HEREDITY 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 classic and molecular genetics.

   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:**
   a. This Event will be administered as a written test which may be arranged in stations. **Questions will emphasize process skills such as quantitative reasoning, making calculations, analyzing and interpreting experimental results, and drawing evidence-based conclusions.** The Event will cover topics listed below without overemphasis on any one particular topic. The list of topics and subtopics should be considered exhaustive.
   b. 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. Mendelian Genetics:
         (1) Describe Mendel's Laws of Inheritance and their implications in heredity.
         (2) Use provided information to construct Punnett Squares of mono- and dihybrid crosses.
         (3) Predict genotypes and phenotypes of offspring and compute their likelihood based on Punnett Squares and experimental data using probability rules.
         (4) Evaluate pedigrees to predict modes of inheritance (i.e. dominant vs recessive traits and autosomal vs sex-linked traits) and construct pedigrees based on data from a case study.
         (5) State and Nationals only: Describe inheritance patterns which violate these laws (i.e. linkage, incomplete and codominance, complementation).
         (6) State and Nationals Only: Understand recessive epistasis and its implications in predicting phenotypic outcomes.
      ii. Mitosis and Meiosis
         (1) Understand, compare, and contrast the major stages and key structures in mitosis and meiosis
         (2) Understand the steps involved in human karyotype analysis and be able to interpret a karyotype
      iii. Molecular Biology of DNA
         (1) Be able to identify and explain the components of DNA (i.e. structure of the nucleotides and backbone), directionality of DNA (5' and 3' ends), and base pairing rules.
         (2) Understand the basic stages of DNA replication, with focus on DNA elongation and the processes that happen at the replication fork, including proofreading
         (3) Identify and understand the organization of DNA structure, such as plasmids, chromatin complexes, euchromatin and heterochromatin, and chromosomes.
         (4) Identify, explain, and classify DNA mutations on the DNA level (i.e. chromosomal rearrangements, insertions, deletions, and substitutions), and the potential impact of the resulting protein sequence (i.e. frameshift, silent, missense, and nonsense mutations).
         (5) State and Nationals only: Understand how UVA and UVB radiation damage DNA and the mechanism of nucleotide excision repair
      iv. Gene & Protein Relationship
         (1) Be able to explain the Central Dogma of Molecular Biology.
         (2) Transcription: Understand and explain initiation, elongation, and termination stages of transcription, the mechanism of RNA polymerase, how transcription is regulated by activators and repressors, and RNA maturation (splicing, capping, and polyadenylation).
         (3) Translation: Understand and explain the initiation, elongation and termination stages of translation, the mechanism of the ribosome, and the role mRNA and tRNA play in translation.
         (4) State and Nationals only: Understand the function and mechanism of the lac operon.

(5) **Nationals only: Understand the function and mechanism of the trp operon**

v. Population & Evolutionary Genetics
   (1) Understand the assumptions and calculations that underlie the **Hardy-Weinberg equilibrium** and the consequences of violating these assumptions. Be able to make these calculations given data.
   (2) Understand and explain the relationships between **changing allele frequencies and genetic drift, founder effects, and bottlenecks, migration, and relative fitness**.
   (3) **State and Nationals only: Explain how additive alleles generate continuous variation and estimate the number of genes contributing to a trait.**

vi. Technology and Techniques
   (1) Polymerase chain reaction (PCR): Describe what occurs and which molecules are involved in the denaturation, annealing, and extension steps of a PCR reaction; Explain the role of temperature in PCR; Identify the components needed for a PCR reaction; Identify experimental questions which could be addressed by PCR.
   (2) State and Nationals only: Sanger sequencing: Describe how the steps and components in Sanger sequencing differ from a standard PCR reaction; Identify experimental questions which could be addressed by Sanger sequencing.

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

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