



## Theoretical Content for CBO/IBO:

NOTE: content outlined below is for use in the CBO and IBO (taken directly from the IBO guide).

### I Cell biology :

#### Structure and function of cells

- \* Chemical components
  - Monosaccharides; disaccharides; polysaccharides
  - Lipids
  - Proteins: amino acids, three letter symbol; structure of proteins;
    - . chemical classification of proteins: simple proteins and conjugated proteins
    - . functional classification of proteins: structural proteins and enzymes
  - Enzymes
    - . Chemical structure: apoenzyme and coenzyme
    - . Model for enzyme action: enzyme binds with substrate
    - . Denaturation
    - . Nomenclature
  - Nucleic Acids : DNA, RNA
  - Other important compounds
    - . ADP and ATP
    - . NAD<sup>+</sup> and NADH
    - . NADP<sup>+</sup> and NADPH
- \* Organelles
  - nucleus - nuclear envelope
    - (nucleohyaloplasm)
    - chromosomes
    - nucleoli
  - cytoplasm - cell membrane
    - hyaloplasm
    - mitochondria
    - endoplasmatic reticulum
    - ribosomes
    - Golgi apparatus
    - lysosomes
    - vacuole membrane
    - proplastides
    - plastides . chloroplasts
      - . chromoplasts
      - . leucoplasts
  - (e.g. amyloplasts)
  - Plant cells are surrounded with a cell wall
- \* Cell metabolism
  - Breakdown of carbohydrates
    - . Anaerobic break down (anaerobic respiration) of glucose: glycolysis
    - . Aerobic break down (aerobic respiration) of glucose: glycolysis
  - citric acid cycle
  - oxidative phosphorylation
  - Dissimilation of fats and proteins
  - Assimilation
    - . Photosynthesis

- . Light reaction
- . Dark reaction (Calvin cycle)
- \* Protein synthesis
  - Transcription
  - Translation
  - Genetic code
- \* Transport through membranes
  - Diffusion
  - Osmosis, plasmolysis
  - Active transport
- \* Mitosis and meiosis
  - Cell cycle: interphase (replication) and mitosis (prophase - metaphase - anaphase - telophase)
  - Chromatids, equatorial plate, haploid and diploid, genome, somatic and generative cells, gamete, crossing over
  - Meiosis I and meiosis II.

### **Microbiology**

- \* Prokaryotic cell organization
- \* Morphology
- \* Phototrophy and chemotrophy

### **Biotechnology**

- \* Fermentation
- \* Genetic manipulation of organisms

## **II Plant anatomy and physiology**

(with emphasis on seed plants)

Structure and function of tissues and organs involved in:

- \* Photosynthesis, transpiration and gas exchange
  - Leaf : structure; function stomata
- \* Transport of water, minerals and assimilates
  - Root : structure (endodermis)
  - Stem : structure (vascular bundles)
- \* Growth and development
  - Apical meristem and cambium
  - Germination
- \* Reproduction (ferns and mosses included)
  - Asexual reproduction (clone forming)
  - Sexual reproduction
- . Structure of flowers
- . Pollination
- . Double fertilization
- Alternation of generation in seed plants, ferns and mosses

## **III Animal anatomy and physiology**

(with emphasis on vertebrates and especially man)

Structure and function of organs and tissues involved in

- \* Digestion and nutrition
  - Digestive tract (including liver, gall bladder and pancreas)
  - Mechanical and chemical breakdown of food
  - Absorption
  - Food components (water, minerals, vitamins, proteins, carbohydrates and fats)
- \* Respiration
  - Breathing mechanism
  - Gas exchange
  - Respiratory organs
- \* Circulation

- Blood : blood plasma, red blood cells, white blood cells, blood platelets
- Blood circulation : arteries, capillaries, veins, heart
- Lymphatic system : tissue fluid, lymph
- \* Excretion
- Structure of the renal system
- Urine production
- \* Regulation (neural and hormonal)
- Nervous system : peripheral nervous system, central nervous system (spinal cord and brain), autonomic nervous system (sympathetic and parasympathetic), reflexes, sense organs (eyes and ears)
- Endocrine system : pituitary gland, thyroid gland, islets of Langerhans, adrenal medulla, adrenal cortex, ovaries and testes
- \* Reproduction and development
- Structure and function of male and female reproductive systems
- Ovulation and menstrual cycle
- Fertilization
- Formation of ectoderm, mesoderm, endoderm
- Embryonic membranes
- \* Immunity
- Antigens, antibodies

#### **IV Ethology**

- \* Methodology of Ethology
- \* Innate and Learned Behavior
- \* Communication and Social Organization
- \* Foraging Behavior
- \* Defensive Behavior
- \* Mating systems and Parental care
- \* Biorhythms

#### **V Genetics and Evolution**

- \* Variation : mutation and modification
- \* Mendelian inheritance
- Monohybrid cross
- Dihybrid cross
- Polyhybrid cross
- \* Multiple allelism, recombination, sex linkage
- \* Hardy-Weinberg principle
- \* Mechanism of evolution
- Mutation
- Natural selection
- Reproductive isolation
- Adaptation
- Fitness

#### **VI Ecology**

- \* Individual Organisms
- Unitary and modular organisms
- \* Population
- Population structure
- . dispersion, age, size and sex structure
- Population dynamics
- . birth rate, death rate
- . exponential and logistic growth, carrying capacity

- Population regulation
- . metapopulation dynamics
- \* Biotic Communities
- Species richness and diversity
- Niche, competition exclusion principle
- Interspecific Interactions
- . competition, predation, symbiosis
- Community dynamics
- . succession
- Terrestrial biomes
- Aquatic biomes
- \* Ecosystems
- Trophic structure
- . food webs
- Trophic levels
- . producers, consumers, decomposers
- Energy flow
- Productivity
- . gross and net primary productivity
- . energy transfer efficiencies
- Matter flux through ecosystems
- Global biogeochemical cycles
- \* Biosphere and man
- Human population growth
- Pollution
- . threats of biodiversity
- . in situ conservation
- . ex situ conservation

## VII BIOSYSTEMATICS

- Structure and function, evolutionary and ecological relationships among typical organisms in the following groups. Knowledge of scientific terms will not be required for successful solution of the tasks. However, competitors should know what the named representatives of genera mentioned below look like.

Domain Archaea *Methanobacterium*,  
*Halobacterium*, *Thermoplasma*,  
*Sulfolobus*

Domain Bacteria *Agrobacterium*, *Anabaena*,  
*Bacillus*, *Escherichia*,  
*Rhizobium*, *Salmonella*,  
*Streptomyces*

Domain Eukarya  
Kingdom Protista

D. Rhodophyta *Chondrus*

D. Phaeophyta *Sargassum*

D. Bacillariophyta *Navicula*

D. Euglenophyta *Euglena*

D. Chlorophyta *Chlamydomonas*, *Spirogyra*,  
*Chlorella*, *Ulothrix*

P. Rhizopoda *Amoeba*

P. Zoomastigophora *Trypanosoma*

P. Apicomplexa *Plasmodium*

P. Ciliophora *Paramecium*

Kingdom Fungi

D. Zygomycota *Mucor*

D. Ascomycota *Claviceps, Penicillium, Saccharomyces*  
D. Basidiomycota *Agaricus*  
Kingdom Plantae  
D. Bryophyta *Polytrichum, Sphagnum*  
D. Hepatophyta *Marchantia*  
D. Rhynophyta *Rhynia*  
D. Lycopodiophyta *Lycopodium*  
D. Equisetophyta *Equisetum*  
D. Polypodiophyta *Pteridium*  
D. Ginkgophyta *Ginkgo*  
D. Pinophyta *Pinus*  
D. Cycadophyta *Cycas*  
D. Magnoliophyta  
C. Magnoliopsida  
F. Magnoliaceae *Magnolia*  
F. Ranunculaceae *Ranunculus, Pulsatilla*  
F. Rosaceae *Rosa, Malus, Prunus*  
F. Fabaceae *Pisum*  
F. Oleaceae *Syringa*  
F. Fagaceae *Quercus*  
F. Cactaceae *Opuntia*  
F. Brassicaceae *Brassica*  
F. Lamiaceae *Lamium*  
F. Solanaceae *Solanum*  
F. Asteraceae *Helianthus*  
C. Liliopsida  
F. Liliaceae *Lilium, Allium*  
F. Orchidaceae *Orchis*  
F. Poaceae *Zea, Triticum, Bambusa*  
F. Arecaceae *Cocos*  
F. Araceae *Monstera*  
Kingdom Animalia  
P. Porifera *Euspongia*  
P. Cnidaria  
C. Hydrozoa *Hydra*  
C. Scyphozoa *Aurelia*  
C. Anthozoa *Corallium*  
P. Platyhelminthes  
C. Turbellaria *Polycelis*  
C. Trematoda *Fasciola*  
C. Cestoda *Taenia*  
P. Nematoda *Ascaris, Trichinella*  
P. Mollusca  
C. Gastropoda *Helix, Arion*  
C. Bivalvia *Ostrea, Mytilus*  
C. Cephalopoda *Sepia, Octopus*  
P. Annelida  
C. Polychaeta *Nereis*  
C. Oligochaeta *Lumbricus*  
C. Hirudinea *Hirudo*  
P. Arthropoda  
SP. Crustacea *Astacus, Daphnia, Cyclops*  
SP. Chelicerata  
C. Arachnida *Euscorpius, Araneus, Ixodes*  
SP. Myriapoda

C. Chilopoda *Scolopendra*  
C. Diplopoda *Julus*  
SP. Hexapoda  
C. Insecta  
O. Thysanura *Lepisma*  
O. Odonata *Libellula*  
O. Blattodea *Blatta*  
O. Phasmatodea *Carausius*  
O. Isoptera *Kalothermes*  
O. Orthoptera *Gryllus, Locusta*  
O. Phthiraptera *Pediculus*  
O. Hemiptera  
SO. Homoptera *Aphis, Cicada*  
SO. Heteroptera *Gerris, Nepa, Cimex*  
O. Coleoptera *Calosoma, Leptinotarsa, Ips, Tenebrio, Dytiscus*  
O. Diptera *Anopheles, Drosophila, Musca*  
O. Lepidoptera *Papilio, Bombyx*  
O. Hymenoptera *Ichneumon, Apis, Formica*  
O. Siphonaptera *Pulex*  
P. Echinodermata  
C. Asteriodia *Asterias*  
C. Echinoidea *Echinus*  
C. Holothuroidea *Holothuria*  
P. Chordata  
SP. Urochordata *Ascidia*  
SP. Cephalochordata *Branchiostoma*  
SP. Vertebrata  
SC. Agantha *Petromyzon*  
SC. Gnathostomata  
C. Chondrichthyes *Scyliorhinus, Carcharodon*  
C. Osteichthyes  
SC. Actinopterygii *Acipenser, Clupea, Salmo, Carassius, Muraena*  
SC. Sarcopterygii *Lepidosiren, Latimeria*  
C. Amphibia  
O. Caudata *Salamandra*  
O. Anura *Rana, Bufo*  
C. Reptilia  
O. Testudinata *Testudo*  
O. Crocodylia *Crocodylus*  
O. Squamata *Lacerta, Vipera*  
C. Aves  
O. Struthioniformes *Struthio*  
O. Sphenisciformes *Spheniscus*  
O. Ciconiiformes *Ciconia*  
O. Anseriformes *Anser*  
O. Falconiformes *Falco*  
O. Galliformes *Gallus*  
O. Columbiformes *Columba*  
O. Strigiformes *Strix*  
O. Piciformes *Dryocopus*  
O. Passeriformes *Parus, Passer*  
C. Mammalia  
O. Monotremata *Ornithorhynchus*  
O. Marsupialia *Macropus*

- O. Insectivora *Erinaceus, Talpa*
- O. Chiroptera *Myotis*
- O. Rodentia *Mus, Rattus*
- O. Carnivora *Ursus, Canis, Felis*
- O. Proboscidea *Elephas*
- O. Perissodactyla *Equus*
- O. Artiodactyla *Sus, Bos*
- O. Cetacea *Delphinus*
- O. Primates *Cebus, Macaca, Hylobates, Pan, Gorilla, Pongo, Homo*
- "Virales" Bacteriophage
- "Lichenes" *Parmelia, Cladonia*

## Practical Component Information:

NOTE: note all are examined, but the practical components draw from this information

### I Science Process skills

- 1 Observation
- 2 Measurement
- 3 Grouping or classification
- 4 Relationship finding
- 5 Calculation
- 6 Data organization and presentation: graphs, tables, charts, diagrams, photographs
- 7 Prediction / projection
- 8 Hypothesis formulation
- 9 Operational definition: scope, condition, assumption
- 10 Variable identification and control
- 11 Experimentation: experimental design, experimenting, result/data recording, result interpretation and drawing conclusions.
- 12 Representing numerical results with appropriate accuracy (correct number of digits)

### II Basic biological skills

- 1 Observation of biological objects using magnifying glasses
- 2 Work with a microscope (objective max. 45 x)
- 3 Work with a stereomicroscope
- 4 Drawing of preparations (from a microscope, etc.)
- 5 Exact description of a biological drawing using tables of biological terms marked with a numerical code

### III Biological methods

Competitors in the IBO should know the following methods and be able to use them. If any method requires extra specific information concerning procedures that depend on special technical equipment, instruction will have to be provided.

#### A Cytological methods

- 1 Maceration and squash technique
- 2 Smear method
- 3 Staining of cells and slide preparation

#### B Methods to study plant anatomy and physiology

- 1 Dissection of plant flower and deduction of flower formula
- 2 Dissection of other plant parts: roots, stems, leaves, fruits
- 3 Free - hand sectioning of stems, leaves, roots

- 4 Staining (for example lignin) and slide preparation of plant tissues
- 5 Elementary measurement of photosynthesis
- 6 Measurement of transpiration

### **C Methods to study animal anatomy and physiology**

- 1 Dissection of invertebrates. Dissection of parts or organs from vertebrates bred for the consumption is allowed, too.
- 2 Whole - mount slide preparation of small invertebrates
- 3 Elementary measurement of respiration

### **D Ethological methods**

- 1 Determination and interpretation of animal behavior

### **E Ecological and environmental methods**

- 1 Estimation of population density
- 2 Estimation of biomass
- 3 Elementary estimation of water quality
- 4 Elementary estimation of air quality

### **F Taxonomic methods**

- 1 Use of dichotomous keys
- 2 Construction of simple dichotomous keys
- 3 Identification of the most common flowering-plant families
- 4 Identification of insect orders
- 5 Identification of phyla and classes of other organisms

## **IV Physical and chemical methods**

- 1 Separation techniques: chromatography, filtration, centrifugation
- 2 Standard tests for monosaccharides, polysaccharides, lipids, protein (Fehling, I<sub>2</sub> in KI(aq), biuret)
- 3 Titration
- 4 Measuring quantities by drip and strip methods
- 5 Dilution methods
- 6 Pipetting, including use of micropipettes
- 7 Microscopy, including use of counting chambers
- 8 Determination of absorption of light
- 9 Gel electrophoresis

## **V Microbiological Methods**

- 1 Preparing nutrient media
- 2 Aseptic techniques (flaming and heating glass material)
- 3 Inoculation techniques

## **VI Statistical methods**

- 1 Probability and probability distributions
- 2 Application of mean, median, percentage, variance, standard deviation, standard error, T test, chi-square test