# Harvard Undergraduate Science Olympiad India 2024
# Open Round
# Biology Syllabus: 9th - 10th

**Reference Material:** A Chi-square table, Chi-square formula, and logistic/exponential growth equations will be provided for reference (see last page).

**Potential Topics Covered on the Exam:**
Please note that not necessarily every topic on this list will be on the exam, don't get overwhelmed! The syllabus is meant to be exhaustive of all *potential* topics that could be on the exam. A great place to start is with making sure you're comfortable with the ICSE curriculum for 9th-10th grade. It will be a difficult exam, but remember you don't need to (nor do we expect you) get a 100%! Just do your best and show us all that you've learned!

*Good luck and happy studying!*

1. Biochemistry:
    a. Carbon and the Basis of Life
    b. Biological Macromolecules
2. Cell Biology:
    a. Tour of the Cell, Cell Membrane
    b. Cellular Respiration, fermentation, metabolic regulation
    c. Photosynthesis + plant connections
    d. Cell Cycle, Mitosis and Meiosis
    e. Cell Signaling
3. Genetics:
    a. Mendelian genetics
    b. Non-mendelian genetics, epistasis
    c. DNA Structure and Replication
    d. Transcription and Translation
    e. Regulation of Gene Expression
    f. Basic statistical tests
    g. Biotechnology
    h. Bacteria and Viruses
    i. Population genetics

4. Evolution:
   a. Natural selection
   b. Phylogeny and phylogenetic trees
5. Plant Anatomy & Physiology:
   a. Plant Structure and Growth
   b. Plant Reproduction
   c. Plant Hormones
   d. Plant Nutrition
6. Animal Anatomy & Physiology:
   a. Intro to animals & homeostasis
   b. Digestive system
   c. Animal Reproduction and Development
   d. Endocrine System
   e. Nervous system and neurons
   f. Immune System
   g. Cardiovascular System
   h. Respiratory System
   i. Excretory System and osmoregulation
   j. Sensory Systems, Musculoskeletal System
7. Biosystematics:
   a. Plant diversity and life cycles: vascular and nonvascular plants
   b. Animal diversity: vertebrates and invertebrates
   c. Fungal diversity and life cycles

**Advanced Topics:**
For those looking to further challenge themselves, below are more advanced topics that may also be tested. Students are encouraged to first learn the topics above before tackling these:
- Current events in biology including recent Nobel Prizes in Medicine and Physiology. Questions will be focused on application of knowledge from the content areas above to understand these topics. No specific information about current events will be tested (e.g. dates, names of scientists, etc.)

**Preparation for Exam:**
- **Campbell Biology**: Gold standard textbook for general biology knowledge. Most knowledge tested on the exam will be based on information from this textbook.
  - Each chapter also comes with a review summary and practice questions.

Note that reading Campbells is not the only way to prepare. Other possible methods to prepare include watching relevant biology videos on YouTube and doing practice problems (see below).

**Sample Questions:**
Example questions of comparable difficulty can be found on Biology Olympiad questions from past INBO and USABO exams:
- See past INBO and past USABO exams.

**Reference sheet**:

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

| Degree of Freedom | Probability of Exceeding the Critical Value | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0.99 | 0.95 | 0.90 | 0.75 | 0.50 | 0.25 | 0.10 | 0.05 | 0.01 |
| 1 | 0.000 | 0.004 | 0.016 | 0.102 | 0.455 | 1.32 | 2.71 | 3.84 | 6.63 |
| 2 | 0.020 | 0.103 | 0.211 | 0.575 | 1.386 | 2.77 | 4.61 | 5.99 | 9.21 |
| 3 | 0.115 | 0.352 | 0.584 | 1.212 | 2.366 | 4.11 | 6.25 | 7.81 | 11.34 |
| 4 | 0.297 | 0.711 | 1.064 | 1.923 | 3.357 | 5.39 | 7.78 | 9.49 | 13.28 |
| 5 | 0.554 | 1.145 | 1.610 | 2.675 | 4.351 | 6.63 | 9.24 | 11.07 | 15.09 |
| 6 | 0.872 | 1.635 | 2.204 | 3.455 | 5.348 | 7.84 | 10.64 | 12.59 | 16.81 |
| 7 | 1.239 | 2.167 | 2.833 | 4.255 | 6.346 | 9.04 | 12.02 | 14.07 | 18.48 |
| 8 | 1.647 | 2.733 | 3.490 | 5.071 | 7.344 | 10.22 | 13.36 | 15.51 | 20.09 |
| 9 | 2.088 | 3.325 | 4.168 | 5.899 | 8.343 | 11.39 | 14.68 | 16.92 | 21.67 |
| 10 | 2.558 | 3.940 | 4.865 | 6.737 | 9.342 | 12.55 | 15.99 | 18.31 | 23.21 |
| 11 | 3.053 | 4.575 | 5.578 | 7.584 | 10.341 | 13.70 | 17.28 | 19.68 | 24.72 |
| 12 | 3.571 | 5.226 | 6.304 | 8.438 | 11.340 | 14.85 | 18.55 | 21.03 | 26.22 |
| 13 | 4.107 | 5.892 | 7.042 | 9.299 | 12.340 | 15.98 | 19.81 | 22.36 | 27.69 |
| 14 | 4.660 | 6.571 | 7.790 | 10.165 | 13.339 | 17.12 | 21.06 | 23.68 | 29.14 |
| 15 | 5.229 | 7.261 | 8.547 | 11.037 | 14.339 | 18.25 | 22.31 | 25.00 | 30.58 |
| 16 | 5.812 | 7.962 | 9.312 | 11.912 | 15.338 | 19.37 | 23.54 | 26.30 | 32.00 |
| 17 | 6.408 | 8.672 | 10.085 | 12.792 | 16.338 | 20.49 | 24.77 | 27.59 | 33.41 |
| 18 | 7.015 | 9.390 | 10.865 | 13.675 | 17.338 | 21.60 | 25.99 | 28.87 | 34.80 |
| 19 | 7.633 | 10.117 | 11.651 | 14.562 | 18.338 | 22.72 | 27.20 | 30.14 | 36.19 |
| 20 | 8.260 | 10.851 | 12.443 | 15.452 | 19.337 | 23.83 | 28.41 | 31.41 | 37.57 |
| 22 | 9.542 | 12.338 | 14.041 | 17.240 | 21.337 | 26.04 | 30.81 | 33.92 | 40.29 |
| 24 | 10.856 | 13.848 | 15.659 | 19.037 | 23.337 | 28.24 | 33.20 | 36.42 | 42.98 |
| 26 | 12.198 | 15.379 | 17.292 | 20.843 | 25.336 | 30.43 | 35.56 | 38.89 | 45.64 |
| 28 | 13.565 | 16.928 | 18.939 | 22.657 | 27.336 | 32.62 | 37.92 | 41.34 | 48.28 |
| 30 | 14.953 | 18.493 | 20.599 | 24.478 | 29.336 | 34.80 | 40.26 | 43.77 | 50.89 |
| 40 | 22.164 | 26.509 | 29.051 | 33.660 | 39.335 | 45.62 | 51.80 | 55.76 | 63.69 |
| 50 | 27.707 | 34.764 | 37.689 | 42.942 | 49.335 | 56.33 | 63.17 | 67.50 | 76.15 |
| 60 | 37.485 | 43.188 | 46.459 | 52.294 | 59.335 | 66.98 | 74.40 | 79.08 | 88.38 |
| | Not Significant | | | | | | | Significant | |

$$\frac{dN}{dt} = \frac{rN(K - N)}{K} \qquad\qquad \frac{dN}{dt} = rN$$