strains with gastric adenocarcinoma and gastric MALT lymphoma in epidemiological studies.

2. *Shigella* species infect M cells, show bacterially-induced endocytosis, as well as directional actin polymerization. These bacteria possess a type III contact secretion system where they can deliver bacterial products to a host cell that facilitates their endocytosis into the cytoplasm. *Shigella* by a syringe-like mechanism then escapes the endosome to enter the cytoplasm proper where it can spread intracellularly and intercellularly using actin polymerization. Parasite-direced endocytosis is most important for bacterial entry into cells that are not normally phagocytic, although M cells act as APCs in the GI tract.