

**Fig. 1.** Universal phylogenetic tree based on SSU rRNA sequences. Sixty-four rRNA sequences representative of all known phylogenetic domains were aligned, and a tree was produced using FASTDNAML (43, 52). That tree was modified, resulting in the composite one shown, by trimming lineages and adjusting branch points to incorporate results of other analyses. The scale bar corresponds to 0.1 changes per nucleotide. ([http://cas.bellarmine.edu/tietjen/RootWeb/a\\_molecular\\_view\\_of\\_microbial\\_di.htm](http://cas.bellarmine.edu/tietjen/RootWeb/a_molecular_view_of_microbial_di.htm) 4/27/10)

# SUMMER STUDY GUIDE

for

## SL IB - BIOLOGY

2011/12

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## HOW TO USE THIS STUDY PACKET:

In this study guide I listed the major IB objectives, that should have been covered during 9<sup>th</sup> grade biology (or 10<sup>th</sup> grade if you transferred from another school). The IB organization has identified command verbs such as, 'state', 'explain', 'draw',.... The command verbs help you identify what it is you need to be able to know or do. I have included a list of these command verbs, together with a description. It is useful to familiarize yourself with these command verbs, since we will be using them throughout the year for tests and assignments.

Some of the objectives are stated such, that they already include the answer. For example, '*Sate that tumours (cancers) are the result of uncontrolled cell division and that these can occur in any organ or tissue*'. When you come across a sentence like that do not just memorise it, but read and study related background information to make sure you know all the details behind it. Sometimes, I added some ideas on what to look up. A safe bet is always a biology textbook. In this example you would read up on cell division and cell differentiation. All biology textbooks will discuss cancer as an example of uncontrolled cell division. I have included in this study guide a resource for textbook access.

In some cases where I ask you to define a term, I added the definition in order to make sure you have the correct one. Again, do not just memorize the definition. You need to know and be able to apply related concepts and therefore need to read and study the background information.

A famous saying is., 'The obstacle to discovery is the illusion of knowledge'. What is meant by that is, sometimes a topic or phrase is familiar to you and everything makes sense to you while reading about it. Recognition, familiarity or the ability to follow an explanation does not automatically mean, that you understand the material enough to explain it to someone else or apply it to new situations. You might explain a topic to your parent, siblings, or friends after completing it. Hopefully, they will ask you questions and your ability to be able to answer their questions will give you further feed back in how solid your understanding is.

## RESOURCES:

I have provided an online link for the 9<sup>th</sup> grade biology textbook. You can also use online tutorials and animations. As usual, a word of caution when using online information. Identify sites that belong to accredited universities or textbook companies. A site, that is geared towards the IB curriculum is <http://click4biology.info/index.htm>, however, I hesitate to recommend this site. The site is the cliff note version of the IB curriculum, and I am afraid you will just copy the information without reading a more detailed description. Use it as a guide, but not as your sole source of information.

## WHAT TO EXPECT IN THE FALL:

We will have days for review and Q&A, and you will get some additional time to study corrected material or points that needed clarification. You will take a test, that will count towards your first semester grade. You can expect multiple choice and short answer questions.

**COMMAND VERBS****Objective 1**

<i>Define</i>	give the precise meaning of a word or phrase or physical quantity
<i>Draw</i>	represent by means of pencil lines
<i>Label</i>	add labels to a diagram
<i>List</i>	give a sequence of names or other brief answers with no explanation
<i>Measure</i>	find a value for a quantity
<i>State</i>	give a specific name, value or other brief answer without explanation or calculation

**Objective 2**

<i>Annotate</i>	add brief notes to a diagram or graph
<i>Apply</i>	use an idea, equation, principle, theory or law in a new situation
<i>Calculate</i>	find a numerical answer showing the relevant stages in the working (unless instructed not to do so)
<i>Describe</i>	give a detailed account
<i>Distinguish</i>	give the differences between two or more different items
<i>Estimate</i>	find an approximate value for an unknown quantity
<i>Identify</i>	find an answer from a given number of possibilities
<i>Outline</i>	give a brief account or summary

**Objective 3**

<i>Analyze</i>	interpret data to reach conclusions
<i>Comment</i>	give a judgment based on a given statement or result of a calculation
<i>Compare</i>	give an account of similarities and differences between two (or more) items, referring to both (all) of them throughout
<i>Construct</i>	represent or develop in graphical form
<i>Deduce</i>	reach a conclusion from the information given
<i>Derive</i>	manipulate a mathematical relationship(s) to give a new equation or relationship
<i>Design</i>	produce a plan, simulation or model
<i>Determine</i>	find the only possible answer
<i>Discuss</i>	give an account including, where possible, a range of arguments for and against the relative importance of various factors, or comparisons of alternative hypotheses
<i>Evaluate</i>	assess the implications and limitations
<i>Explain</i>	give a detailed account of causes, reasons or mechanisms
<i>Predict</i>	give an expected result
<i>Show</i>	give the steps in a calculation or derivation
<i>Sketch</i>	represent by means of a graph showing a line and labeled but unscaled axes but with important features (for example, intercept) clearly indicated
<i>Solve</i>	obtain an answer using algebraic and/or numerical methods
<i>Suggest</i>	propose a hypothesis or other possible answer

**Biology text book on-line access:**

Go to: <http://my.hrw.com>,  
**Username:** generic12,  
**Password:** x2e6

**Topic 1: STATISTICAL ANALYSIS****1. Calculate the mean (average) of a set of values.**

*You have to be able to calculate the average of a set of given measurements. Remember you can only average values from the same trial. See example below for an experiment measuring the height of three bean plants grown at 10°C and three grown at 20°C and three grown at 30°C. Plants were measured once a week for three weeks.*

Table 1: BEAN HEIGHTS DEPENDENT ON TEMPERATURE AND TIME

Temp. (°C)	Height (+/- 1 cm) Week 1			Height (+/- 1 cm) Week 2			Height (+/- 1 cm) Week 3		
	Bean 1	Bean 2	Bean 3	Bean 1	Bean 2	Bean 3	Bean 1	Bean 2	Bean 3
10	10	11	10	12	11	13	12	11	15
20	15	15	16	20	22	25	24	30	29
30	8	10	6	10	11	9	12	11	12

*Correct calculation on mean: Week 1, 10°C:  $(10\text{cm} + 11\text{cm} + 10\text{cm}) / 3$*

*Incorrect would be to average all heights for bean 1, week 1, for the different temperatures  $[(10\text{cm} + 15\text{cm} + 8\text{cm}) / 3]$*

*Incorrect would be to average all heights for one temperature (i.e. 10°C) for all three weeks  $[(10\text{cm} + 11\text{cm} + 10\text{cm} + 12\text{cm} + 11\text{cm} + 13\text{cm} + 12\text{cm} + 11\text{cm} + 15\text{cm}) / 9]$*

**Topic 2: CELLS****2. Outline the cell theory.**

Include the following:

- Living organisms are composed of cells.
- Cells are the smallest unit of life.
- Cells come from pre-existing cells.
- Cells are the unit of structure and function.

*Do not just memorise the concepts above, but be able to explain each point thoroughly with example.*

**3. Discuss the evidence for the cell theory.**

*You might want to find examples and experiments that let to each point of the cell theory listed above.*

**4. State that unicellular organisms carry out all the functions of life.**

Include: metabolism, response, homeostasis, growth, reproduction, and nutrition.

*Again make sure you understand how the processes above are functions of life and how one cell can carry out the processes. Make sure you understand each process with example.*

**5. Compare the relative sizes of molecules, cell membrane thickness, viruses, bacteria, organelles, and cells, using the appropriate SI unit.**

*Appreciation of relative size is required, such as molecules (1 nm), thickness of membranes (10 nm), viruses (100 nm), bacteria (1  $\mu\text{m}$ ), organelles (up to 10  $\mu\text{m}$ ), most cells (up to 100  $\mu\text{m}$ ), [Distinguish between bacteria cells and eukaryotic cells. Are all cells in your body the same size? What is the range in cell-size?] The three-dimensional nature/shape of cells should be emphasised.*

*On-line resource: Power of ten: <http://www.powersof10.com/>, <http://micro.magnet.fsu.edu/primer/java/scienceopticsa/powersof10/> and University of Utah, Learn Genetics: <http://learn.genetics.utah.edu/content/begin/cells/scale/>.*

**6. Draw and label a diagram of the ultrastructure of a liver cell as an example of an animal cell.**

Include but do not limit yourself to, plasma (cell) membrane, cytoplasm, free ribosomes, rough endoplasmic reticulum (rER), lysosome, Golgi apparatus, Mitochondrion, and nucleus

*Use smooth pencil lines, ruled label lines, labels parallel to top of page, label lines do not cross*

**7. Annotate the diagram drawn for step 6 with the functions of each named structure.**

**8. State three differences between plant and animal cells.**

**9. Outline the stages in the cell cycle, including interphase ( $G_1$ , S,  $G_2$ ), mitosis and cytokinesis.**

**10. State that tumours (cancers) are the result of uncontrolled cell division and that these can occur in any organ or tissue.**

*You might want to discuss this further: How does an organism grow? Compare cell division (duplication) and cell differentiation. Describe how cell division and differentiation work together to form tissues, organs and result in the overall growth and development of a multicellular organism. How then can uncontrolled cell division cause a disease. How do organisms ultimately die of cancer? Research a few cancers. The most investigated cancers are leukemias, colon cancer, and breast cancer.*

**11. State that interphase is an active period in the life of a cell, when many metabolic reactions occur, including DNA replication, protein synthesis, and an increase in the number of mitochondria and/or chloroplasts.**

*Read up of what all is going on inside the cell during interphase. Are the processes the same for all different cells in your body (liver cell vs. nerve cell vs. skin cell vs. cell of the small intestines)?*

**12. Draw and label a chromosome.**

**13. State what each chromatid of a chromosome represent.**

**14. Explain the need to copy DNA prior to cell division.**

**15. Describe and draw (with labels) the events that occur in the four phases of mitosis (prophase, metaphase, anaphase and telophase).**

Include: supercoiling of chromosomes, attachment of spindle microtubules to centromeres, splitting of centromeres, movement of sister chromosomes to opposite poles, and breakage and re-formation of nuclear membranes.

*Textbooks vary in the use of the terms chromosome and chromatid. In this course, the two DNA molecules formed by DNA replication are considered to be sister chromatids until the splitting of the centromere at the start of anaphase; after this, they are individual chromosomes. The terms centrosome and kinetochore are not expected.*

**16. Explain how mitosis produces two genetically identical nuclei.**

**17. State that growth, embryonic development, tissue repair and asexual reproduction involve mitosis.**

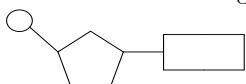
*Explain for each process how mitosis is involved or how mitosis accomplishes embryonic development or growth?*

**Topic 3: THE CHEMISTRY OF LIFE**

**18. State that the most frequently occurring chemical elements in living things are carbon, hydrogen, oxygen and nitrogen.**

**19. Outline DNA nucleotide structure in terms of sugar (deoxyribose), base and phosphate.**

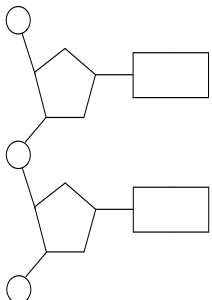
*Chemical formulas and the purine/pyrimidine subdivision are not required. Simple shapes can be used to represent the component parts. Only the relative positions are required, see example. Outlining means, that simply drawing a nucleotide is not enough. You need to label the drawing and provide a written outline explaining how the three molecules form the nucleotide. How many different nucleotides does a cell use and how do they differ?*



**20. State the names of the four bases in DNA.**

**21. Outline how DNA nucleotides are linked together by covalent bonds into a single strand.**

*Only the relative positions are required. Again you need to label each drawing and provide a written description. What parts of the nucleotide are involved in covalent bond formation.*



**22.Explain how a DNA double helix is formed using complementary base pairing and hydrogen bonds.**

*Again provide a labeled drawing with written description. Make sure you also label the phospho-sugar backbone. Explain complementary base pairing.*

**23. Compare the structure of RNA and DNA.**

*Limit this to the names of sugars, bases and the number of strands.*

**24.Outline DNA transcription in terms of the formation of an RNA strand complementary to the DNA strand by RNA polymerase.**

**25.Describe the genetic code in terms of codons composed of triplets of bases.**

*Stress in your description the importance of the base pair rule.*

**26. Explain what is meant by ‘universal genetic code’.**

**27.Explain the process of translation, leading to polypeptide (protein) formation.**

Include the roles of messenger RNA (mRNA), transfer RNA (tRNA), codons, anticodons, ribosomes and amino acids.

**28. Discuss the relationship between one gene and one polypeptide.**

*Keep in mind, that originally it was assumed that one gene would invariably code for one polypeptide, but many exceptions have been discovered.*

**Topic 4: GENETICS**

**29.Define: GENE, ALLELE, AND GENOME.**

*Gene: a heritable factor that controls a specific characteristic. (The differences between structural genes, regulator genes and genes coding for tRNA and rRNA are not expected at SL).*

*Allele: one specific form of a gene, differing from other alleles by one or a few-bases only and occupying the same gene locus as other alleles of the gene. Do not just memorise this, I know from experience, that allele is a difficult concept for students to comprehend and explain. Make sure you can provide examples and apply the concept.*

*Genome: the whole of the genetic information of an organism.*

**30.State that meiosis is a reduction division of diploid nuclei to form a haploid nuclei.**

**31.Define HOMOLOGOUS CHROMOSOMES.**

*Again provide an example to clarify an abstract definition, so you really understand the concept and not just memorize a definition.*

**32. Outline the process of meiosis, including pairing of homologous chromosomes and crossing over, followed by two divisions, which results in four haploid cells.**

*Limit crossing over to the exchange of genetic material between non-sister chromatids during prophase I. Names of the stages are required.*

**33. Define GENOTYPE, PHENOTYPE, DOMINANT ALLELE, RECESSIVE ALLELE, CODOMINANT ALLELES, LOCUS, HOMOZYGOUS, HETEROZYGOUS, CARRIER TEST CROSS.**

*Genotype: the alleles of an organism.*

*Phenotype: the characteristics of an organism.*

*Dominant allele: an allele that has the same effect on the phenotype whether it is present in the homozygous or heterozygous state.*

*Recessive allele: an allele that only has an effect on the phenotype when present in the homozygous state.*

*Codominant alleles: pairs of alleles that both affect the phenotype when present in a heterozygote. (The terms incomplete and partial dominance are no longer used.)*

*Locus: the particular position on homologous chromosomes of a gene.*

*Homozygous: having two identical alleles of a gene.*

*Heterozygous: having two different alleles of a gene.*

*Carrier: an individual that has one copy of a recessive allele that causes a genetic disease in individuals that are homozygous for this allele.*

*Test cross: testing a suspected heterozygote by crossing it with a known homozygous recessive. (The term backcross is no longer used.)*

**34. Determine the genotypes and phenotypes of the offspring of a monohybrid cross using a Punnett grid.**

*The grid should be labelled to include parental genotypes, gametes, and both offspring genotype and phenotype.*

**Topic 5 and Option G: ECOLOGY**

**35. Define SPECIES, HABITAT, POPULATION, COMMUNITY, ECOSYSTEM, ECOLOGY.**

*Species: a group of organisms that can interbreed and produce fertile offspring.*

*Habitat: the environment in which a species normally lives or the location of a living organism.*

*Population: a group of organisms of the same species who live in the same area at the same time.*

*Community: a group of populations living and interacting with each other in an area.*

*Ecosystem: a community and its abiotic environment.*

*Ecology: the study of relationships between living organisms and between organisms and their environment.*

**36. Distinguish between AUTOTROPH and HETEROTROPH.**

*Autotroph: an organism that synthesises its organic molecules from simple inorganic substances.*

*Heterotroph: an organism that obtains organic molecules from other organisms.*

**37.Distinguish between CONSUMERS, DETRITIVORES and SAPROTROPHS.**

*Consumer: an organism that ingests other organic matter that is living or recently killed.*

*Detritivore: an organism that ingests dead organic matter.*

*Saprotroph: an organism that lives on or in dead organic matter, secreting digestive enzymes into it and absorbing the products of digestion.*

**38.Describe what is meant by a food chain, giving three examples, each with at least three linkages (four organisms).**

*Only real examples should be used from natural ecosystems.  $A \rightarrow B$  indicates that  $A$  is being “eaten” by  $B$  (that is, the arrow indicates the direction of energy flow). Each food chain should include a producer and consumers, **but not decomposers**. Named organisms at either species or genus level should be used. Common species names can be used instead of binomial names. General names such as “tree” or “fish” should not be used.*

**39.Describe what is meant by a food web.**

**40.Define trophic level.**

**41. Deduce the trophic level of organisms in a food chain and a food web.**

*You should be able to place an organism at the level of producer, primary consumer, secondary consumer, and so on, as the terms herbivore and carnivore are not always applicable.*

**42.Construct a food web containing up to 10 organisms, using appropriate information.**

**43.State that light is the initial energy source for almost all communities.**

*No reference to communities where food chains start with chemical energy is required.*

**44. Explain the energy flow in a food chain.**

*Energy losses between trophic levels include material not consumed or material not assimilated, and heat loss through cell respiration.*

**45. State that energy transformations are never 100% efficient.**

**46.Explain reasons for the shape of pyramids of energy.**

**47. Explain that energy enters and leaves ecosystems, but nutrients must be recycled.**

**48. Explain how saprotrophic bacteria and fungi (decomposers) recycle nutrients.**

**49. Draw and label a diagram of the carbon cycle to show the processes involved.**

*The details of the carbon cycle should include the interaction of living organisms and the biosphere through the processes of photosynthesis, cell respiration, fossilization and combustion. Recall of specific quantitative data is not required.*

**50. Outline the factors that affect the distribution of plant species, including temperature, water, light, soil pH, -salinity mineral nutrients.**

**51. Explain the factors that affect the distribution of animal species, including temperature, water, breeding sites, food supply territory.**

*For both, 50 and 51 read up and be able to explain why or how these factors determine the distribution of plants and animals.*

**52. Distinguish between biome and biosphere.**

**53. Explain how rainfall and temperature affect the distribution of biomes.**

**54. Outline the characteristics of six major biomes.**

*Examples of major biomes could include:*

- *desert*
- *grassland,*
- *shrubland (chaparral, matorral, maquis and garigue, dry heathlands, fynbos),*
- *temperate deciduous forest*
- *tropical rainforest*
- *tundra.*

*The description should be limited to temperature, moisture and characteristics of vegetation.*

### **Topic 5 and Option D: EVOLUTION**

**55. Define evolution.**

*Evolution is the cumulative change in the heritable characteristics of a population. It is a (and can be measured by a) change in allele frequency in population over time. If we accept not only that species can evolve, but also that new species arise by evolution from pre-existing ones, then the whole of life can be seen as unified by its common origins.*

**56. Outline the evidence for evolution provided by the fossil record, selective breeding of domesticated animals and homologous structures.**

**57. State that populations tend to produce more offspring than the environment can support.**

**58. Explain that the consequence of the potential overproduction of offspring is a struggle for survival.**

**59. State that the members of a species show variation.**

**60. Explain how sexual reproduction promotes variation in a species.**

**61. Explain how natural selection leads to evolution.**

*Use terms such as, inheritability of characteristics, limited resources or selection pressure, overproduction, adaptation, fitness, allele (frequency), generations, survival, reproduction, and variation. Avoid phrases such as 'in order to...'; or 'they had to adapt...':*

**62. Distinguish between adaptation and fitness.**

*Be careful, an individual cannot adapt but populations can.*

**63. Explain two examples of evolution in response to environmental change; one must be antibiotic resistance in bacteria.**

*Other examples could include: the changes in size and shape of the beaks of Galapagos finches; pesticide resistance, industrial melanism or heavy-metal tolerance in plants.*

**64. Outline the binomial system of nomenclature.**

**65. List seven levels in the hierarchy of taxa - using an example from two different kingdoms for each level.**

*Kingdom, a group of related phyla*

*Phylum, a group of related classes*

*Class, a group of related orders*

*Order, a group of related families*

*Family, a group of related genera*

*Genus, a group of related species*

*Species*