GUIDELINES FOR ENTRY EXAMINATIONS FOR THE MASTER OF SCIENCE IN VETERINARY MEDICINE

The **Master of Science in Veterinary Medicine**, is a five-year course that integrates theoretical and practical learning - the first two years made up of foundation modules followed by three other years entailing clinical and other specialized modules. During the first two years, students learn about the normal functions of the animal body- from the cellular level to the functioning of the whole organism. Through various practical sessions and extra-mural placements, animal handling skills and professional skills will also be taught. During the clinical years, students will learn about the diagnosis and treatment of medical and surgical conditions in companion, equine and farm animal species, as well as about other relevant topics, including veterinary public health and pharmacology.

Further information about this programme of studies delivered by MCAST at its Institute of Applied Science - Centre for Agriculture, Aquatics, and Animal Sciences (IAAS – CAAAS), is available through
https://mcast.edu.mt/prospectus-2025-26/ag7-w01-24/

There are various routes as entry into the Programme, including Entry Examinations as may be required.

- ✓ ***Matriculation Certificate (Two (2) A' and Two (2) I' Level subjects)***
  Compulsory Subjects: Advanced levels at Grade B or better in Biology and Chemistry and an Intermediate Level at Grade B or better in Physics or Pure Mathematics (applicable for a limited period of time – refer to Prospectus published for every academic year). Where an applicant presents the above A' and I' level subjects but with a grade which is not achieved at B or better, the applicant will be given the opportunity to sit for Entry Examinations in the subject/s. If a Grade B or better is achieved as a result of these Entry Examinations, eligiblity for the course will be considered and the required process of classification (given the set maximum number of possible students in this course) will take off.

OR

- ✓ ***Internal Progression through MCAST Advanced Diploma in Animal Management and Veterinary Nursing or MCAST Bachelor of Science (Honours) in Animal Management and Veterinary Nursing***, will be considered in conjunction with a Grade B or better resulting from Entry Examinations in the set subject/s depending on the programme the applicant will be internally progressing from.

  OR

- ✓ Applications submitted under the Maturity Clause (aged 27 years and over) and which will include a recognized MQF /EQF Level 4 (minimum of 120 credits) qualification in an area related to this programme's area of study (as will be reviewed and decided upon by the Admissions Board) will be considered to be included in the eligibility vetting process. In addition, these applicants will need to sit for the Programme's Entry Examinations in Chemistry, Physics and Biology/Animal Sciences, and achieve the required Grade B or better. An Interview may also be required.

OR

- ✓ Applicants in possession of an MQF/EQF Level 6 (minimum 180 credits) and / or an MQF / EQF Level 7 (minimum of 90 credits) qualification, proving a proper and good quality academic performance, and in an area which is closely related to the subject matter of the MSc in Veterinary Medicine – as well as providing the foundations needed for this Level 7 programme – will also have their application considered for the eligibility vetting process. Based on the content covered (as will be evidenced by the applicant) the Admissions Board will be reviewing and deciding on any waiver in as far as the three Entry Examinations which applicants are expected to sit for aimed at achieving a Grade B or better.

Other Important matters to be noted and considered:

Given the nature of the Programme, the number of seats available on this course, are limited. To this effect, the final classification following eligibility achievement will be published as based on chronological order of full and complete application received (submitted by applicant by the deadline as set in the Admissions' Timeline https://mcast.edu.mt/application-online-ft-mcast-courses/) AS WELL AS a related classification of scores (highest first) based on points achieved for all qualifications submitted and considered as entry to this programme (including th set Entry Examinations, as will be applicable).
Through an Award in Biology, an Award in Chemistry, and an Award in Physics, MCAST organised Preparatory Programmes leading to the Entry Examinations required for entry into this programme

Applicants who would be doing a similar Veterinary Medicine course in a recognised EU Institution, can apply for this course and will have their entry eligibility vetted accordingly. Should applicants consider requesting exemptions from certain units of study based on identical unis they would have already achieved (from the recognised EU Institution they would be coming from) an RPCL process (terms and conditions

apply, as per MCAST RPL procedure) will take off. Applicants would first need to be found eligible for the MCAST Level 7 programme (prior to start of RPCL process). Any other administrative matters related to any previous Scholarships (or similar) which the applicant would have previously availed of, are to be discussed and clarified directly with the respective Scheme Administration, prior to submitting any application for this programme at MCAST.

MCAST Programme Entry Examinations, leading to eligibility for MSc Veterinary Medicine

Set Programme Entry Examinations, will be administered as follows:

- *Animal Science / Biology* - **Fri**day **22nd Aug**ust 2025 starting at **0915h**
- *Chemistry* - **Mon**day **25th Aug**ust 2025 starting at **0915h**
- *Physics* - **Wed**nesday **27th Aug**ust 2025 starting at **0915h**

- Each set Programme Entry Examination is 3 hours long and will consist of 10 short questions (7 marks each) together with another 3 long questions (10 marks each).
- Exams will be held at MCAST Main Campus, Paola… Block A, Room 105 within the Institute of Applied Science.

It is important that all candidates are seated *by latest 0905h on the morning of every Entry Examination*. Candidates are to present their National ID Document upon entering the Examination venue.

MCAST's student conduct regulations for time-constrained assessment (TCA) must be followed at all times. These are summarized in **Annex I**.

Once scripts are collected, they will be corrected and verified within 15 working days after which results will be communicated to the applicants accordingly.

Grading brackets for the exams, are as follows;

% Mark	Grades
90-100	A*
80-89	A
70-79	B
60-69	C
50-59	D
<50	Unclassified (U)

Content upon which exams will be based is found in Annex II.

ANNEX I

CANDIDATE CONDUCT REGULATIONS DURING EXAMS

The following rules of conduct apply for assessments/examinations:

a) Candidates are to be punctual for their examination sessions (at least, ten minutes prior to the commencement of the examination session), knowing exactly in which lecture room they have to report to for their examination.

b) Candidates cannot enter the examination room more than thirty (30) minutes after an examination has started except with the permission of the Director or the Deputy Director. In such cases, extra time may be allowed if the candidate's late arrival is justified by the Director or the Deputy Director.

c) All answers returned on the candidate's examination manuscript must be his/her work completed during the examination session.

d) Candidates are expected to comply with any specific instructions given by the invigilator before and during the examination session.

e) Candidates are not permitted to communicate or attempt to communicate with any other candidates during the examination session.

f) Any form of copying is unacceptable and such misconduct leads to automatic disqualification from the examination session.

g) It is strictly forbidden to use any answer book, writing paper or graph paper other than that supplied in the examination room unless there is a special provision for using material authorised by the examiners. Any other material required for an examination will be provided in the examination room.

h) Any electronic devices/items, for example, personal audio equipment, mobile phones, tablets, laptops etc., are to be switched off before the start of the examination. All electronic devices/items, bags and other material which are not related to and not permitted for use during the examination must be placed at the location as indicated by the invigilator.

i) All material (including examination manuscripts, graph paper, information sheets, etc.) supplied during the examination session has to be returned to the invigilators at the end of the examination.

j) Candidates are not permitted to bring with them any scrap pieces of paper.

k) Before leaving the examination room, the candidate has to seek the invigilator's permission. Candidates are allowed to leave the examination room after the first half-hour of the examination. No candidate may leave the examination hall during the last ten minutes of the examination session.

l) A candidate who falls ill while sitting for an assessment/examination session may leave the room, with the invigilator's permission, and return while the assessment/examination is in progress, to resume the paper on one occasion only. In such cases, no extra time is allowed.

m) When a candidate cannot complete the assessment/examination work/paper because s/he is taken seriously ill, s/he should inform the invigilator so that the incomplete manuscript/work can be handed in.

n) It is absolutely forbidden for candidates to return part of or the whole examination manuscript/s after they leave their examination room.

o) Candidates shall not directly and/or indirectly offer or seek to offer assistance to, or seek to obtain and/or accept assistance from, any other examination candidate. Such behaviour will disqualify the candidate from that examination, and his/her script will not be corrected.

p) Food and drinks (except water or non-alcoholic drinks) are not allowed during the examinations.

q) Any form of unacceptable conduct during examinations, including cheating, copying and disturbing others during examinations, will be reported to the Institute Disciplinary Board. This could, among other disciplinary measures, lead to the annulment of the examination result.

r) Candidates are to keep exam papers flat on the desk at all times.

s) In case of serious uncontrolled behaviour or persistent defiance of examination regulations, the invigilator is authorised to suspend the candidate immediately from the lecture room/examination hall. Such cases will be immediately reported in writing to the Registrar's office within 24 hours of the incident.

ANNEX II

CONTENT TO BE ASSESSED THROUGH PROPGRAMME ENTRY EXAMINATIONS

ANIMAL SCIENCES

- Animal Anatomy & Physiology

Definition of various anatomical terms.

 Planes of reference (e.g. sagittal, median, transverse, dorsal, etc.),
 directional terms (e.g. cranial, caudal, rostral, etc.),
 bilateral symmetry in the animal body;
 other anatomical terms: anterior/ventral, posterior/dorsal, superior, inferior, medial, median, lateral, proximal, distal

Anatomy and physiology of the haematopoietic and immune systems.

 Haematopoietic system
o Blood composition and components (red blood cells and hemoglobin, platelets, white blood cells- neutrophils, eosinophils, basophils, lymphocytes, monocytes-, plasma and serum),
o Blood function
 Immune system:
o lymphatic system (function, formation, primary lymphoid tissue, secondary lymphoid tissue; lymphatic vessels, lymph nodes)
o the function of the immune system (how the body recognises foreign cells and mounts a response, the importance of an immune response, why animals get a fever, when the immune system does not function well – case examples of immunodeficiency (e.g. caused by drugs, infectious agents, congenital), autoimmune disease.

Anatomy and function of the musculoskeletal and nervous systems.

 Skeleton:
o bones (functions- support, protection, storage, etc.),
o structure (cancellous, compact), cells,
o bone shapes (long, short, flat, irregular),
o axial skeleton
o appendicular skeleton (thoracic limb [scapula, humerus, ulna, radius, carpal, metacarpal, phalanges], pelvic limb [pelvis, femur, patella, tibia, fibula, tarsal bones, metatarsal bones, phalanges],
o joints (examples of types)
o synovial fluid,

 Muscle types (examples of skeletal and those acting on various parts of the body – skeletal vs smooth) and function- contraction and relaxation, attachment to bones to produce movement

 Nervous system:
o Gross anatomy of the central nervous system, CNS: brain (cerebrum, cerebellum, brainstem, cerebrospinal fluid) and spinal cord; functions of CNS
o Peripheral nervous system, PNS (nerves outside the brain and spinal cord); function of PNS (autonomic [controls involuntary smooth muscular movements] vs somatic [controls voluntary skeletal muscular movements]; autonomic nervous system: sympathetic (flight or fight), parasympathetic
o spinal nerves, neurons and synapse (structure, function: neurotransmitters, depolarization vs. repolarization, refractory period, saltatory conduction), afferent (sensory) vs. efferent (motor) neurons
o reflexes (stretch, withdrawal) and the reflex arc

Anatomy and function of the cardiovascular and respiratory systems.

Cardiovascular system (CVS):
o heart (location, shape, walls, chambers, valves);
o blood vessels (arteries, capillaries, veins);
o blood circulatory system, cranial vena cava, caudal vena cava, portal system, aorta
o Circulation of blood, flow in the heart; variations across species
o cardiac output, heartbeat, cardiac cycle (systole, diastole);
o pulse;
o function of the CVS in the animal body;

Respiratory system:
o upper respiratory tract (nose, pharynx, larynx, trachea);
o lower respiratory tract (bronchial tree, alveoli), lungs, thorax;
o inspiration, expiration;
o ventilation and gas exchange, oxygen and carbon dioxide transport;

Anatomy and physiology of the digestive and genito-urinary systems.

Digestive system: gross structure and function of:
o oral cavity, teeth, tongue, salivary glands, pharynx;
o process of mastication, swallowing;
o oesophagus;
o stomach, stomach secretions, stomach digestion;
o small intestine digestion
o pancreas, liver, bile duct, gall bladder
o overview of carbohydrate, lipid, protein digestion and absorption,
o large intestine digestion, gastrointestinal motility, defaecation

 Urinary system:
o kidneys, ureters, urinary bladder, urethra (function, location, nephrons);
o renal function (blood filtration, reabsorption, secretion);
o urine formation, evacuation/urination
 Reproductive system:
o male reproductive system (structure and function);
o female reproductive system (structure and function);
o oestrous cycle (examples of specificities of different species)

- Veterinary Nursing and Animal Care

The veterinary regulations

 Veterinary legislation: Animal Welfare Act, Veterinary Services Act, Veterinary Medicinal Products Regulations, Private Veterinary Establishment regulations, S.L.465.01 Medical Exposures (Ionising Radiation) Regulations; S.L. 585.01 Basic safety standards for ionizing radiation regulations; S.L. 585.04 commission for the protection from ionizing and non-ionising radiation regulations, Medicines Act 458, Prescription and dispensing requirements rules 458.49, Waste Regulations S.L. 549.63.
 General role of the veterinary nurse; listed veterinary nurse, registered veterinary nurse.
 Health and safety at the veterinary work place; risk assessment, minimizing risk.

Maintaining the wellbeing of animals and their human carers

 Principles of animal welfare: what constitutes animal welfare (the three pillars as proposed by Fraser, 2008: physical state, emotional state [freedom from negative emotions such as pain and fear and also presence of positive emotions], ability to express normal behaviours); discussing the five freedoms – advantage and disadvantages of using these in animal welfare assessments.

 Animal welfare in the veterinary setting: animal emotions (approaching and handling various animals in the veterinary setting; creating a veterinary environment that promotes positive veterinary experiences for animals and their carers [consider waiting areas, waiting times, pheromone use, noise, music, kennels structure e.g. separate cat/dog areas etc.] approach to various animals and their handling/restraint in the veterinary clinic including in waiting area, consult room and as in-patients in kennels or during various procedures (use of equipment e.g. different types of muzzles, gloves, crush cages etc) , signs of distress and fear, principles of cooperative care, advising clients on measures that can be taken to improve an animal's veterinary experience e.g. training animals to being touched, visiting clinic frequently and not only when sick or requiring treatment etc;), mental stimulation for in-patients; satisfying physical needs of animals (food, water, hygiene, comfort (bedding, temperature)

 Signs of health and ill-health in companion animals: assessing animal health (distant observation, observing and monitoring behaviour, history e.g. acute vs chronic presenting symptoms, physical examination)

 Examples of clinical signs and treatment of common diseases in dogs: e.g. infectious disease (e.g. parvovirus, Leishmaniasis, Ehrlichiosis, Kennel cough), gastrointestinal symptoms e.g. diarrhoea, vomiting and possible causes (e.g. infectious, foreign body ingestion, toxin ingestion), pyoderma, flea allergy dermatitis (pruritus), otitis and aural haematoma, pyometra.

 Examples of clinical signs and treatment of common diseases in cats: e.g. infectious disease (e.g. FIV, FeLV, FIP, feline herpes/calicivirus [cat flu]), gastrointestinal symptoms e.g. diarrhoea, vomiting and possible causes (e.g. hair balls, infectious, foreign body ingestion), dermatitis, FLUTD.

 Importance of vaccinations in animals and discussion of various vaccines and protocols available for cats, dogs, rabbits.

 Communication (verbal and non-verbal) at the veterinary clinic (including client communication e.g. in reception area, waiting area, consult room etc. and communication with the veterinary team/staff); importance of adequate communication (for animal wellbeing, human carer wellbeing and satisfaction with veterinary service, collegial relationships, personal wellbeing etc.)

 Awareness of self and recognising personal limitations: importance in terms of safeguarding animal welfare, personal safety and client satisfaction; professional indemnity/liability.

Veterinary nursing tasks related to first aid, emergencies and surgery

 What constitutes a veterinary emergency: patient assessment, primary survey (including Airway, Breathing, Circulation), recognition and treatment of cardiopulmonary arrest, secondary survey (major body system evaluation: respiratory, cardiovascular, neurological), principles of CPR (when to use it, how to perform it); examples of specific veterinary emergencies e.g. following an RTA, poison ingestion, GDV in dogs, haemorrhage; principles of shock.

 Principles of triage: defining the concept, importance of triage.

 Identification of equipment required during emergencies (oxygen supply, laryngoscope, ET tubes, syringe for cuff inflation, tape, tracheostomy kit, suction equipment, artery forceps, catheters, fluid therapy materials and equipment, blades, various syringes, needles, electrocardiograph, defibrillator, pen/paper for record keeping, clock, surgical scrub, steriles gloves in various sizes, familiarity with drug names (e.g. adrenaline, atropine, lidocaine, calcium gluconate 10%, dextrose 50%, dobutamine, dexamethasone, doxopram, diazepam, furosemide, sodium bicarbonate, mannitol, multiple syringes of heparinized saline)

 Preparing for an emergency: following veterinary instructions, preparing requested equipment, setting up fluid bag/drip line and supplies required for IV catheterisation; familiarity with ET tube function and cuffing procedure; controlling haemorrhage, cleaning wounds

 Client communication and support during an emergency.

 Preparation of animals for surgical interventions through clipping, shaving and disinfection.

 Descriptions of the most common surgical equipment and respective specialised equipment needed

 Scrubbing procedures

 Assisting veterinary surgeons during surgical procedures.

Patient monitoring, administration of medication and diagnostic imaging in the veterinary clinic

 Caring for inpatients (physical requirements [food, water, bedding, hygiene, urination, defecation, nails and clipping, wound and bandage care], mental and social requirements, introduction to nursing care plans, patient monitoring and record-keeping, ensuring patient comfort, recognising arising needs, administration of medication via enteral and parenteral routes, enemas, monitoring and assessing response to medication, communicating with the veterinary team and clients.

 Diagnostic imaging: familiarity with equipment e.g. digital versus manual X ray machines, film, cassette, protective equipment, X ray machine parts; principles of radiography (how an image is produced, contrast studies); safe handling of patients during X-ray procedure (handling of anaesthetised and sedated patients, patient monitoring, ways of immobilizing patients for X ray e.g. cradles,weighted bags), patient positioning for various X ray views (terminology, examples of positioning for various views of radiographs e.g. thoracic, abdominal, pelvis, stifle), labelling of radiograph, development of radiograph (manual versus automatic), health and safety in radiography.

 Ultrasonography: principles, animal preparation and handling during procedure.
 Collection and processing of samples including skin scraping, collection of urine, collection of blood, the collection of stool samples, milk samples, vaginal smears, impression smears and sheath washing.

- Animal Nutrition

Structure and function of the macro- and micro-nutrients required for a number of animal species

 Macro-nutrient function: carbohydrates, fiber, lipids, proteins, water, macro-minerals.
 Micro-nutrients: vitamins, micro-minerals.
 Quantities required by different life stages for identified species- lactation, egg production, early age, adolescents, adulthood, old age- maintenance and production
 Ingredients/feeds that are good sources of specified macro- and micro-nutrients- forages, cereals, legumes, by-products (plant and animal), minerals, etc.
 Pre-mixes, additives and supplements
 Maintenance and production diets, nutritional density, dry matter analysis, calorific values etc.
 Pricing, and effects of supply and demand- ingredient and balanced feed prices

Digestive process for monogastrics, ruminants and hindgut fermenters

 Overview of structure of different digestive systems with particular emphasis on distinguishing organs of particular animals e.g.:
o Rumen in ruminants,
o Caecum in hindgut fermenters,
o Crop and gizzard in birds, etc.,
 Ratios of forage to cereals-in ruminants and hind-gut fermenters to avoid animal digestive upsets
 Rumen digestible protein vs. bypass protein,
 Milk quality as a result of rumen digestion- VFAs and fibre digestibility

 Effect of forage on rumen health- digestible/undigestible fibres- pectin/cellulose/hemicellulose/lignin
 Effect of rumen on digestion of forage

Feeding regimes for a range of animal species according to their life stages

 Feeding behaviours of a range of species and how consideration of this influences provision of feed; feeding program- including timing, quantity, enrichment; record keeping; monitoring of diet/wastage
 Symptoms of important nutritional deficiencies common in a range of species e.g. obesity, mineral deficiencies, toxicity, diarrhea, anorexia, diabetes and their prolonged impact on animal health and welfare; biometrics that can be used to monitor/detect/confirm nutritional disorders eg weight, blood chemistry, behavior, condition score, liver function, faecal analysis etc.

- Animal Behaviour

The scientific basis for controlling animal behavior

Historical basis for the changing trends in the study of animal behavior
o The Ethological approach of
o Tinbergen (Proximate and ultimate questions)
o Lorenz (imprinting and testing hypothesis in nature)
o The experimental psychology approach of
o Skinner (Operant conditioning)
o The cognitive psychology approach of
o Lashley (memory)
 Neurophysiological control of behavior
o Stimulus/ response sequences
o Detection
o Perception and senses
o Stimuli
o Neurophysiological co-ordination
o Reflex responses
o Motivation and link to abnormal behaviours
o Orientation behaviours
 Genetic control and evolutionary significance of behavior in animals
o Gene pools
o Speciation
o Island model
o Genetic drift
o Natural selection
 Theories of conditioning and learning in animal species
o Sensitization
o Habituation
o Classical conditioning
o Operant condition
o Social learning
o Insight learning

The importance of functional behavior to social interaction, feeding and reproduction in a range of species

 Roles of communicative behavior in animals
o Methods of communication
o Medium
o Modality
o Benefits and limitations of each
o Examples of intraspecific communication
o Examples of interspecific communication
o Honest signals
o Evolutionary deceits
 Concepts of altruism and symbiotic associations
o Kin selection and altruism
o Examples of co-evolution
o Modelling e.g. 'The Prisoners Dilemma'
 Theories of predation and feeding
o Optimal model
o Predator-prey cycles
o Types of defence behavior
o Batesian and Mullerian mimicry
o Territoriality
 Reproductive behavior
o A range of reproductive strategies
o Sexual selection
o Copulation
o Gestation
o Nesting behavior
o Parturition
o Nursing
o Infanticide

The implications of animal behavior for animal husbandry and management

 Species-specific training- techniques appropriate for species being trained
 Factors affecting progress: animal's physical and mental capacities, environment, equipment, management, motivation, animal-trainer relationship, life history, animal personality
 Operant vs. Classical conditioning (components and concepts)
 Application of learning theory to training:
o Positive & negative reinforcement
o Positive & negative punishment
o Flooding
o Counter-conditioning
o Schedule of re-enforcement
 Practical significance of applied ethology
o Using behavior to assess welfare
o Maintenance of natural behaviors for successful conservation
o Negative behaviours indicating exploitation
o Practical training methods for health and management e.g. clicker training
o Behaviours as indicators of good/ poor health
Motivation and development of abnormal behaviours
o Ex-situ management systems
o Environmental enrichment

o Stereotypical behaviours
o Link to abnormal behaviour
 Application of animal training:
o Service animals
o Animal-assisted therapy
o Zoos
o Farm animals (e.g. transport)

TEXTBOOK RECOMMENDATION

Alcock, J. (2009). Animal Behaviour: An Evolutionary Approach. Sinauer Associates USA.

McDonald P, Greenhalgh JFD, Morgan CA, Edwards R, Sinclair L, Wilkinson R - Animal Nutrition 7th Edition (Pearson 2011)

Mullineaux, E. and Jones, M., 2007. BSAVA manual of practical veterinary nursing. British Small Animal Veterinary Association.

Sturtz, R. and Asprea, L., 2012. *Anatomy and physiology for veterinary technicians and nurses: A clinical approach*. John Wiley & Sons.

BIOLOGY

Basic Molecules and Life

Molecules

- Carbohydrates- monosaccharides (pentoses and hexoses- 2 examples of each), alpha and beta glucose, disaccharides- 2 examples, polysaccharides (starch and glycogen- structure and function)
- Lipids- triglycerides (structure and function), phospholipids (formation of membranes), steroids (cholesterol, hormones and Vitamin D)
- Proteins- structure including properties of R-groups, peptide linkage, primary, secondary, tertiary and quaternary structures including bonding, shape and function of fibrous and globular proteins (examples)
- Nucleic acids- nucleotides forming polynucleotides, pyrimidines and purines, structures of DNA, mRNA and tRNA
- Vitamins and co-enzymes
- ATP and creatine phosphate
- Water- dipole, hydrogen bonding and associated characteristics

The animal and plant cell

- Organization (cells, tissues, organs, systems)
- Differences between animal and plant cells including organelles, fluid mosaic model
- Plant primary metabolites (compared to bacterial, fungal, and animal metabolism)
- Diffusion, osmosis, facilitated diffusion, primary and secondary active transport, endocytosis (use of receptors), exocytosis, effects of hypertonic, isotonic and hypotonic solutions on the cell

Body systems

- Homeostasis- definition
- Circulatory system (open, closed, single, double)
    - Pressure differences, blood flow, concentration gradient, diffusion across exchange surface, advantages of double circulation, functions of circulatory systems
    - Structure of mammalian heart and histology of cardiac muscle, cardiac cycle, pressure curves and volume changes, cardiac output, heart rate, stroke volume, sino-atrial note, atrioventricular node, bundle of His, Purkinje fibres, nervous and hormonal control
    - Arteries, arterioles, capillaries, venules and veins, structure and pressure changes (arteries, capillaries and veins), vasoconstriction and vasodilation
    - Blood- composition
    - Rhesus blood grouping
    - Adaptations of red blood cells to carry oxygen, haemoglobin, dissociation curves, Bohr effect, formation of red blood cells

- Skeletal system
    - Hydroskeleton, exoskeleton and antagonistic muscles to being about limb bending and extension in the insect
    - Endoskeleton- role in movement and support, gross bone structure, spongy and compact bone, synovial joints (overview), compact bone histology, structure of a vertebra
- Muscular system
    - Tendons and myofibrils, bound by sarcolemma
    - Muscle histology, I-bands, A-bands, H-zone, Z-line, M-line, sarcomere, troponin, tropomyosin, sarcoplasmic reticulum, T-tubules
    - Controlling and bringing about muscle contraction, sliding filament theory, cross bridge formation, role of ATP
- Nervous system
    - Hypothalamus- neurosecretory cells, release and release-inhibiting neurohormones
    - Pituitary gland- anterior hormone-producing lobe, prolactin and tropic hormones, posterior non-producing lobe, ADH and oxytocin
    - Structure and properties of a neuron, resting potential, generation and propagation of an action potential, speed of conductance as affected by myelination diameter and temperature, refractory period
    - Synapse structure, transmission mechanism, EPSPs, IPSPs, temporal and spatial summation, neurotransmitters (acetylcholine and noradrenaline), neuromuscular junction
    - Autonomic nervous system- functions of the sympathetic and parasympathetic nervous systems
    - Central nervous system- brain gross structure, structure of spinal cord in transverse section, reflex arc
    - Structure of eye, outline of image processing, sensitivity of rods and cones, monochromatic and trichromatic vision, nocturnal eye
- Reproductive system
    - Asexual vs. sexual reproduction- definitions, advantages and disadvantages, binary fission, gamete transfer, external and internal fertilization
    - Structure and function of male and female reproductive systems (in humans), testes histology, spermatogenesis, ovary histology, oogenesis, menstrual cycle
    - Fertilization- transfer of gametes, capactiation, sperm penetration in oocyte, acrosome reaction
    - Development- cleavage, morula, blastula formation, implantation, placenta (structure and function)
    - Colostrum, importance of passive immunity
    - Roles- Luteinising hormone, follicle stimulating hormone, testosterone, oestrogen, progesterone, human choronic gonadotropin, oxytocin, prolactin

- Digestive system
    - Heterotrophic nutrition- alimentary canal of a monogastric (digestion and absorption), ileum wall (mucosa, submucosa, muscle layer and serosa), secretions to digest carbohydrates, lipids and proteins, nervous and hormonal control of the release of enzymes and gut activity

- Ruminants- dentition, 4-chambered stomach (mutualistic interactions), differences with hind-gut fermenters
- Dentition of carnivores

- Respiratory system
  - Cellular respiration- major conversions and reactions
  - Aerobic respiration- Krebs cycle- major conversions and reactions, the electron transport chain, oxygen forming water, role of the mitochondrion in aerobic respiration, location of enzymes and enzyme carriers
  - Anaerobic respiration- situations for incomplete oxidation of pyruvate, lactic acid formation, differences in ATP yields, oxygen debt
  - Fick's law and the maximization of diffusion rate
  - Gill structure of bony fish, ventilation, countercurrent exchange,
  - Structure and function of mammalian lungs, ventilation, control of rate and depth of breathing
  - Chloride shift
  - Outline of fat respiration, gluconeogenesis and amino acid metabolism
- Endocrine system
  - Endocrine pathway
  - Hormones- mode of action, peptide, protein, amine and steroid hormones, secondary messenger mechanisms, intra-cellular hormone-receptor complex formation
  - Pheromones
- Lymphatic system
  - Tissue fluid and lymph- formation and reabsorption of tissue fluid, lymphatic system (structure and function)
- Excretory system and osmoregulation
  - differences in osmoregulation between insect, fish and mammal
  - structure of kidney, structure and histology of nephron
  - functions of kidneys (excretion, osmoregulation and pH regulation)
  - processes in nephron, countercurrent multiplier in the Loop of Henle, vasa recta as countercurrent exchangers
  - antidiuretic hormone and aldosterone
- Immune system
  - Lines of defence
    - first line of defence
    - second line of defence
    - third line of defence (humoral and cell-mediated immunity [helper cells, activation of B-cells, immunoglobulin/antibodies, cytotoxic cells, cytokines], lymphocytes)
  - Passive and active natural immunity
  - Passive and active artificial immunity

- Control systems
  - negative and positive feedback, examples
  - Ectothermy and endothermy (advantages and disadvantages), thermoregulation in reptiles, role of mammalian skin, structural, behavioural and physiological mechanisms of thermoregulation in mammals, hibernation and aestivation

- Regulation of blood glucose levels, insulin and glucagon, secretion site, processes to lower or increase blood glucose, role of adrenalin and cortisol
- Structure of liver lobule, overviews of glycogenesis, glycogenolysis, gluconeogenesis, deamination, urea formation, transamination, plasma protein synthesis, bile production, lipid metabolism
- Enzymes- structure, function, role, enzyme-substrate complex, rate (temperature, pH and concentration), competitive and non-competitive inhibition, allosteric enzymes

Ecology, Diversity and Classification

Ecology and Ethology

- Levels of organization
- Interactions in ecosystems
- Plant photosynthesis
- Population size- natality, mortality, immigration and emigration.
- Recruitment, biotic potential, environmental resistance, carrying capacity, density-dependent and density-independent factors. S-shaped and J-shaped growth curves.
- Boom and bust curves.
- Population crashes.
- Competition and overcrowding
- RelationshipsPredation, parasitism, mutualism, commensalism, amensalism. Gause's principle of competitive exclusion. Resource partitioning. Ecological niche. Fundamental and realized niche. Generalist and specialist species (advantages and disadvantages)
- Ecological succession- mechanism, pioneer communities, seral stages and climax communities, primary and secondary succession
- Instinct, Learning, Basic animal behaviours

Diversity and Genetics

- Species diversity, Ecosystem diversity, Genetic diversity
- Chromosome structure
- Protein synthesis- transcription (template and non-template strand, RNA polymerase, post-transcriptional processing, charging tRNA) and translation (initiation, elongation and termination, roles of mRNA, tRNA, ribosomes, codon and anticodon, polysome, post-translational processing).
- Point mutations, frame shift mutations, aneuploidy and polyploidy
- Nuclear division, cell division, interphase
- Mitosis- where and when it occurs, daughter cells, prophase, metaphase, anaphase, telophase, cytokinesis in animal cells
- Meiosis- where and when it occurs, haploid cells, first and second meiotic division, processes giving rise to genetic diversity (3 examples)
- Compare and contrast mitosis and meiosis
- Plant alternation of generations
- Gene and allele, dominant and recessive allele, homozygote and heterozygote, genotype and phenotype, test cross for monohybrid inheritance, codominance, incomplete dominance, multiple alleles, pedigree analysis, test-cross for dihybrid inheritance, autosomal linkage, crossing over and recombinants in relation to meiosis events, sex determination in mammals and sex linkage, X chromosome inactivation,

gene interaction between two unlinked genes, polygenic inheritance, Gaussian frequency distribution curve

- Genetic variation- continuous and discontinuous, gene pool, Hardy-Weinberg equilibrium principle and factors affecting it (e.g. mutations, gene flow, non-random mating, genetic drift, selection)
- Selection- artificial and natural, directional, disruptive and stabilizing mechanisms
- Balanced and transient polymorphism
- Gradualistic and punctuated equilibrium modes of evolution
- Geographical isolation and allopatric speciation
- Behavioural isolation, polyploidy and sympatric speciation
- Reproductive isolating mechanisms- pre-zygotic and post-zygotic isolating mechanisms

Classification

- Biological nomenclature- Kingdom, Phylum, Class, Order, Family, Genus, Species; Dichotomous Keys
- Viruses (e.g. bacteriophage): structure, differences between viruses and living organisms, lytic and lysogenic life-cycles
- Differences between- prokaryotic and eukaryotic cells, gram positive and gram negative bacteria
- Protoctista- differences between a green and brown alga
- Fungi- moulds and yeasts
- Animals- absence of cell wall, heterotrophy, motility, cephalisation, blastula
- Cnidarians- radial symmetry, diploblastic, nervous system, stinging cells and cnida, polyp and medusa stages (one example)
- Playhelminthes- bilateral symmetry, triploblastic acoelomate, cephalisation (e.g. tapeworm)
- Annelid- segmented coelomate, chaetae (e.g. polychaete)
- Arthropods- tagmatization, exoskeleton, articulated appendages, compound eyes, crustacea (antennae and gills, two examples), insecta (tagmata, antennae, limbs, wings, metamorphosis- examples of complete and incomplete), arachnids (tagmata, antennae, legs, eyes, chelicerae, pedipalps, one example)
- Mollusca- segmentation, shell (one example)
- Echinodermata- symmetry, cephalization, skeleton, tube feet, (one example)
- Chordata- vertebral column, pectoral and pelvic girdle, jaws, cranium, sense organs, vascular system, external features of fish, amphibians, reptiles, birds and mammals, pentadactyl tetrapod limb, cleidoic egg

TEXTBOOK RECOMMENDATIONS

Hillis, D.M, Heller, H.C. *et. al* (2020) *Life : The Science of Biology, 12th Edition.* W.H. Freeman, US

Taylor, D.J., Green, N.P.O., Stout G.W. (Editor: R. Soper) (1997). *Biological Science 1 and 2*. Cambridge University Press, UK

CHEMISTRY

The Structure of the Atom

· Bohr model of the atom:
- protons, electrons and neutrons
- charges and relative masses of sub-atomic particles
- s and p orbitals and their hybridization (sp, sp2, sp3)
· Atomic number and mass number
· Electronic configurations using 'spdf' notation for atoms 1 to 36.
· Calculation of relative atomic mass from relative isotopic abundance

Radioactivity

· Definition and properties of alpha and beta particles and gamma rays
· Definition and calculation of half-life
    o Calculations of the initial/final amount of atoms after a number of half-lives
· Using isotopes as tracers in chemical reactions and in medicine

The Periodic Table and Properties of Atoms

· Groups, periods and blocks of elements
· Trends in Groups 1 and 2 of the periodic table, including:
    o Atomic size
    o Electronegativity
    o Ionization Energy
    o Electron Affinity
    o Shielding

Bonding (General)

· Topics related to bonding, including:
    o electron sharing and covalent bonding
    o electron transfer
    o dative bonding
    o polar covalent bonds and dipoles (ex: HF)
    o dipole moment
    o metallic bonding

· Lewis Structures
· Sigma and pi bonds
· Delocalization of electrons (strength and variation in groups and periods),
· Different dipole-dipole forces
· Hydrogen bonding
· Intermolecular forces and their effects on:

- o the solubility of molecules in polar and non-polar solvents
- o the density of ice
- o the boiling points of water and alcohol

Bonding (Carbon)

· Hybridization of carbon atoms into organic molecules
· Molecular geometry and VSEPR
· Delocalization in benzene and similar organic structures

Quantities

· The mole and molar quantities
· Conversion between mass and number of moles
· Conversion between different metric units of volume
· Calculation of molar concentration
· Calculation of mass concentration
· Calculation of number of particles using the Avogadro constant
· Determination of empirical and molecular formulae

Chemical Equations

· Balancing of full and ionic chemical equations
· The use of chemical equations for calculations (amounts, concentrations)
· Calculations involving limiting reactants in a chemical reaction
· Calculation of the percentage yield of a product in a chemical reaction

Equilibria

· Characteristics of the equilibrium state
· Le Chatelier's Principle
· Equilibrium constant in terms of concentrations and pressures for homogenous and heterogenous equilibria
· Equilibrium positions as affected by concentrations, temperatures and pressure (in gaseous and solid-gas equilibria)

· Effects of catalysts on equilibria
· Extent of reaction from magnitude of equilibrium constant
· Degree of dissociation of covalent molecular substances and its relation to concentrations and pressures

Gases

· The ideal gas equation
· Deviations of real gases from ideality
· Dalton's Law of partial pressures
· Vapour pressure and saturated vapour pressure
· Saturated vapour pressure and temperature
· The kinetic molecular model

Solutions

· Colligative properties of solutions
· Osmosis, osmotic pressure and its relationship with the amount of particles of solute
· Reverse osmosis
· Solubility Product

Acids and Bases

· Arrhenius, Bronsted-Lowry and Lewis acids and bases

  o Conjugate pairs
  o Proticity/basicity of acids and bases
  o Strong and weak acids and bases

· Dissociation constants and pK values
· Amphoteric nature of water and the hydrogencarbonate ion
· Stepwise dissociation of dibasic acids
· Calculation of dissociation constants and ion concentrations
· Calculation of pH and pOH of aqueous solutions
· Salt hydrolysis
· Buffer systems
  o pH calculation in buffer solutions

Electrochemistry

· Degree of ionization of weak electrolytes
· Acidic or basic salts
· Conductivity of solutions of strong and weak electrolytes
· Relation between conductivity and dissolved ions

Redox Reactions

· Oxidation number of elements in different chemical species
· Redox reactions using half equations, including their balancing
· Disproportionate and comproportionate reactions
· Hydrogen as a reducing agent

Titrations

· The use of a primary standard and standard solutions
· Acid-base titrations (including pH curves)
· Redox titrations
· Back titrations
· Indicators and titration end-points

Rates of Reaction and Catalysis

· Methods to determine the rate of a chemical reaction
· The rate equation and the rate constant
· Order of reaction and its determination
· Calculation of variables in the rate equation
· Plots of concentration against time and rate against concentration
· Collision Theory
· Rate of a chemical reaction as affected by:

    o Pressure
    o Concentration
    o Surface area
    o Temperature
    o Catalysts

· The Arrhenius equation

    o Activation energy
    o Pre-exponential factor

· The Maxwell-Boltzmann Distribution
· Homogenous and heterogenous catalysts

    o Intermediate compound formation theory
    o Adsorption theory

· Energy profiles with and without catalysts
· Autocatalytic reactions

Energetics in Chemical Reactions

· Endothermic and exothermic energy changes, applied to phase changes and chemical changes.
· Temperature-time curves for phase changes
· Definition and calculation of enthalpy changes of:

    o Neutralization
    o Solution
    o Reaction

· Hess's Law

Chemistry of Nitrogen

· Chemical and physical properties (lack of reactivity)
· Properties of ammonia

  - o As a base
  - o As a ligand
  - o As a reducing agent

· Ammonium salts
· Reactions and uses of nitric acid, including as an oxidising agent

Chemistry of Oxygen

· Chemical and physical properties
· Reaction through direct union
· Classification of oxides (acidic, basic, amphoteric, neutral)
· Normal and mixed oxides
· Structure and bonding of hydrogen peroxide and its main properties (oxidizing agent, reducing agent, thermally unstable, homolysis to form radicals)

Organic Chemistry - Nomenclature

· Display methods for organic molecules and formulae:

  - o Condensed formulae
  - o Display structures
  - o Skeletal structures

· Functional groups and different classes of organic molecules:

  - o Alkanes, alkenes, and alkynes
  - o Arenes
  - o Alcohols (including phenols)
  - o Ethers
  - o Esters
  - o Aldehydes
  - o Ketones
  - o Carboxylic acids
  - o Halogenoalkanes
  - o Halogenoarenes
  - o Amines

· Nomenclature of organic molecules
· Shapes and angles of bonds (tetrahedral, planar, linear)
· Isomerism, including:

    o Structural isomerism (chain, positional, functional, keto-enol tautomerism)
    o Stereoisomerism (cis-trans, enantiomerism, conformational)
    o Optical isomerism (+/-) and chiral molecules (including racemic mixtures)

· Prediction of the effects of molecule size, shape and polarity on relative physical properties, including of intra- vs. inter-molecular hydrogen bonding

Organic Chemistry - Hydrocarbons

· Unreactivity of alkanes
· Free radical substitution by halogens, including the reaction mechanism (Initiation, propagation and termination steps)
· The alkene double bond (sigma and pi bond)
· Electrophilic attack
· Addition reactions of alkenes including Markovnikov's rule
· Oxidation of the double bond
· Addition polymerization (repeating units)
· Bonds in alkynes and addition reactions

Organic Chemistry – Alcohols, Esters and Ethers

· Primary, secondary and tertiary alcohols
· Physical properties
· Alcohol reactions:

    o Oxidation

    o Haloform

· Preparation of esters
· Preparation of ethers
· Preparation of aromatic alcohols
· Reaction of HI with ethers
· Phenol acidity
· Phenol reactions:

    o substitution reactions
    o reduction to benzene

Organic Chemistry - Halogenoalkanes

· Primary, secondary or tertiary halogenoalkanes and halogenoarenes
· Conversion of halogenoalkanes into alcohols and ethers
· Conversion of halogenoalkanes into alkenes and alkanes
· Relative reactivity of halogenoalkanes (affected by structure and halogen atom)
· Relative unreactivity of halogen atom in halogenoarenes

Organic Chemistry – Aldehydes, Ketones and Carboxylic Acids

· Addition reaction of the carbonyl group (with H- and ROH)
· Condensation reactions (hydrazine and phenylhydrazine)
· Structure of stability of the carboxylic anion
· The inductive effect and its effect on acidity
· Reduction of carboxylic acids and aldehydes, Oxidation of alcohols into aldehydes, ketones and carboxylic acids
· Dicarboxylic acids and acid anhydrides
· Alkalinity of carboxylate
· Soaps
· Acid derivatives, including:

    o acid and alkaline hydrolysis of amides and esters
    o Hofmann degradation of amides
    o reduction of acid amides and nitriles to amines
    o reduction of esters to alcohols

Organic Chemistry – Amines

· Primary, secondary and tertiary amines
· Quaternary ammonium compounds
· Basicity of amines relative to ammonia
· Difference in basic strength between primary amines, acid amides and benzenamine

· Alkylammonium salts from amines
· Alkylation reaction
· Diazonium salts
· Diazonium salt to phenols and arenes
· Coupling reactions of diazonium salts with phenols

Organic Chemistry – Amino Acids

· Structure of amino acids
· Reactions of amino acids (carboxyl and amino groups)
· Dipolar ions and their influence on physical properties
· Effect of pH on amino acid ionization (isoelectric point)
· Optical activity

Organic Chemistry – Benzene

· Structure and bonding of benzene
· Delocalization in conjugated systems and the lowering of the energy of the system
· Electrophilic substitution in aromatic compounds, including activating and deactivating groups
· Addition reactions to benzene

Spectroscopy Techniques

· Principles and uses of Thin layer chromatography
· Principles and uses of Mass Spectrometry
· Uses of Infrared (IR) Spectroscopy
· Uses of Ultraviolet (UV) Spectroscopy

TEXTBOOK RECOMMENDATIONS

- Cann, C. & Hughes, P. (2020), *Cambridge International AS & A Level Chemistry Student's Book Second Edition*, Hodder Education, UK
- Tabone Adami, J.P. (2017), *A Guide to Advanced Level Practical Chemistry*, Cogito Publishers, Malta

PHYSICS

Physical quantities and units, base units, based and derived quantities and units, unit of a quantity in terms of the base unit, SI prefixes as powers of 10 (e.g. pico, nano, micro, milli, centi, kilo, mega, giga) Homogenous equations by using base units Vector and scalar quantities, resultant of a vector set, sign convention (add/subtract vectors), resolving vector into two perpendicular components, mutually perpendicular vectors treated separately, resultant of coplanar vectors
Newton's first law of motion and its link to inertial mass, density, fundamental forces acting outside the nucleus, free body diagrams, centre of mass, smooth and rough surfaces, moments Newton's second law of motion, linear momentum, rate of change of momentum, the newton, equation representing Newton's second law of motion Time of impact and its affects on the force of impact, impulse Weight of an object (given mass and acceleration due to gravity) Drag and viscosity, drag increases/decreases depending on area, viscosity and velocity, velocity-time graph for a body falling in a viscous medium, terminal velocity Pressure- in terms of force and area on which it acts (and related equation), hydrostatic pressure equation Newton's third law of motion- pairs of forces- action and reaction Conservation of linear momentum, perfectly elastic and inelastic collisions
Different forms of energy, energy transformation, principle of conservation of energy, potential energy and gravitational acceleration
Heat – energy transfer due to temperature difference, direction of net heat flow depending on temperature Heat capacity and specific heat capacity (including equations), latent heat and specific latent heat of fusion and vaporization (including equation) Thermometry- thermometric property, temperature fixed point, ice point and steam point of water, equation relating temperature and thermometric property, converting between Celsius and Kelvin
Work done on a system in relation to energy transferred to the system that is not due to temperature change
Conduction, convection, radiation and evaporation as modes of heat transfer
Tensile and compressive forces, Hooke's law (forces and change in length), spring/stiffness constant, stress, strain and Young's modulus (including equations), Hooke's law in terms of stress and strain Proportionality limit, elastic limit, yield point, ultimate tensile strength (stress), force-extension and stress-strain graphs, elastic behaviour, plastic behaviour, stiffness and tensile strength, plastic

behaviour leading to necking (and identification on force-extension and stress-strain graphs), stiffness related to stiffness constant and Young's modulus, brittle and ductile material (and identification on force-extension and stress-strain graphs), stress-strain or force-extension graphs to determine stiffer materials, determine Young's modulus and stiffness constant, hysteresis behaviour of rubber
Newton's Law of Universal Gravitation including equation, gravitational force in relation to weight, gravitational field, gravitational field lines and directions for radial gravitational fields
Electrical attraction and repulsion between charges Coulomb's law of electrostatics (including equation), permittivity Electric field, direction of the lines of force of a field, lines of force for a radial field for a uniform field and for the field between two point charges of equal magnitude in a vacuum, electric field strength at a point, electric field strength equation Electrostatic potential difference, W=qV, V=Ed, electronvolt
Magnetic field- direction of magnetic field lines Magnetic flux density, flux linkage Magnetic force on a current carrying conductor and its relation to the magnetic flux density (related equation), Fleming's left hand rule, tesla Relating the direction of the force to that of a charged particle in motion and the magnetic field Faraday's and Lenz's Law of electromagnetic induction, Lenz's law and energy conservation, E=Blv, relating the directions of the magnetic field, current and the motion of the conductor in a simple generator, determining the polarity at the ends of a conductor due to an induced e.m.f. Basic structure of a simple generator, why e.m.f. is induced, graphs of output e.m.f. and current
Waves- progressive and mechanical waves, crest, trough, amplitude, periodic time, frequency and wavelength, wave equation Electromagnetic spectrum- regions of the spectrum and respective wavelength, colours and respective wavelength order
Optics- reflection, refraction and absorption, transparent and opaque, laws of reflection, angle of incidence and angle of reflection, ray diagrams, multiple reflecting surfaces, change of wavelength when wave passes from one medium to another, laws of refraction, angle of incidence and angle of refraction, angle of deviation Lenses- principal axis, principal focus, optical centre, focal plane, focal length, formation of an image by a single converging lens, the lens equation, linear magnification
Nuclear and atomic physics- nature of the atom- properties of protons, electrons and neutrons, atomic number, neutron number, nucleon number, element and isotope, radioactive decay, activity, decay constant, half-life, decay rate, law of radioactive decay, equation for activity in relation to radioactive decay, equation for half-life, physical properties of and decay processes of alpha particles, beta particles, gamma radiation, nuclear equations of alpha and beta decay Nuclear energy- atomic mass unit, conversion between number of moles and number of atoms, mass defect, equation to relate energy, mass and speed of light, conversion factors to convert between mass and energy, safety around nuclear energy

TEXTBOOK RECOMMENDATIONS

Farrell, M. P. (2011). *Intermediate Physics*. Agenda, Malta