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<td>E</td>
<td>104.</td>
<td>Acquired Immunodeficiency Syndrome (accept “AIDS”)</td>
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<td>Bilirubin</td>
<td>105.</td>
<td>Human Immunodeficiency Virus (accept “HIV”)</td>
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<td>Hepatitis C (accept “C” or “Hep C”)</td>
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<td>107.</td>
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<td>78.</td>
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<td>108.</td>
<td>Grave’s Disease (accept “Toxic Diffuse Goiter”)</td>
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<td>79.</td>
<td>Lactose</td>
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<td>110.</td>
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<td>Vermiform Appendix (accept “Appendix”)</td>
<td>111.</td>
<td>Iodine (do NOT accept “I”)</td>
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<td>82.</td>
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<td>Rheumatoid Arthritis (accept “RA”)</td>
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<td>83.</td>
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<td>84.</td>
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<td>114.</td>
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<td>92.</td>
<td>Cystic Fibrosis (Do NOT accept “CF”)</td>
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<td>Alveoli</td>
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<td><em>Streptococcus Pneumoniae</em></td>
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STATION 1

1. Which of following body systems is NOT being tested in Anatomy & Physiology this year?
   A. Immune System
   B. Respiratory System
   C. Skeletal System
   D. Digestive System

2. Which university are you currently at?
   A. The University of North Carolina at Chapel Hill
   B. North Carolina State University
   C. Duke University
   D. Davidson College
   E. North Carolina Central University

3. The lumen of the digestive tract is considered to be _____________ and nearly all secretions into the digestive tract are from glands that are _____________ in nature.
   A. Intracellular, Endocrine
   B. Intracellular, Exocrine
   C. Extracellular, Endocrine
   D. Extracellular, Exocrine

4. Which form of digestion triggers the breaking of chemical bonds in food?
   A. Chemical Digestion
   B. Mechanical Digestion
   C. A & B
   D. None of the above

5. The enteric nervous system is ________________ of the central nervous system but is heavily regulated by the ________________ nervous system. **TIEBREAKER**
   A. Independent, Sympathetic
   B. Independent, Parasympathetic
   C. Dependent, Sympathetic
   D. Dependent, Parasympathetic
STATION 1

For the questions that follow the figure below, select the letter or pairing of letters that corresponds to the digestive structure that fits the description. Structures may or may not be used more than once.

6. The inflammation of this "organ" is the number 1 cause of unplanned surgery in the U.S. **TIEBREAKER**

7. This organ concentrates bile.

8. This part of the GI has both endocrine and exocrine function.

9. The ileocecal valve facilitates the passage of digested entities into this part of the GI tract.

10. This structure forms the bolus.
STAION 2

11. The small intestine is _________ the large intestine.
   A. Wider
   B. Longer
   C. Shorter
   D. The same width
   E. The same length

12. Water absorption in the _________ intestine is _________ than that of the _________ intestine.
   A. Large, Less, Small
   B. Small, Less, Large
   C. Large, The same as, Small

13. Which of the following parts of the small intestine contains plicae circulares?
   A. Duodenum
   B. Jejunum
   C. Ileum
   D. B & C
   E. A, B, & C

14. Which of the following enzymes is NOT activated by trypsin? **TIEBREAKER**
   A. Chymotrypsinogen
   B. Proelastase
   C. Proamylase
   D. Prolipase
   E. Procarboxypeptidase

15. Pepsinogen is secreted by _________ cells and is activated by _______ in the stomach.
   A. Parietal, hydrochloric acid
   B. Mucous, bicarbonate ions
   C. Enteroendocrine, hydrofluoric acid
   D. Chief, hydrobromic acid
   E. None of the above

16. _________ stimulates the release of both bile and pancreatic juices into the small intestine.
   A. Cholecystokinin
   B. Secretin
   C. Gastrin
   D. Leptin
   E. Glucagon
STATION 3

17. What is the scientific term for vomiting?
   A. Defecation
   B. Mastication
   C. Micturition
   D. Deglutition
   E. Emesis

18. The scientific term for the opposite of vomiting is ____________ . **TIEBREAKER**
   A. Defecation
   B. Mastication
   C. Micturition
   D. Deglutition
   E. Emesis

19. The main purpose of _____ is to _____ lipids.
   A. Lipase , Emulsify
   B. Bile , Digest
   C. Lipase , Digest
   D. A & B
   E. A,B, & C

20. Digested proteins are absorbed through ________ tissues called ________ .
   A. Lymphatic , Lacteals
   B. Circulatory , Lacteals
   C. Lymphatic , Capillaries
   D. Circulatory , Capillaries
   E. None of the above

21. Digested lipids are absorbed through ________ tissues called ________ .
   A. Lymphatic , Lacteals
   B. Circulatory , Lacteals
   C. Lymphatic , Capillaries
   D. Lymphatic , Capillaries
   E. None of the above

22. True/False: Digested carbohydrates are absorbed by the same mechanism as lipids are.
   A. True
   B. False
23. What is the name of this structure?
   A. Large Intestine
   B. Small Intestine
   C. Spleen
   D. Liver
   E. Stomach

24. What is the name of this structure? **TIEBREAKER**
   A. Esophagus
   B. Gallbladder
   C. Spleen
   D. Pancreas
   E. Anus
STATION 4

Rest Station
STATION 5

Each question will present an aspect of the human immune system.

Bubble in “A” if the aspect contributes to the 1st Line of Defense in Innate Immunity
Bubble in “B” if the aspect contributes to the 2nd Line of Defense in Innate Immunity
Bubble in “C” if the aspect contributes to Humoral Immunity
Bubble in “D” if the aspect contributes to Cytotoxic Immunity
Bubble in “E” if the aspect contributes to BOTH Humoral and Cytotoxic Immunity

25. Lysozyme
26. Fever
27. Major Histocompatibility Complex
28. Immunoglobulins
29. Clonal Selection **TIEBREAKER**
30. CD8 Cells
31. CD4 Cells
32. Agglutination
STATION 6

The following questions pertain to the five general types of leukocytes in the image below. Select the letter or letters of the cell(s) that fit(s) the description. Letters may be used more than once and there may be more than one letter that satisfies a given description. For example, if “B” and “D” both fulfill a description, then you will have to bubble both “B” and “D”

A  B  C  D  E

33. Eosinophil
34. Basophil
35. Monocyte
36. Neutrophil
37. Granulocyte
38. The first cell type to respond to a bacterial infection. **TIEBREAKER**
39. Develops into macrophages.
40. Primarily responsible for attacking parasitic worms.
41. Activation of _______ cells by an antigen presenting cell exhibiting MHC Class ______ occurs in adaptive immunity.
   A. CD4, II
   B. CD8, II
   C. CD8, I
   D. A & C
   E. A, B, & C

42. True/False: for a CD_ cell and its associated MHC Class _ for activation, the product of the two digits that go in each blank is 8.
   A. True
   B. False

43. Activation of CD8 cells goes on to lead to:
   A. Activation of B cells
   B. Production of suppressor T cells
   C. Production of helper T cells
   D. A & B
   E. None of the above

44. Activation of CD4 cells goes on to lead to: **TIEBREAKER**
   A. Production of memory B cells
   B. Production of plasma cells
   C. Production of memory T cells
   D. A & B
   E. A, B, & C

45. Which specific cell type produces immunoglobulins?
   A. Helper T cells
   B. Memory B cells
   C. Plasma cells
   D.Suppressor T cells
   E. Memory T cells

46. True/False: Cytokines are secreted by CD4 cells.
   A. True
   B. False
47. True/False: The final set of bronchioles before alveoli are called terminal bronchioles.
   A. True
   B. False

48. Choose the correct pathway of bronchi/bronchioles down the bronchial tree.
   A. Trachea, Segmental bronchi, Primary bronchi, Lobar bronchi, Respiratory bronchioles, Terminal bronchioles
   B. Primary bronchi, Trachea, Lobar bronchi, Segmental bronchi, Terminal bronchioles, Respiratory bronchioles
   C. Trachea, Primary bronchi, Lobar bronchi, Segmental bronchi, Terminal bronchioles, Respiratory bronchioles
   D. Primary bronchi, Trachea, Segmental bronchi, Lobar bronchi, Respiratory bronchioles, Terminal bronchioles
   E. Trachea, Primary bronchi, Segmental bronchi, Lobar bronchi, Respiratory bronchioles, Terminal bronchioles

49. The respiratory membrane is made up of which of the following?
   A. Type 1 Alveolar cells
   B. Type 2 Alveolar cells
   C. Capillary endothelium
   D. A & C
   E. A, B, & C

50. Which of the following is correct?
   A. Alveolar Type 1 cells secrete surfactant
   B. Oxygen gas has a higher solubility coefficient than CO₂ gas
   C. Surfactant prevents collapsing of the lung after expiration
   D. Gas exchange happens from a low to high gradient
   E. None of the following is correct

51. The diaphragm relaxes during _________ where the lung volume _________ and the pressure within the lungs _________.
   A. Inspiration, Increases, Increases
   B. Inspiration, Decreases, Decreases
   C. Expiration, Increases, Decreases
   D. Expiration, Decreases, Increases
   E. Inspiration, Decreases, Increases
52. In descending order, the 3 regions of the pharynx are:
   A. Nasopharynx, Oropharynx, Laryngopharynx
   B. Nasopharynx, Laryngopharynx, Tracheopharynx
   C. Nasopharynx, Laryngopharynx, Oropharynx
   D. Oropharynx, Tracheopharynx, Brachiopharynx
   E. Laryngopharynx, Tracheopharynx, Brachiopharynx

53. True/False: The internal intercostals are major muscles for forced inspiration.
   A. True
   B. False

54. What partial pressure of oxygen gas corresponds to 75% saturation?
   A. 15
   B. 30
   C. 40
   D. 65
   E. 100
The following questions refer to the gas exchanges that go on within the body. You are to select the letter the corresponds to the correct relationship.

55. The partial pressure of CO$_2$ after leaving the systemic tissues is approximately equal to _________ and is _________ the partial pressure of O$_2$.
   A. 45 mmHg, lower than 
   B. 40 mmHg, higher than 
   C. 45 mmHg, higher than 
   D. 40 mmHg, lower than 
   E. 45 mmHg, equal to

56. The partial pressure of CO$_2$ in the lungs is approximately equal to _________ and is _________ the partial pressure of O$_2$.
   A. 104 mmHg, lower than 
   B. 40 mmHg, higher than 
   C. 45 mmHg, equal to 
   D. 40 mmHg, lower than 
   E. 104 mmHg, equal to

57. The partial pressure of O$_2$ after leaving the lungs is approximately equal to _________ and is _________ the partial pressure of CO$_2$.
   A. 104 mmHg, lower than 
   B. 40 mmHg, higher than 
   C. 45 mmHg, higher than 
   D. 40 mmHg, lower than 
   E. 104 mmHg, higher than

58. The partial pressure of CO$_2$ before entering the systemic tissues is approximately equal to _________ and is _________ the partial pressure of O$_2$.
   A. 40 mmHg, lower than 
   B. 104 mmHg, higher than 
   C. 45 mmHg, equal to 
   D. 104 mmHg, lower than 
   E. 40 mmHg, higher than

59. The partial pressure of O$_2$ in the systemic tissue is approximately equal to _________ and is _________ the partial pressure of CO$_2$.
   A. 45 mmHg, equal to 
   B. 70 mmHg, higher than 
   C. 45 mmHg, higher than 
   D. 70 mmHg, equal to 
   E. 40 mmHg, lower than
STATION 9

60. During inspiration the pulmonary pressure is ________ the atmospheric pressure and approximately equal to ________.
   A. Higher than, 761 mmHg
   B. Lower than, 761 mmHg
   C. Higher than, 760 mmHg
   D. Lower than, 759 mmHg
   E. Equal to, 760 mmHg

61. During expiration the atmospheric pressure is ________ the pulmonary pressure and approximately equal to ________.
   A. Higher than, 760 mmHg
   B. Lower than, 760 mmHg
   C. Higher than, 761 mmHg
   D. Lower than, 759 mmHg
   E. Equal to, 759 mmHg

62. This structure accounts for ¾ of the volume change in the lungs. **TIEBREAKER**
   A. Diaphragm
   B. External intercostals
   C. Internal intercostals
   D. A & B
   E. B & C
STATION 10

The following questions pertain to the oxygen-hemoglobin dissociation curve(s) shown below.

63. Which of the following would NOT cause a decreased affinity to oxygen? **TIEBREAKER**
   A. Increase in temperature
   B. Increase in pH
   C. Increase in CO₂
   D. Increase in 2,3-BPG (2,3-Bisphosphoglyceric acid)
   E. B & D

64. A left shift corresponds to a(n) ________.
   A. Increased affinity to O₂
   B. Decreased affinity to CO₂
   C. Increased affinity to CO₂
   D. Decrease affinity O₂
   E. A & B

65. Which of the following would cause a right shift of the oxygen-hemoglobin dissociation curve?
   A. Increase in temperature
   B. Decrease in H⁺ ions
   C. Decrease in pH
   D. Decrease in CO₂
   E. A & C
STATION 10

66. What is the approximate oxygen saturation of hemoglobin in the systemic circulation while at rest?
   A. 0%
   B. 25%
   C. 50%
   D. 75%
   E. 100%

67. What is the approximate oxygen saturation of hemoglobin in the systemic circulation during strenuous exercise? **TIEBREAKER**
   A. 0%
   B. 25%
   C. 50%
   D. 75%
   E. 100%

68. What is the name for the effect during which a conformational change is caused by H⁺ ions binding to hemoglobin?
   A. Leibnitz effect
   B. Bohr effect
   C. Haldane effect
   D. Brockhampton effect
   E. Green effect

69. Which of the following is not a type of breathing?
   A. Thoracic breathing
   B. Abdominal breathing
   C. Clavicular breathing
   D. Pectoral breathing
   E. All of the above are types of breathing

70. During the process of carbon dioxide loading, which ion moves into the red blood cell as the bicarbonate ion \( \text{HCO}_3^- \) moves out?
   A. Bromide ion
   B. Chloride ion
   C. Oxide ion
   D. Potassium ion
   E. Sodium ion
**Instructions:** Read the following case studies and answer the questions that are contained in each one. There will be one case study and 15 pertinent questions for each body system, culminating in a grand total of three case studies and 45 questions. There is no spelling penalty. Good luck and may the force be with you.

---

**CASE STUDY #1**

Aang, Katara, Sokka, and Toph are all buddies that are trying to save the world from being conquered by the evil force called The Fire Nation. In the middle of April, these four buddies are traveling to the large metropolitan of *Ba Sing Se* that is entirely surrounded by very massive walls. The reason that they are making this journey to *Ba Sing Se* is to stop The Fire Nation from drilling through the walls and invading the city. However, the four buddies run into a few health difficulties along the way. Fortunately for the group, Katara possesses profound medical knowledge and healing abilities.

The first medical issue involves Sokka. Sokka is experiencing general malaise accompanied by a fever and jaundice. Katara then proceeds to examine Sokka’s chest and abdomen for any signs of inflammation and discovers that one key organ in Sokka’s body is enlarged and inflamed.

---

**71. Which organ in Sokka’s body is enlarged, given that it is an accessory digestive organ?**

---

After identifying this key organ as being inflamed, Sokka asks Katara to tell him the specific disease he is suffering from. Katara then proceeds to tell him the disease and makes it clear to him that there are several different types or manifestations of this disease.

---

**72. What is the **general** name of the disease that Sokka has? Do NOT give a specific form.**

---

**73. What is the **general** class of pathogen that causes this disease?**

A. Bacterium  
B. Prion  
C. Protozoan  
D. Virus  
E. Fungus

---

**74. Given that Sokka has jaundice as a symptom, which of the following signs could potentially be present?**

A. Yellowing of the eyes  
B. Dark Urine  
C. Yellowing of the skin  
D. A & C  
E. A, B, & C

---

**75. Jaundice is caused by a build up of which specific pigment in the blood?**

---

Furthermore, Katara further investigates Sokka’s disease and discovers that it is a specific type.

---

**76. Given that this **specific form** of the disease is the most common bloodborne infection in the U.S., what is it? Be specific.**
Sokka then asks Katara if there is a cure for this specific form of the disease.

77. What would Katara tell Sokka?
   A. Yes, there is a cure. I will get it for you once we get to Ba Sing Se.
   B. No. There is no cure for this specific form of the disease.

The next individual who experiences health difficulties is Aang. Aang has been experiencing non-stop flatulence after consuming milk. Katara immediately figures out what is wrong.

78. What is Katara’s diagnosis of Aang?

79. The cause of Aang’s condition is the inability of his body to digest __________.

Aang then asks Katara if there is a cure for his condition.

80. What would Katara tell Sokka?
   A. Yes, there is a cure. Once we get to Ba Sing Se I will find it for you.
   B. No, there is no cure unfortunately.

Lastly, Toph experiences some health difficulties too. Toph is experiencing severe nausea and vomiting, along with a fever and diarrhea. These signs seemed to general to Katara so she probed Toph a little bit more. Toph then exclaimed that her right, lower abdominal region was extremely painful. Katara then immediately began to suspect acute inflammation as a possible cause.

81. What specific entity in Toph’s digestive tract is likely inflamed?

82. Which organ of the digestive tract is this specific entity a part of?

83. What is the general name of Toph’s condition?

Toph then becomes worried and asks Katara about her treatment options. Katara then reassures and tells her not to panic and that this is easily treatable through surgery. However, time is limited and they need to find a surgeon immediately upon going to Ba Sing Se.

84. True/False: Peritonitis is a complication associated with prolonging Toph’s condition?
   A. True
   B. False

85. Peritonitis, in general, is an inflammation of the lining of the ____________.

END OF CASE STUDY # 1
CASE STUDY #2

Korra, Mako, Bolin, and Asami are a group of heros on their way to the government building of Republic City to stop the evil force called The Equalists, who seek to incite a revolution against the government of Republic City. Asami’s car is pretty fast, so there’s no worry that they will get there in time. Unfortunately for them, there are a few health issues to take care of. Fortunately for the group, Korra is quite experienced with healing and possesses considerable medical knowledge.

First off, Bolin used to be exposed to significant amounts of cigarette smoke when he was growing up on the streets of Republic City. Unfortunately, this may have taken a toll on his respiratory system, as evidenced by difficulties breathing, wheezing, and the use of accessory muscles of breathing to force air out of his lungs. Korra takes a note of this and suspects that Bolin’s alveoli have become enlarged, leading to damage of the alveolar walls.

86. What is Korra’s likely diagnosis of Bolin?

87. True/False: This disorder is characterized as a chronic obstructive pulmonary disorder.
   A. True
   B. False

88. What is the scientific term for wheezing?
   A. Pertussis
   B. Stoana
   C. Anthracosis
   D. Rhornchi
   E. None of the above

89. True/False: There is possibility that the walls of capillaries adjacent to these enlarged alveoli could become damaged as well.
   A. True
   B. False

Bolin begins to worry so he asks Korra about the prognosis of the disease.

90. What is Korra’s likely answer to Bolin’s question about the prognosis?
   A. It’s not looking too good in the long-run for you, Bolin.
   B. You’ll be just fine Bolin. Most people end up doing well.

91. Should Bolin worry about any changes to his respiratory physiology that could cause poor gas exchange?
   A. No, because levels of oxygen and carbon dioxide will remain under homeostatic control.
   B. No, because the disease does not affect blood chemistry.
   C. Yes, because there will be an unpreventable decrease in oxygen levels and increase in the acidity of the blood.
   D. Yes, because there will be an unpreventable decrease in oxygen levels and decrease in the acidity of the blood.
Next, Korra notices that whenever Mako coughs, he also coughs up a decent bit of phlegm and blood. This excessive amount of phlegm is uncharacteristic of normal respiratory physiology, so Korra wanted to further investigate. Conveniently, due to the high temperatures, Mako is also sweating. This makes it easier for Korra to perform a sweat test so that she can confirm her initial diagnosis.

92. What is Korra's initial diagnosis of Mako?

93. True/False: This disease is purely caused by an external factor and is not genetically passed on.
   A. True
   B. False

94. The sweat test should indicate elevated levels of ________ ions and _________ ions.
   A. Bicarbonate, Calcium
   B. Sodium, Bicarbonate
   C. Bicarbonate, Chloride
   D. Calcium, Chloride
   E. Sodium, Chloride

95. Which of the following is NOT typically a possible symptom associated with Mako's disease?
   A. Clubbing of the fingers
   B. Coughing up mucus
   C. Difficulty breathing
   D. Blood in the urine
   E. Shortness of breath

96. Is there a cure for Mako's disease?
   A. Yes
   B. No

Lastly, Asami is not feeling well as she has a fever and is experiencing lots of chills. Furthermore, she is also coughing and experiencing shortness of breath. She also has a feeling of her chest being heavier than normal when walking up stairs.

97. What is Korra's diagnosis of Asami?

98. Which specific aspect of Asami's respiratory system anatomy is directly affected by this disease?

99. The specific bacterium that causes this disease is ____________.

100. Which visual tool is initially and most commonly used to diagnose this disease when suspected?
   A. Chest CT Scan
   B. Chest X-Ray
   C. Chest MRI
   D. Chest Ultrasound
   E. Chest Laparoscopy

END OF CASE STUDY # 2
CASE STUDY #3

Ashwin, Surya, Peter, and Vinit are yet another group of friends (sorry if this friends group thing is getting old) that love the North Carolina Science Olympiad and everything that it does for students in K-12 education. One Saturday, the four of these friends are helping to run events at a local Science Olympiad tournament. All of a sudden, there are several medical issues that arise that the four friends are forced to assess and determine the causes of.

The first case involves Vinit helping a middle-aged woman who is complaining of a strange electrical sensation that runs down her spine and throughout her limbs. It is very uncomfortable and accompanied by a tingling sensation of her extremities. It is clear to Vinit that while the damage is neurological in nature, it is also a result of autoimmunity.

101. What is Vinit's diagnosis of the middle-aged woman?

102. In this disease, what is the primary autoimmune mechanism that affects the body?
   A. Presence of a tumor in the brain
   B. Damage to the myelin sheath of neurons in the central nervous system
   C. Clumping together of immune cells in the neuronal membranes
   D. A & B
   E. B & C

103. Which of the following is not a possible additional symptom that is possible with this disease?
   A. Double vision
   B. Muscle weakness
   C. Difficulty with sensation
   D. Lack of coordination
   E. All of the above are possible symptoms of this disease

The second case involves Ashwin dealing with a very troubling situation involving a man exhibiting severe flu-like symptoms with enlarged lymph nodes throughout the body. Furthermore, there are purple lesions on the man’s nose that are clearly evident of a form of cancer accompanying the main disease.

104. What is Ashwin’s diagnosis of the man?

105. What is the name of the virus that causes this disease?

106. What is the name of the cancer causing the purple lesions on the nose?
   A. Melanoma
   B. Fibrosarcoma
   C. Ewing's Sarcoma
   D. Kaposi's Sarcoma
   E. Synovial Sarcoma

107. True/False: It is possible to not have the disease even if the virus is in the body.
   A. True
   B. False
The third case involves Surya helping a woman out who is exhibiting a low tolerance of heat along with a very fast heartbeat. There is also a visible enlargement beneath the skin that is protruding outward at the base of her neck, which is due to an overactivity of a certain entity in the body.

108. What is Surya's diagnosis of the woman?

109. What is the organ responsible for the visible enlargement on the woman's neck?

110. What is the specific term for the visible enlargement on the woman's neck?
   A. Thyrotoxicosis
   B. Goiter
   C. Laryngeal Prominence
   D. Thymotoxication
   E. None of the above

111. This visible enlargement can also be due to a dietary deficiency in ____________.

The fourth and final case involves Peter aiding a middle-aged man who presents with general malaise and joint stiffness. His joints are also experiencing tenderness and warmth, especially in the joints of his fingers, knees, and toes. However, his spine and hip seem to be alright and not affected.

112. What is Peter's diagnosis of this middle-aged man?

113. Which of the following is a possible complication of this disease, after it has already begun?
   A. Spontaneous bone fusion in small joints
   B. Loss of cartilage in joints
   C. Tearing of ligaments in bones
   D. A & B
   E. A, B, & C

114. True/False: Men are affected by this disease more than women.
   A. True
   B. False

115. What is a key difference between the occurrence of the disease in adults versus in children.
   A. NSAIDS are not effective in treating adults with this disease while it is very effective for children.
   B. Complete remission of the disease occurs in approximately 75% of cases in children but not with adults.
   C. The disease is considered to be systemic only in adults, not children.
   D. Heredity only plays a role in the onset of the disease in children, but not adults.
   E. None of the above are key differences in the disease between adults and children.

END OF CASE STUDY # 3