MICROBE MISSION B

See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

1. **DESCRIPTION:** Teams will answer questions, solve problems, and analyze data pertaining to microbes.
   A TEAM OF UP TO: 2 **EYE PROTECTION:** C
   CALCULATOR: Class II **APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:** For events with a lab practical portion, each student must wear goggles. Each team may bring one 8.5" X 11" sheet of paper, which may be in a sheet protector sealed by tape or laminated, that may contain information on both sides in any form and from any source without any annotations or labels affixed along with two stand-alone non-programmable, non-graphing calculators (Class II). Any measurements must be made to the precision of the device.

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. Participants may be asked to perform simple laboratory procedures such as taking measurements using a microscope or using probes to collect data (sufficient information will be provided at the station to do so). **Questions should emphasize process skills such as quantitative reasoning, making calculations, analyzing and interpreting experimental results, and drawing evidence-based conclusions.** The Event will cover the topics listed below without any overemphasis on any one particular topic. The list of topics and subtopics should be considered exhaustive.
   a. For each of the following topics, participants will be expected to use quantitative reasoning and computational skills, analyze and interpret experimental results, and draw evidence-based conclusions.
      i. Microscopy:
         (1) Identify and describe the parts/functions of bright-field light microscopes.
         (2) Compare and contrast light (i.e., bright-field, dark-field, and phase contrast) and electron microscopy (i.e., TEM and SEM) and be able to identify what type of microscope was used to take provided images.
         (3) Estimate the size of microbes using scale bars.
      ii. Structure and Morphology:
         (1) Describe the basic structure, composition, and function of components of a bacterial cell (i.e., membrane, cell wall, flagella, pilus, fimbria, nucleoid, cytoplasm).
         (2) Contrast Gram (+) and Gram (-) cells and explain the Gram stain procedure.
         (3) Identify bacterial cell shapes (i.e., vibrio, bacillus, coccus, spirochete).
         (4) Describe basic structural components of viruses and their functions.
         (5) State and Nationals only: Describe the structure and function of specialized organelles in bacteria and eukaryotic microbes (i.e., gas vesicles, endospores, contractile vacuoles, eyespots, carboxysomes).
         (6) State and Nationals only: Connect and explain how (1 & 5) are determined by the habitat and life strategy of microbes.
      iii. Culture and Growth:
         (1) Describe applications of different methods to culture bacteria (i.e., liquid vs. agar) and different media used to do this (i.e., selective vs. differential).
         (2) Interpret bacterial growth curves and discuss what is happening at each stage.
         (3) Use plate count data (i.e., CFUs) to calculate the number of cells in a culture.
         (4) Outline the steps of bacterial cell division (i.e., binary fission) and genome replication, including the function and properties of the origin of replication, DNA unwinding element, DnaA, and DNA polymerase.
         (5) Describe how sterilization and disinfection techniques (i.e., heat, ultraviolet radiation, filtration, and chemical) are able to compromise/eliminate microbes.
         (6) State and Nationals only: Understand the limitations of culture-based approaches to study microbes.

iv. Metabolism and Applications:
  (1) Describe microbial metabolic strategies based on carbon and energy sources.
  (2) Describe the primary inputs and outputs of major metabolic processes (i.e., fermentation, oxygenic photosynthesis, nitrogen fixation) and where they occur in the cell.
  (3) Describe the role of microbes in: fermentation in bread baking, soy sauce production, and sauerkraut production; photosynthesis in biofuel production; and nitrogen fixation in the rhizosphere. Connect these applications of microbes to the processes listed in (2).

v. **Evolution & Ecology**
  (1) **Discuss the endosymbiotic theory of organellar evolution.**
  (2) Describe common adaptations to extreme environmental conditions (i.e., temperature, salinity, pH).
  (3) Describe lytic and lysogenic viral life cycles using examples from the Microbes and Agents List.
  (4) **Outline the mechanisms of horizontal gene transfer (i.e., transduction, conjugation, and transformation) and explain the role of horizontal gene transfer and viral infection in microbial evolution.**
  (5) Identify and describe community interactions between microbes (i.e., cooperation/mutualism, commensalism, predation, parasitism).
  (6) State and Nationals only: **Describe applications and limitations of 16S amplicon sequencing, interpret data from 16S amplicon sequencing experiments (i.e., bacterial community composition, alpha diversity, beta diversity).**

b. Microbes and Agents List: **Participants will be expected to be able to describe the general characteristics (i.e., life cycle/replication strategy, genome structure, and morphology). For disease-causing agents, identify what disease they cause. Otherwise, understand their environmental function. Microbes not listed here may be included on the exam, but sufficient background information will be provided to answer questions.**
  i. Bacteria: *Escherichia coli, Rickettsia rickettsii, Mycobacterium leprae, Mycobacterium tuberculosis, Microcystis aeruginosa, Staphylococcus aureus, Helicobacter pylori*
  ii. Archaea: State and Nationals only: *Pyrococcus furiosus*
  iii. Eukaryotes: *Plasmodium falciparum, Saccharomyces cerevisiae, Nannochloropsis sp.*. State and Nationals only: *Paramecium sp.*
  iv. Viruses & other subcellular agents: Escherichia virus T4, Escherichia virus Lambda, Measles virus, Smallpox virus. State and Nationals only: SARS-CoV-2 virus, Human Immunodeficiency Virus, Major Prion Protein

4. **SCORING:**
  a. High score wins. Selected questions may be used as tiebreakers.
  b. Points will be awarded for quality and accuracy of answers, quality of supporting reasoning, and the use of proper scientific methods.

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries a variety of resources to purchase; other resources are on the Event Pages at soinc.org.