ANATOMY & PHYSIOLOGY C

1. **DESCRIPTION:** Participants will be assessed on their understanding of the anatomy and physiology for the **respiratory, digestive and immune systems of the human body.**

   A TEAM OF UP TO: 2 **APPROXIMATE TIME: 50 minutes**

   CALCULATOR: Class II

2. **EVENT PARAMETERS:**
   a. Each team may bring writing utensils.
   b. Each team may bring two Class II calculators.
   c. Each team may bring one (1) 8.5" x 11" sheet of paper that may contain information on both sides in any form and from any source. The sheet of paper may be laminated or placed in a sheet protector to increase durability. Affixed labels, as well as multiple sheets of paper (whether in a single sheet protector or not) are prohibited.
3. **THE COMPETITION:** This Event may be administered as a written test or as a series of lab-practical stations which can include but are not limited to experiments, scientific apparatus, models, illustrations, specimens, data collection and analysis, and problems for students to solve. **Content topics will include the following:**
   a. RESPIRATORY SYSTEM:
      i. Understand the anatomy and function of the respiratory system at macroscopic and cellular levels
      ii. Mechanisms of breathing, including inspiratory and expiratory mechanics, pressure gradients, lung compliance, elastic recoil, and airway resistance
      iii. Compare and contrast the walls of the pharynx, larynx, trachea, bronchi, bronchioles, and alveoli
      iv. Quantitatively understand and be able to interpret measures and patterns of breathing, including lung volumes and capacities, spirometry, flow-volume loops, and differentiation of obstructive versus restrictive patterns
      v. Explain mechanisms of gas exchange and oxygen transport, including diffusion principles and oxygen-hemoglobin dissociation curves
      vi. Explain the effects of exercise and high altitude on the respiratory system
      vii. Understand the following respiratory disorders: asthma, chronic obstructive pulmonary disease (COPD), emphysema, cystic fibrosis, pneumonia, and sleep apnea

   State & National Level only
      viii. ***Regulation and control of respiration, including respiratory centers, chemoreceptors, blood chemistry, and respiratory rhythm***
      ix. ***Additional diseases/disorders: tuberculosis, pulmonary edema, pleurisy, pulmonary fibrosis, pneumoconiosis (limited to silicosis, coal worker's lung, asbestosis)***

   National Level Only
      x. ***Additional diseases/disorders: acute respiratory distress syndrome, infant respiratory distress syndrome, pulmonary hypoplasia, small cell lung cancer, and non-small cell lung cancer***
      xi. ***Prevention, diagnosis, and treatment for all diseases/disorders listed above***

   b. **DIGESTIVE SYSTEM:**
      i. Understand the anatomy and functions of the **alimentary tract and the spatial relationships between organs**
         (1) **Layers of the abdominal wall**
         (2) **Distinguish between intra-peritoneal organs and retro-peritoneal organs**
      ii. Understand the basic anatomy of the component parts of the alimentary canal and accessory organs of digestion (e.g., salivary glands, liver, gallbladder, pancreas)
      iii. Anatomy of the four layers of the wall of the alimentary canal
      iv. Compare and contrast the lining of the esophagus, stomach, small intestine, and large intestine
      v. Mechanisms of gastrointestinal motility, regulation of digestion by hormones and the enteric nervous system
      vi. Compare and contrast mechanical and chemical digestion
      vii. Understand the physiology of chemical digestion of proteins, fats, and carbohydrates
      viii. Understand physiology of nutrient, vitamin, mineral, and water absorption, including the role of fiber
      ix. Explain the effects of exercise and obesity on the digestive system

x. Understanding of digestive system diseases/disorders: gastroesophageal reflux disease (GERD), peptic ulcer disease, lactose intolerance, ulcerative colitis, Crohn's disease, celiac disease, appendicitis, and diverticular disease (limited to diverticulosis, complicated and uncomplicated diverticulitis, symptomatic uncomplicated diverticular disease, segmental colitis associated with diverticulosis, smoldering diverticulitis)

State & National Level only

xi. **Cellular-level organization and function of the liver (e.g., Kupffer cells) and pancreas, including roles in energy metabolism (e.g., glucose homeostasis) and cholesterol balance (e.g., HDL, LDL)**

xii. **Effects of metabolic syndrome and toxins (limited to acetaminophen, anabolic steroids, alcohol, heavy metals, bisphenols, and polychlorinated biphenyls) on the liver and pancreas**

xiii. **Role of intestinal microbes in digestion and defense**

xiv. **Additional diseases/disorders: pancreatitis, metabolic dysfunction-associated steatotic liver disease, cirrhosis, hepatitis, cancers (limited to colorectal, gastric, and hepatic)**

National Level Only

xv. **Additional diseases/disorders: motility disorders of the digestive system (limited to achalasia, Hirschsprung disease), cholecystitis and biliary system disorders (limited to choledocholithiasis, ascending cholangitis, Mirizzi syndrome, primary biliary cholangitis, primary sclerosing cholangitis, Gilbert syndrome, Crigler-Najjar syndrome), cancers (limited to esophageal, pancreatic and neuroendocrine)**

xvi. **Prevention, diagnosis, and treatment for all diseases/disorders listed above**

c. IMMUNE SYSTEM:

i. Anatomy and functions of the immune system (bone marrow, thymus, spleen, lymph nodes, skin)

ii. Anatomy and physiology of innate immune system (e.g., anatomical barriers, antimicrobial proteins, complement system, Toll-like receptors, inflammation, fever, and innate immune cells)

iii. Anatomy and physiology of adaptive immune system (e.g., B and T cells, antigen recognition, maturation, selection, tolerance, antigen presentation, activation, and memory)

iv. Physiology of the immune response, and integration of the innate and adaptive immune systems

v. Compare and contrast active and passive immunity, understand the role of immunization

vi. Compare and contrast the general structure as well as the general roles of the 5 human immunoglobulin classes (IgG, IgM, IgA, IgD, and IgE).

vii. Understanding of immune system diseases/disorders: acquired and genetic immunodeficiencies (limited to HIV/AIDS, common variable immunodeficiency, severe combined immunodeficiency), autoimmune diseases (limited to multiple sclerosis, rheumatoid arthritis, Hashimoto thyroiditis, Graves' Disease, Sjogren's syndrome), and type I-IV hypersensitivities (limited to asthma, anaphylaxis, urticaria, myasthenia gravis, Arthus reaction, serum sickness, contact dermatitis, celiac disease)

State & National Level Only

viii. **Immune signaling molecules and pathways (e.g., cytokines, interferons, JAK-STAT pathway, cGAS-STING pathway), understand the molecular structural variation in immunoglobulin constant regions, understand the detailed structure and function of immunoglobulins (including the IgG and IgA subclasses), and the roles of the immune molecules and pathways in all physiologic and pathologic processes listed in this section**

ix. **Types of organ transplantation (e.g., allograft and autograft), mechanisms of rejection (i.e., hyperacute, acute, chronic), prevention of rejection, and graft-versus-host disease**

x. **Additional diseases/disorders: Type I diabetes, systemic lupus erythematosus, dermatomyositis, scleroderma, psoriasis, and psoriatic arthritis, erythroblastosis fetalis, immunodeficiencies (limited to DiGeorge's syndrome, Bruton's agammaglobulinemia, Job's syndrome, Bloom's syndrome, Wiskott-Aldrich Syndrome, MHC class I and class II deficiency)**

National Level Only

xi. **Tumor immunology, including immune surveillance, tumor evasion, and cancer immunotherapies (therapeutic cancer vaccines, cytokine therapies, antibody therapies, CAR T-cell therapy)**
xii. **Compare and contrast vaccine routes and the role of vaccine adjuvants in common use**
xiii. **Suboptimal Antibodies: Understand immunological imprinting and antibody-dependent enhancement**
xiv. **Additional diseases/disorders: Leukemia (Acute lymphoblastic, acute myeloid, chronic lymphocytic, and chronic myeloid), severe congenital neutropenia, cyclic neutropenia, diseases caused by superantigens (limited to staph enterotoxin food poisoning and toxic shock syndrome)**
xv. **Prevention, diagnosis, and treatment for all diseases/disorders listed above**

4. **SCORING:**
   a. High Score wins.
   b. Preselected questions will be used to break ties.

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