Study Plan for NSF Senior Science Bee (SSC) (Grades 6 - 8)

Resource:

16 WEEKS
(Adapted from GLENCOE SCIENCE –Level Red, Green, and Blue)

The syllabus is divided into four sections

- LIFE SCIENCES
- EARTH SCIENCES
- PHYSICAL SCIENCES
- SCIENTIFIC INQUIRY

Refer to table at the end of the SSC syllabus for study plan.

LIFE SCIENCES

WEEK 1

a. Cell Biology:

- What are the main components and functions of animal and plant cells?
- How are proteins made?
- What are genes?
- Differentiate: Light and electron microscopes; Mitosis and Meiosis; Haploid and Diploid cells; DNA and RNA.

WEEK 2

b. Classification of Living organisms:
• How do viruses multiply and cause disease?
• Terms to understand: Kingdom, Phylum, Class, Order, Family, Genus, Species, origins of Life, Binomial nomenclature.

**c. Plants:**

• What are vascular tissues made up of?
• What are the main features of vascular and non-vascular plants?
• Seedless and seed plants?
• Know the difference: monocots and dicots.

**Leaf:**

• How is a leaf constructed?
• What are the light and dark reactions in photosynthesis?
• What are photoperiods?
• Terms to understand: Cellular respiration; plant tropisms and plant hormones.

**Life cycles:**

• Terms to understand: gametophyte and sporophyte stages.
• How do these pants reproduce - non-vascular seedless plants (moss), vascular seedless plants (ferns), and seed plants (gymnosperms and angiosperms)?
• How is seed dispersed?
• How does a seed develop?

**WEEK 3**

**d. Animals:**

**Bacteria and fungi:**

• What are the characteristics of bacteria, eubacteria and archaebacteria?
• How are bacteria beneficial and harmful?
• What are the main features of the 3 types of protists?
• Different types of fungi? How are fungi beneficial?
• What are lichens?

**Invertebrates:**
What are key features (and examples) of sponges, cnidarians, mollusks, echinoderms, arthropods, flatworms, roundworms and segmented worms?

Vertebrates:
- What are key features (and examples) of mammals, birds, amphibians, and reptiles, fish?
- What are bony, jawless and cartilaginous fish?
- What adaptations of birds are useful for flight?
- What are different types of feathers and their functions?
- Compare the features of monotremes, marsupials and placentals.

WEEK 4

e. Life Processes:

Skeletal and Integumentary systems:
- What are the key aspects of skeletal (including types of bones and joints), and muscular (including types of muscles) systems?
- What are the main layers and functions of skin (integumentary system)?

I. Digestive system:
- What happens in different organs of the digestive system?
- How are enzymes compartmentalized?
- Terms to understand: the food pyramid, different classes of nutrients.

II. Respiratory and Excretory systems:
- What happens in different organs of the respiratory and excretory systems?
- What are some common diseases that affect these systems?

III. Circulatory system:
- What are the functions of the heart, arteries, capillaries and veins?
- What is coronary, pulmonary and systemic blood circulation?
- What are the main components of blood?
- What are the blood groups?
- Measuring blood pressure.
- Discuss some common diseases.

IV. Immune system:
- What is the immune system?
- What is active and passive immunity?
- What is vaccination?
- Examples of infectious diseases caused by viruses, bacteria, protozoa and fungi.
- What is AIDS?

2016 © North South Foundation
V. Nervous system:
- What are the components of the nervous system?
- How many types of neurons are there?
- Know the difference: Central and peripheral nervous system.
- What are the main parts of the brain and their functions?
- Structure and function of eye and ear.

VI. Inheritance:
- What determines traits?
- What are dominant and recessive traits?
- How would you use Punnett squares?
- What are Sex-linked disorders?
- What is selective breeding?
- Terms to understand: Genetic engineering, gene therapy and mutations.

Behavior:
- Know the difference: innate behavior (reflexes, instinct) and learned behavior (imprinting, conditioning, insight).
- Terms to understand: social and territorial behavior; communication.

WEEK 5

VI. Ecosystems:

a. Basics:
- What are the key biotic and abiotic factors?
- What are key features of the 6 major biomes?
- In the Ocean ecosystems, what are plankton, nekton and bottom dwellers?
- How are animal and plant adaptations (with examples) useful for survival?
- Terms to understand: migration, camouflage, mimicry, hibernation and estivation.

b. Species interdependence:
- How do food chains and food webs operate?
- What are the roles of producers, consumers, decomposers, and energy pyramid?
- How may biodiversity be threatened?
- How is biodiversity being protected?
- Terms to understand: Population, community, habitat, carrying capacity, biotic potential, endangered species, threatened species, extinction, primary succession, and secondary succession.

c. Evolution:
- What is the theory of Darwin’s natural selection?
What is relative and absolute (radiometric) dating?
What are homologous and vestigial structures?
Know the difference: Gradualism vs. Punctuated equilibrium.
What clues do fossils provide?
How did primates and early humans evolve?

WEEK 6 and 7

EARTH SCIENCES

I. Geology:
   a. Landforms:
      • What are the major landforms?
      • What are the key features of the ocean floor?
      • Terms to understand: Plains, plateaus and mountains (folded, upwarped, fault-block).
   b. Plate tectonics:
      • What is the evidence for continental drift and seafloor spreading?
      • Terms to understand: Divergent, convergent and transform boundaries with features at these boundaries.
   c. Erosion:
      • What are the different agents and types of erosion?
      • How is soil formed? What are deflation, abrasion, sheet flow, rills and gullies?
      • Terms to understand: Mechanical and chemical weathering; glacial erosion and deposition.
   d. Rocks:
      • What is the rock cycle?
      • What are the properties of minerals (such as color, hardness, luster, streak, cleavage and fracture)?
      • What are Gems and Ores?
      • What are the soil types and horizons?
      • Differentiate: Intrusive and Extrusive Igneous rocks, Sedimentary (Detrital, Chemical and Organic) and Metamorphic (foliated or non-foliated) rocks.
   e. Fossils:
• What are different the types of fossils – mold, cast, imprint, amber?
• What are their uses?
• How do you determine relative versus absolute age?
• What is an Era?
• What are fossil fuels?
• What are examples of renewable energy sources?

WEEK 8

II. Earth and Space:

a. Spin:
• What are the consequences of Earth’s tilted axis?
• What are seasons, solstices and equinoxes?
• What causes day and night, seasons?
• What are the key features of the Moon (both surface and interior)?
• Terms to understand: Lunar phases, lunar eclipse, and solar eclipse.

b. Space probes:
• What is radiation from space?
• What is ISS, Hubble Space Telescope?
• How do we use rockets, satellites and probes, space shuttles and space stations?
• Know the difference: Reflecting telescope, refracting telescope and radio telescope.

c. Solar system:
• How did solar system originate?
• How many Sun’s layers are there?
• What are sunspots, prominences, flares and CMEs?
• What are the special features of inner and outer planets, and their moons?
• Know the difference: Sun-centered and Earth-centered models; asteroids and meteoroids, comets, Oort Clouds.

d. Stellar evolution:
• How do medium-sized and massive stars evolve?
• Understand Hertzsprung-Russell diagram?
• What are circumpolar constellations?
• Differentiate Red shift and Blue shift?
• Differentiate: Spiral, elliptical and irregular galaxies; absolute and apparent magnitude; light year and astronomical unit (AU).
• What is The Big Bang Theory?

III. Oceans
   a. Understand what ocean water contains.
   b. What is desalination?
   c. Recognize the different ocean currents – surface currents, the Gulf Stream, density currents, upwelling.
   d. Recognize key features of ocean waves and tides.
   e. Identify tidal range, tidal bore, spring tides, and neap tides.

WEEK 9

IV. Weather:
   a. Atmosphere:
      • What are the key features and temperature changes in the layers of Earth’s atmosphere?
      • What is relative humidity and dew point?
      • How do you classify clouds by shape and height in sky?
      • What are Weather Maps?
   b. Wind:
      • What are easterlies, westerlies, trade winds, and jet streams?
      • What is the Coriolis effect?
      • What are air masses and fronts (warm/cold/occluded/stationary)?
      • Know the difference: Sea breeze vs. Land breeze.
   c. Currents and climate:
      • What are climatic changes?
      • What are El Nino, La Nina and Global warming?
   d. Earthquakes:
      • How earthquakes form at faults?
      • What are focus, epicenter, P, S and surface waves of an earthquake?
      • How do you map the epicenter and Earth’s interior?
      • What is Liquefaction?
      • Know the difference: the Richter scale and Mercalli intensity scale.
   e. Volcanoes:
      • How may volcanoes form at divergent and convergent boundaries and at hotspots?
      • How can you differentiate types of volcanoes by lava content and shape?
f. Pressure:
- How do thunderstorms, hurricanes, tornados and blizzards form?
- What are high and low pressure centers?
- What are tornado watches and tornado warnings?

g. What are the water, carbon and nitrogen cycles?

h. Pollution:
- What are the main causes of soil, air and water pollution?
- How can water $\frac{1}{2}$ and soil be conserved?
- Terms to understand: ozone layer, smog, acid rain, Global $\frac{1}{2}$ warming.

i. Conservation:
- What are the 3 Rs of resource conservation?
- What are non-renewable $\frac{1}{2}$ and renewable energy sources?
- What are the main features of wind, water, geothermal, solar, and nuclear energy?

WEEK 10 and 11

a. States and transitions:
- What are the different states of matter?
- How do they transition? Do physical properties depend on size?
- How do you use physical properties to identify, separate and classify substances?
- How do physical properties (like viscosity, surface tension) change due to change of state?
- What are the effects of temperature and pressure on physical properties of matter at a macro- and a micro- (particle) level?
- Terms to understand: dissolution, vaporization, condensation, sublimation, deposition, and specific heat, different physical properties and units of measurements.
- Know the difference: elements, compounds and mixtures.

b. Reactions:
- How are physical and chemical changes in matter different?
- What are some common chemical reactions that you can observe in nature?
- Understand physical factors that affect chemical reactions.
- How can you identify chemical change(s) and differentiate it from physical change(s)?
- What are reversible and irreversible reactions?
- What happens during a chemical reaction?
- How do catalysts and inhibitors affect a chemical reaction?
- What is the role of energy in a chemical reaction?
- Understand chemical equation, reactants, products, activation energy, endothermic reaction, and exothermic reaction.
• What is balancing of a chemical equation?
• Why should a chemical equation be balanced?
• Understand law of conservation of mass in relation to physical or chemical change.
• Understand some chemical reactions that occur in everyday life.
• What are acids, bases, and neutralization?
• What is pH and what are indications of acidity?
• How do hydronium ions affect acidity?

c. The Periodic Table:
• What is a symbol and a formula?
• How are elements arranged in a periodic table?
• What are atoms and its constituents?
• Understand atomic number, atomic mass, and mass number.
• Understand electronic configuration.
• How do atomic and physical properties vary in a periodic table?
• Understand period, group, representative elements, transition elements, metals, nonmetals, metalloids, alkali metals, alkaline earth metals, carbon group semiconductor metals, Oxygen family, halogens, noble gases, lanthanides, and actinides.
• Understand the relation between electronic configuration and chemical reactivity?
• What is bond formation?
• Understand metallic bonds, ions, covalent bonds, single bond, double bond, and triple bond and how electrons are configured in these cases.
• What are polar and non-polar molecules?
• What are isotopes?

d. Atoms:
• Why is an atom the basic unit of matter?
• What are atoms made of?
• What experiments led scientists to the discovery of subatomic particles, especially electrons, protons and neutrons?
• Know the scientists: Dalton, Crookes, Thompson, Rutherford, and Bohr.
• What were the different models for the structure of the atom and how the current accepted model was derived?
• What do you know about the dual nature of electrons and how it changed the structure of the atom?
• What are alpha particles?
• What is meant by radioactive decay and how was it discovered?
• What is half-life?
• What are beta rays?
• What is carbon dating?
• How are radioactive isotopes made and used for human health? What are quarks?
WEEK 12

I. Force:
   a. Laws of motion:
      • What are distance, speed, velocity, and acceleration (with calculations and graph interpretations)?
      • What are the different types of forces involved in Newton’s laws of motion?
      • What are balanced forces, unbalanced forces and combination of forces (with problem-solving involving balance of forces)?
      • What is friction, inertia, action versus reaction, and momentum?
      • What is the law of conservation of momentum (with different types of calculations involving momentum)?

II. Work:
   • What are work and power and its relation to forces?
   • How is work and power measured (with problem-solving)?
   • What are different types of machines?
   • What is mechanical advantage and efficiency?
   • What is pressure?
   • Terms to Understand: simple machines - pulley, lever and inclined plane, mechanical advantage, efficiency, and balance of forces (with problem-solving); buoyancy - Archimedes’ and Pascal’s principles; density (with problem-solving).

WEEK 13

III. Energy:
   • Forms, conservation, and transformation:
      • How are energy and work related?
      • What are different forms of energy (potential, kinetic, thermal, electrical, magnetic, and chemical)?
      • What is the law of conservation of energy?
      • How may energy be transformed (graph and data interpretations)?
      • What are the different sources -- renewable and non-renewable -- of energy?
      • What are conduction, convection and radiation? How do you measure heat energy?

WEEK 14

a. Electricity:
   • What are electric charges?
   • How would you define electric field and electric force?
   • How is lightning caused?
   • What are electric current and its units?
How is electrical energy transferred to a circuit?
Terms to understand: induction, insulator, conductor, static charge, electric and discharge; Ohms law and the relation between current, resistance and voltage (including problem-solving).
Know the difference: series and parallel circuits.

b. Magnetism:
- What is magnetism?
- How are electricity and magnetism related?
- What is electromagneticism?
- What is magnetic domain and electromagnetic induction?
- What are magnetic declination and its relation to latitude and longitude?
- Terms to understand: electric generator, direct and alternating currents.
- What are the advantages of alternating current over direct current?
- What are transformers and superconductors?
- What are the applications of magnetism?

WEEK 15

a. Duality of matter:
- What are waves and its relationship to energy and matter?
- How is energy transferred in waves?
- Understand interaction of waves with particles.
- What is electromagnetic spectrum and how is energy distributed in it?
- How is light both a wave and a particle?
- How do you distinguish constructive and destructive interference?
- How does the eye perceive light?
- Know the difference: transverse waves, compressional waves and electromagnetic waves.
- Terms to understand: wavelength, amplitude, frequency, wave speed, crest, and trough (different wave properties); reflection, refraction, diffraction, and interference.

b. Sound:
- What type of waves are sound waves?
- How are sound waves produced and propagated?
- How does ear detect sound waves?
- Terms to understand: compression, rarefaction, loudness, pitch, intensity and reverberation.

WEEK 16

SCIENTIFIC ENQUIRY

2016 © North South Foundation
• Scientific Methods:

Theories and laws:
• How are knowledge, experiments and observations useful to explain the world around you?
• What are scientific theories, scientific laws and systems?
• What are different branches of Science?
• How do scientists use the scientific method to observe, understand and offer possible explanations for the world around us?

Elements and models:
• What do you understand by the different elements of the scientific method: observation, hypothesis, experiment, measure, analysis, inference, and communication?
• What are controlled experiments, dependent, independent variables and constants?
• What are different types of models (physical, computational, conceptual) and how are they useful in the scientific method?

Units and Measurements:
• What are SI units?
• Define some of the SI units used in measurement of quantities like length, mass, temperature, time, etc.
• Terms to understand: estimation, precision vs. accuracy, rounding, and significant digits (includes problem-solving).

Presentation:
• What are some visualization methods used to analyze and communicate results of scientific experiments?
• How do you make and interpret tables and graphs? What are the different Map projections and how do they compare?
# Study Plan

<table>
<thead>
<tr>
<th>Study Plan</th>
<th>Level Red</th>
<th>Level Green</th>
<th>Level Blue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1: Cell Biology</td>
<td>Unit 5: Chapter 16 and 20</td>
<td>Unit 3: Chapter 9,10,11 and 12</td>
<td></td>
</tr>
<tr>
<td>Week 2:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a)Classification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b)Plants</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 3: Animals</td>
<td>Unit 5: Chapter 17 and 18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 4: Life Processes</td>
<td>Unit 5: Chapter 19</td>
<td>Unit 4: Chapter 13, 14, 15 and 16</td>
<td>Unit 1: Chapter 2 and 3</td>
</tr>
<tr>
<td>Week 5: Ecosystems</td>
<td>Unit 6: Chapter 21</td>
<td>Unit 5 Chapter 18</td>
<td>Unit 2: Chapter 4,5 and 6</td>
</tr>
<tr>
<td>Week 6 and 7: Geology</td>
<td>Unit 3: Chapter 9,10 and 11</td>
<td>Unit 1: Chapter 2 and 3</td>
<td>Unit 3: Chapter 7,8,9 and 10</td>
</tr>
<tr>
<td>Week 8: Earth and Space</td>
<td>Unit 4: Chapter 14 and 15</td>
<td>Unit 2: Chapter 7</td>
<td>Unit 4: Chapter 11,12 and 13</td>
</tr>
<tr>
<td>Week 9:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a)Oceans</td>
<td>Unit 3: Chapter 13</td>
<td>Unit 2: Chapter 4,5 and 6</td>
<td>Unit 2: Chapter 7,22 and 23</td>
</tr>
<tr>
<td>b)Weather</td>
<td>Unit 3: Chapter 12</td>
<td>Unit 5: Chapter 19</td>
<td></td>
</tr>
<tr>
<td>Unit 6: Chapter 22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 10 and 11: Matter</td>
<td>Unit 1: Chapter 3 and 4</td>
<td>Unit 6: Chapter 20, 21 and 22</td>
<td>Unit 5: Chapter 14, 15,16 and 17</td>
</tr>
<tr>
<td>Week 12: Forces</td>
<td>Unit 2: Chapter 5</td>
<td>Unit 6: Chapter 23</td>
<td>Unit 6: Chapter 18,19 and 20</td>
</tr>
<tr>
<td>Week 13: Energy</td>
<td>Unit 2: Chapter 6</td>
<td>Unit 6: Chapter 24</td>
<td>Unit 6: Chapter 21</td>
</tr>
<tr>
<td>Week 14: Electricity and Magnetism</td>
<td>Unit 2: Chapter 7</td>
<td></td>
<td>Unit 7: Chapter 22 and 23</td>
</tr>
<tr>
<td>Week 15: Wave and Sound</td>
<td>Unit 2: Chapter 8</td>
<td></td>
<td>Unit 7: Chapter 24</td>
</tr>
<tr>
<td>Week 16: Scientific Enquiry</td>
<td>Unit 1: Chapter 1 and 2</td>
<td>Unit 1: Chapter 1</td>
<td>Unit 1: Chapter 1</td>
</tr>
</tbody>
</table>

(Adapted from GLENCOE SCIENCE –Level Red, Green, and Blue)