Diploma Programme

Sports, exercise and health science guide

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The International Baccalaureate Organization (known as the IB) offers four high-quality and challenging educational programmes for a worldwide community of schools, aiming to create a better, more peaceful world. This publication is one of a range of materials produced to support these programmes.

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IB mission statement

The International Baccalaureate aims to develop inquiring, knowledgeable and caring young people who help to create a better and more peaceful world through intercultural understanding and respect.

To this end the organization works with schools, governments and international organizations to develop challenging programmes of international education and rigorous assessment.

These programmes encourage students across the world to become active, compassionate and lifelong learners who understand that other people, with their differences, can also be right.

IB learner profile

The aim of all IB programmes is to develop internationally minded people who, recognizing their common humanity and shared guardianship of the planet, help to create a better and more peaceful world.

As IB learners we strive to be:

INQUIRERS
We nurture our curiosity, developing skills for inquiry and research. We know how to learn independently and with others. We learn with enthusiasm and sustain our love of learning throughout life.

KNOWLEDGEABLE
We develop and use conceptual understanding, exploring knowledge across a range of disciplines. We engage with issues and ideas that have local and global significance.

THINKERS
We use critical and creative thinking skills to analyse and take responsible action on complex problems. We exercise initiative in making reasoned, ethical decisions.

COMMUNICATORS
We express ourselves confidently and creatively in more than one language and in many ways. We collaborate effectively, listening carefully to the perspectives of other individuals and groups.

PRINCIPLED
We act with integrity and honesty, with a strong sense of fairness and justice, and with respect for the dignity and rights of people everywhere. We take responsibility for our actions and their consequences.

OPEN-MINDED
We critically appreciate our own cultures and personal histories, as well as the values and traditions of others. We seek and evaluate a range of points of view, and we are willing to grow from the experience.

CARING
We show empathy, compassion and respect. We have a commitment to service, and we act to make a positive difference in the lives of others and in the world around us.

RISK-TAKERS
We approach uncertainty with forethought and determination; we work independently and cooperatively to explore new ideas and innovative strategies. We are resourceful and resilient in the face of challenges and change.

BALANCED
We understand the importance of balancing different aspects of our lives—intellectual, physical, and emotional—to achieve well-being for ourselves and others. We recognize our interdependence with other people and with the world in which we live.

REFLECTIVE
We thoughtfully consider the world and our own ideas and experience. We work to understand our strengths and weaknesses in order to support our learning and personal development.

The IB learner profile represents 10 attributes valued by IB World Schools. We believe these attributes, and others like them, can help individuals and groups become responsible members of local, national and global communities.

Purpose of this document

This publication is intended to guide the planning, teaching and assessment of sports, exercise and health science (SEHS) in schools. Subject teachers are the primary audience, although it is expected that teachers will use the guide to inform students and parents about the subject.

This guide can be found on the subject page of the Programme Resource Centre (PRC) at resources.ibo.org, a password-protected International Baccalaureate (IB) website designed to support IB teachers. It can also be purchased from the IB store at store.ibo.org.

Additional resources

Additional publications such as specimen papers and markschemes, teacher support material (TSM), subject reports and grade descriptors can also be found on the PRC. Past examination papers as well as markschemes can be purchased from the IB store.

Teachers are encouraged to check the PRC for additional resources created or used by other teachers. Teachers can provide details of useful resources, for example: websites, books, videos, journals or teaching ideas.

Acknowledgement

The IB wishes to thank the educators and associated schools for generously contributing time and resources to the production of this guide.

First assessment 2026

The Diploma Programme

The Diploma Programme (DP) is a rigorous pre-university course of study designed for students in the 16 to 19 age range. It is a broad-based two-year course that aims to encourage students to be knowledgeable and inquiring, but also caring and compassionate. There is a strong emphasis on encouraging students to develop intercultural understanding, open-mindedness, and the attitudes necessary for them to respect and evaluate a range of points of view.

The Diploma Programme model

The course is presented as six academic areas enclosing a central core (see figure 1). It encourages the concurrent study of a broad range of academic areas. Students study two modern languages (or a modern language and a classical language), a humanities or social science subject, an experimental science, mathematics and one of the creative arts. It is this comprehensive range of subjects that makes the DP a demanding course of study designed to prepare students effectively for university entrance. In each of the academic areas students have flexibility in making their choices, which means they can choose subjects that particularly interest them and that they may wish to study further at university.

Figure 1

Diploma Programme model

Choosing the right combination

Students are required to choose one subject from each of the six academic areas, although they can, instead of an arts subject, choose two subjects from another area. Normally, three subjects (and not more than four) are taken at higher level (HL), and the others are taken at standard level (SL). The IB recommends 240 teaching hours for HL subjects and 150 hours for SL. Subjects at HL are studied in greater depth and breadth than at SL.

At both levels, many skills are developed, especially those of critical thinking and analysis. At the end of the course, students' abilities are measured by means of external assessment. Many subjects contain some element of coursework assessed by teachers.

The core of the Diploma Programme model

All DP students participate in the three course elements that make up the core of the model.

Theory of knowledge (TOK) is a course that is fundamentally about critical thinking and inquiry into the process of knowing rather than about learning a specific body of knowledge. The TOK course examines the nature of knowledge and how we know what we claim to know. It does this by encouraging students to analyse knowledge claims and explore questions about the construction of knowledge. The task of TOK is to emphasize connections between areas of shared knowledge and link them to personal knowledge in such a way that an individual becomes more aware of their own perspectives and how they might differ from others.

In TOK, students explore the means of producing knowledge within the core theme of "knowledge and the knower" as well as within various optional themes (knowledge and technology, knowledge and politics, knowledge and language, knowledge and religion, and knowledge and indigenous societies) and areas of knowledge (the arts, natural sciences, human sciences, history and mathematics). The course also encourages students to make comparisons between different areas of knowledge and reflect on how knowledge is arrived at in the various disciplines, what the disciplines have in common and the differences between them.

Creativity, activity, service (CAS) is at the heart of the DP. The emphasis in CAS is on helping students to develop their own identities, in accordance with the ethical principles embodied in the IB mission statement and the IB learner profile. It involves students in a range of activities alongside their academic studies throughout the DP. The three strands of CAS are creativity (arts and other experiences that involve creative thinking), activity (physical exertion contributing to a healthy lifestyle) and service (an unpaid and voluntary exchange that has a learning benefit for the student). Possibly, more than any other component in the DP, CAS contributes to the IB's mission to create a better and more peaceful world through intercultural understanding and respect.

The extended essay (EE), including the world studies EE, offers the opportunity for IB students to investigate a topic of special interest, in the form of a 4,000-word piece of independent research. The area of research undertaken is chosen from one of the students' six DP subjects, or in the case of the interdisciplinary world studies essay, two subjects, and acquaints them with the independent research and writing skills expected at university. This leads to a major piece of formally presented, structured writing, in which ideas and findings are communicated in a reasoned and coherent manner, appropriate to the subject or subjects chosen. It is intended to promote high-level research and writing skills, intellectual discovery and creativity. An authentic learning experience, it provides students with an opportunity to engage in personal research on a topic of choice, under the guidance of a supervisor.

Approaches to learning and approaches to teaching

Approaches to learning and approaches to teaching across the DP refers to deliberate strategies, skills and attitudes that permeate the learning and teaching environment. These approaches and tools, intrinsically linked with the learner profile attributes, enhance student learning and assist student preparation for the DP assessment and beyond. The aims of approaches to learning and approaches to teaching are to:

- empower teachers as teachers of learners as well as teachers of content
- empower teachers to create clearer strategies for facilitating learning experiences in which students are more meaningfully engaged in structured inquiry and greater critical and creative thinking
- promote both the aims of individual subjects (making them more than course aspirations) and linking previously isolated knowledge (concurrency of learning)
- encourage students to develop an explicit variety of skills that will equip them to continue to be actively engaged in learning after they leave school, and to help them not only obtain university admission through better grades but also prepare for success during tertiary education and beyond
- enhance further the coherence and relevance of the students' DP experience
- allow schools to identify the distinctive nature of an IB DP education, with its blend of idealism and practicality.

The five approaches to learning (developing thinking skills, social skills, communication skills, self-management skills and research skills) along with the six approaches to teaching (teaching that is inquiry-based, conceptually focused, contextualized, collaborative, differentiated and informed by assessment) encompass the key values and principles that underpin IB pedagogy.

The IB mission statement and the IB learner profile

The DP aims to develop in students the knowledge, skills and attitudes they will need to fulfil the aims of the IB, as expressed in the organization's mission statement and the learner profile. Learning and teaching in the DP represent the reality in daily practice of the organization's educational philosophy.

Academic integrity

Academic integrity in the DP is a set of values and behaviours informed by the attributes of the learner profile. In teaching, learning and assessment, academic integrity serves to promote personal integrity, engender respect for the integrity of others and their work, and ensure that all students have an equal opportunity to demonstrate the knowledge and skills they acquire during their studies.

All coursework—including work submitted for assessment—is to be authentic, based on the student's individual and original ideas with the ideas and work of others fully acknowledged. Assessment tasks that require teachers to provide guidance to students or that require students to work collaboratively must be completed in full compliance with the detailed guidelines provided by the IB for the relevant subjects.

For further information on academic integrity in the IB and the DP, please consult the IB publications *Academic integrity*, *Effective citing and referencing*, *Diploma Programme: From principles into practice* and the general regulations in *Diploma Programme Assessment procedures* (updated annually). Specific information regarding academic integrity as it pertains to external and internal assessment components of this DP subject can be found in this guide.

Acknowledging the ideas or work of another person

Coordinators and teachers are reminded that candidates must acknowledge all sources used in work submitted for assessment. The following is intended as a clarification of this requirement.

DP candidates submit work for assessment in a variety of media that may include audiovisual material, text, graphs, images and data published in print or electronic sources. If a candidate uses the work or ideas of another person, the candidate must acknowledge the source using a standard style of referencing in a consistent manner. A candidate's failure to acknowledge a source will be investigated by the IB as a potential breach of regulations that may result in a penalty imposed by the IB final award committee.

The IB does not prescribe which style(s) of referencing or in-text citation should be used by candidates; this is left to the discretion of appropriate faculty/staff in the candidate's school. The wide range of subjects, response languages and the diversity of referencing styles make it impractical and restrictive to insist on particular styles. In practice, certain styles may prove most commonly used, but schools are free to choose a style that is appropriate for the subject concerned and the language in which candidates' work is written. Regardless of the reference style adopted by the school for a given subject, it is expected that the minimum information given includes: name of author, date of publication, title of source and page numbers as applicable.

Candidates are expected to use a standard style and use it consistently so that credit is given to all sources used, including sources that have been paraphrased or summarized. When writing text candidates must clearly distinguish between their words and those of others by the use of quotation marks (or other method, such as indentation) followed by an appropriate citation that denotes an entry in the bibliography. If an electronic source is cited, the date of access must be indicated. Candidates are not expected to show faultless expertise in referencing, but are expected to demonstrate that all sources have been acknowledged. Candidates must be advised that audiovisual material, text, graphs, images and data published in print or in electronic sources that is not their own must also attribute the source. Again, an appropriate style of referencing/citation must be used.

Learning diversity and learning support requirements

Schools must ensure that equal access arrangements and reasonable adjustments are provided to candidates with learning support requirements that are in line with the IB documents *Access and inclusion policy* and *Learning diversity and inclusion in IB programmes: Removing barriers to learning.*

The publications *Meeting student learning diversity in the classroom* and *The IB guide to inclusive education: A resource for whole school development* are available to support schools in the ongoing process of increasing access and engagement by removing barriers to learning.

Programme standards and practices

The programme standards and practices are a set of principles for schools to ensure quality and fidelity in the implementation of IB programmes. Learning and teaching are important markers of quality and effective practice in schools; thus the expectations teachers and learners share across all IB programmes can be found in the programme standards and practices.

The programme standards and practices provide a framework to help teachers understand their rights and responsibilities in IB World Schools as they develop learning environments and experiences for their students. The IB recognizes that in order for effective teaching to take place, teachers must be supported in their understanding, well-being, environment and resources. Teachers use the core tenets of IB philosophy and pedagogy (approaches to learning, approaches to teaching, the learner profile and international-mindedness) to design learning experiences that prepare learners to fulfil the aims and objectives outlined in this guide.

To learn more about teachers' rights and responsibilities, please see the IB publication *Programme standards and practices* on the PRC.

Nature of science

What is nature of science?

Nature of science (NOS) is an overarching theme in the biology, chemistry, physics and SEHS courses that seeks to explore conceptual understandings related to the purpose, features and impact of scientific knowledge.

What do we want to know in science?

Nobel laureate and influential popularizer of science, Richard Feynman, once described the process of science using the analogy of watching an unknown board game being played "... and you don't know the rules of the game, but you're allowed to look at the board from time to time. And from these observations, you try to figure out what the rules are of the game, [and] the rules of the pieces moving".

(Feynman, R., Leighton, R., & Sands, M. (1963). The Feynman lectures on physics. California Institute of Technology, Gottlieb, M. A., & Pfeiffer, R. https://www.feynmanlectures.caltech.edu/I_02.html)

What is the scientific endeavour?

Classifying such observations and underlying patterns in the natural world is the essence of what scientists do, underpinned by the assumption that the universe exists as an external reality accessible to the human experience. The varied and often non-linear processes used in scientific methodologies have several key features in common to maximize the validity and reliability of knowledge produced. The development of falsifiable hypotheses, a requirement for replicable data, and the utilization of peer review may be among the most essential of these and help differentiate a scientific process from a pseudoscientific one. The communal and collaborative nature of this approach further strengthens the objectivity of science by ensuring the inclusion of diverse perspectives and shared responsibility for its outcomes.

What type of knowledge do we produce?

Formal scientific knowledge may encompass several categories including representative models, explanatory theories and descriptive laws. As the focus of each discipline of natural science differs, so too does the balance of their contributions to each category. What remains constant, however, is the acknowledgement of assumptions, exceptions and limitations of scientific knowledge to provide realistic parameters to our understanding of the natural world. Claims of certainty are treated with caution given the presence of paradigmatic shifts throughout the history of science.

What is the impact of scientific knowledge?

As well as the pursuit of knowledge for its own sake, it is useful to consider the interplay of science with other areas of society. Although advances in technology traditionally fuelled great leaps in scientific understanding, in recent times it may be more common to see science as a driver of technological development. In addition, the implications of science within environmental, political, social, cultural and economic domains can also be profound. These connections illustrate the importance of local, national and international scientific bodies that engage with the public understanding of science and heighten the responsibility of scientists to adhere to principles of academic integrity in their research.

How is NOS different from TOK?

In contrast to the specificity of understanding of science, the TOK course encourages students to think critically about the concepts that underpin knowledge production. For example, peer review is used as a tool to support objectivity in scientific research. Through the study of TOK, students question the limitations of the peer review process and extend their thinking to an assessment of objectivity in other areas of knowledge.

Table 1

Aspects of nature of science

Aspects	How are scientific knowledge claims generated, tested, communicated, evaluated and used? What issues arise from these actions?
Observations	Scientists act as observers, looking at Earth and all other parts of the universe, to obtain data about natural phenomena. Observations can be made directly using human senses, or with the aid of instruments such as electronic sensors. Unexpected or unplanned observations can open up new research fields.
Patterns and trends	Scientists analyse their observations, looking for patterns or trends, and try to draw general conclusions by inductive reasoning. They also look for discrepancies. Scientists classify objects through pattern recognition. A trend may take the form of a positive or negative correlation between variables. Correlations may be based on a causal relationship, but correlation does not prove causation.
Hypotheses	Scientists make provisional explanations for the patterns that they have observed in natural phenomena. These hypotheses can be tested, with further observations or experiments, to obtain support for a hypothesis or show that it is false.
Experiments	Scientists design and perform experiments to obtain data, which can be used to test hypotheses. The quality of experimental evidence depends on careful control of variables and on the quantity of data generated. Progress in science often follows technological developments that allow new experimental techniques. Creativity and imagination play a role in experimental design, interpretation and conclusion.
Measurement	Quantitative measurements are more objective than qualitative observations, but all measurements are limited in precision and accuracy. Measurements are repeated to strengthen the reliability of data. Random errors in measurement due to unknown or unpredictable differences lead to imprecision and uncertainty, whereas systematic errors lead to inaccuracy.
Models	Scientists construct models as artificial representations of natural phenomena. They are useful when direct observation or experimentation is difficult. Models are simplifications of complex systems and can be physical representations, abstract diagrams, mathematical equations or algorithms. All models have limitations that need to be considered in their application.
Evidence	Scientists adopt a sceptical attitude to claims and evaluate them using evidence. Some claims cannot be tested using verifiable evidence, so cannot be falsified. They are therefore not scientific. Scientific knowledge must be supported by evidence.
Theories	Scientists develop general explanations that are widely applicable, based on observed patterns or tested hypotheses. Predictions can be generated from these theories by deductive reasoning. If these predictions are tested, they may corroborate a theory or show that it is false and should be rejected. Paradigm shifts take place when a new theory replaces an old one. The term “law” is sometimes

Aspects	How are scientific knowledge claims generated, tested, communicated, evaluated and used? What issues arise from these actions?
	used for statements that allow predictions to be made about natural phenomena without explaining them.
Falsification	Scientists can use evidence to falsify a claim formulated as a hypothesis, theory or model, but they cannot prove with certainty that such a claim is true. There is therefore inherent uncertainty in all scientific knowledge. Nonetheless, many theories in science are corroborated by strong evidence and allow for prediction and explanation. Scientists must remain open-minded with respect to new evidence.
Science as a shared endeavour	Scientists communicate and collaborate throughout the world. Agreed conventions and common terminology facilitate unambiguous communication. Peer review is essential to verify the research methods of knowledge claims prior to their publication in journals.
Global impact of science	Scientists have an obligation to assess the risks associated with their work and must aim to do no harm. Developments in science may have ethical, environmental, political, social, cultural and economic consequences that must be considered during decision-making. The pursuit of science may have unintended consequences. Research proposals are often filtered through ethics boards. Scientists have a responsibility to communicate their findings to the public with honesty and clarity.

Nature of sports, exercise and health science

What is SEHS?

A human and experimental science

SEHS is a human science driven by curiosity about what makes humankind flourish, both physically and mentally. Spanning multiple disciplines, it is the formal study of the impacts of physiology, biomechanics and psychology on human health and athletic performance. Its most prominent advances have occurred from the late 19th century onwards, in tandem with similar advances in other scientific and technological fields.

Like other DP sciences, SEHS is also an experimental science that combines academic study with the acquisition of practical and investigative skills. Students undertake practical experimental investigations in both laboratory and field settings. This helps them to acquire the knowledge and understanding necessary to apply scientific principles to the critical analysis of humankind and its sporting endeavours.

Three key themes

The course is divided into three themes: "Exercise physiology and nutrition of the human body", "Biomechanics" and "Sports psychology and motor learning". Each of these themes is explored through the dual lenses of health and performance.

In "Exercise physiology and nutrition of the human body", students explore three subtopics:

- Communication
- Hydration and nutrition
- Response

They may explore guiding questions such as: "How does our body respond to changes in lifestyle, environment and qualities of training?"

In "Biomechanics", students delve into three subtopics:

- Generating movement in the body
- Forces, motion and movement
- Injury

Guiding questions include: "What are the primary causes of musculoskeletal injury?" and "How can they be prevented and treated?"

The third theme is "Sports psychology and motor learning", where students probe five subtopics:

- Individual differences
- Motor learning
- Motivation
- Stress and coping
- Psychological skills

Guiding questions may include: "What characteristics explain how and why some individuals succeed and experience well-being in sport and health contexts more than others?"

Why study SEHS?

Thriving through sports

By studying SEHS, students explore what it means to thrive in terms of physical activity, athletic performance and personal health. Uniquely among the DP sciences, the course has immediate everyday applicability outside the classroom. Students can apply what they have learned to their daily lives, positively impacting their personal health and sporting performance.

Excelling in sports requires a mixture of innate ability and the dedicated pursuit of self-improvement. Sporting excellence is best achieved through a planned, incremental, long-term programme of physical and mental training and skills development. This also needs to be accompanied by appropriate nutrition, rest and sleep. Planning such a programme is the role of the sports, exercise and health scientist who, regardless of the sport involved, must be equipped with the necessary knowledge to perform this task competently. The design of a training programme should be considered and analytical, requiring careful consideration of the physiological, biomechanical and psychological demands of the individual and the activity they will be involved in.

Through the lenses of both health and performance, students can apply the concepts and skills they develop in this course to their own sporting endeavours, demonstrating agency in making informed personal choices. They can also apply these to their broader community. In a world where millions are physically inactive and afflicted by chronic disease and ill health, the sports, exercise and health scientist can be as proficient in prescribing exercise for general health and well-being as they can be in prescribing it for an aspiring athlete. SEHS is therefore an excellent grounding for more advanced courses in higher or further education related to sports, fitness and health, and serves as useful preparation for employment in physical activity fields.

Distinction between SL and HL

Students at SL and HL share the following.

- An understanding of science through a stimulating experimental programme
- The nature of science as an overarching theme
- The study of a concept-based syllabus
- One piece of internally assessed work, the scientific investigation
- The collaborative sciences project

The SL course provides students with a fundamental understanding of SEHS and experience of the associated skills. The HL course requires students to increase their knowledge and understanding of the subject, and so provides a solid foundation for further study at university level.

The SL course has a recommended 150 teaching hours, compared to 240 hours for the HL course. This difference is reflected in the additional content studied by HL students. Some of the HL content is conceptually more demanding and explored in greater depth. The distinction between SL and HL is therefore one of both breadth and depth. The increased breadth and depth at HL result in increased networked knowledge, requiring the student to make more connections between diverse areas of the syllabus.

SEHS and the core

SEHS and theory of knowledge

The TOK course plays a special role in the DP by providing opportunities for students to reflect on the nature, scope and limitations of knowledge and the process of knowing through an exploration of knowledge questions.

The areas of knowledge (AOK) are specific branches of knowledge, each of which can be seen to have a distinct nature and sometimes use different methods of gaining knowledge. In TOK, students explore five compulsory AOK: history, the human sciences, the natural sciences, mathematics and the arts.

There are several different ways in which aspects of the SEHS course can be connected to the exploration of knowledge. During the learning and teaching of the SEHS course, teachers and students evaluate knowledge claims by exploring questions concerning their validity, reliability, credibility and certainty, as well as individual and cultural perspectives on them.

Exploration of the relationship between knowledge and TOK concepts can help students to deepen their understanding and make connections between disciplines. For example, when discussing motivational theories in SEHS, students can explore the concepts of certainty, interpretation and culture.

Many aspects of the SEHS course lend themselves to the exploration of knowledge questions. Some examples are provided in the following table.

Table 2

Examples of knowledge questions

Learning opportunities	Knowledge questions
A.2.2 Fuelling for health and performance	What role does personal experience play in the formation of knowledge claims?
C.3 Motivation	What beliefs, if any, are independent of culture? Can personal experience be equated with knowledge? To what extent can it be shared knowledge?
A.1.1 Inter-system communication	How can we establish whether hormones are an “active ingredient” impacting performance? Under what circumstances might doubt undermine the construction or acquisition of knowledge? How important is visual or perceivable proof in the natural sciences?
A.2.2.3 Gut microbiome	How do we distinguish science from pseudoscience? How is it possible that scientific knowledge changes over time? What role do paradigm shifts play in the progression of scientific knowledge?
B.3 Injury	What constitutes an acceptable level of risk in sport?
B1.3 Muscular function and adenosine triphosphate (ATP)	How can we trust knowledge that we cannot see?
C.2.1 Motor learning processes	How should scientists choose between conflicting theories?

For more information, please refer to the *Theory of knowledge guide* and the *Theory of knowledge teacher support material.*

SEHS and the extended essay

Students who choose to write an EE in SEHS undertake independent research as part of an in-depth study of a focused topic. The topic for study may be generated from the SEHS course or may relate to a subject area beyond the syllabus content. This detailed study will help develop research, thinking, self-management and communication skills, which will support students’ learning in the SEHS course, and in further studies.

Examples of areas for research topics

- Motivational climate—how different types of feedback may affect serving technique in volleyball.

- Inter-system communication—the effects of the menstrual cycle on perceived or actual performance in some athletes.
- Recovery from training—methods for optimal recovery following high-intensity interval training (HIIT).

Students and supervisors must ensure that an EE does not duplicate other work submitted for the diploma. For more information, please refer to the *Extended essay guide* and the *Extended essay teacher support material*.

SEHS and creativity, activity, service

The CAS component of the DP core provides many opportunities for students to link science, sport and health concepts and topics to practical experiences. Teachers can highlight how knowledge and understanding developed through the course might inform meaningful experiences. Outside the classroom, CAS experiences might also ignite students' passion for addressing topics inside the SEHS classroom.

Some examples of relevant CAS experiences are as follows.

- Organizing a sports club for students in lower years
- Implementing health initiatives within the school or local community: for example, a nutrition and exercise awareness day
- Organizing or participating in a social media outreach or advocacy campaign: for example, on an environmental issue or health concern

CAS experiences can be a single event or may be an extended series of events. It is important that CAS experiences be distinct from and not submitted as part of a SEHS assessment.

For more information, please refer to the *Creativity, activity, service guide* and the *Creativity, activity, service teacher support material*.

SEHS and international-mindedness

Science has been, and continues to be, a truly international endeavour. From the beginnings of seismology in China, through material science in Mesopotamia to astronomy in the Islamic Golden Age, the search for an objective understanding of the natural world transcends the limitations imposed by national boundaries. The scientific process, requiring curiosity, insight and an open-minded approach, benefits from the widest possible participation across genders and cultures through inclusivity and diversity.

Given the global nature of many scientific issues, international organizations often have a focus on the engagement of science with the public domain. The World Health Organization and the Intergovernmental Panel on Climate Change are two well-known examples that model a responsibility to inform nations of scientific progress on an equitable basis. Underlying this responsibility is the interest of promoting a peaceful and sustainable future.

Advancements in technology, along with the cost of modern research facilities, continues to reinforce the role of international collaborative work. Both the Human Genome Project and the Human Microbiome Project are good examples of international collaboration.

The importance of collaboration in contemporary science is reflected by the large number of international organizations tasked with collating and sharing data with the scientific community. Access to shared knowledge through websites and databases must be integrated into classroom teaching as it plays an important role in validating experimental work.

In addition to integrating technology and collaborative work, the collaborative sciences project provides an excellent opportunity for students to engage with global issues.

Teachers are encouraged to consider the resources developed in the TSM, to allow students to reflect on where and how science might interact with society. These conversations may also introduce ethical questions such as those identified in the TOK syllabus.

SEHS and the IB learner profile

Each box provides an example of how each learner profile attribute could be modelled by learners and teachers.

Example attribute
• Learners who best embody the attribute with reference to science. • Directing teachers with possible routes to develop the attribute in the classroom. • Practical ways in which learners demonstrate the attribute in the process of "doing" science.

Attributes of the IB learner profile

Inquirer
• Inquirers are curious, they actively use research skills, work independently and show enthusiasm about the world around them. • Teachers facilitate skill development and promote inquiry; they provide students with opportunities to ask questions, search for answers and experiment. • Learners use their inquiry skills to extend their scientific knowledge and engage with research.

Knowledgeable
• Learners explore concepts, ideas and issues related to science in order to broaden and deepen their understanding of factual and procedural knowledge. • Access to a variety of resources and opportunities provides learner agency to develop scientific knowledge and understanding. • Learners apply their knowledge to unfamiliar contexts and make connections between concepts and facts to illustrate their understanding of science.

Thinker
• Learners are eager to solve complex problems and reflect on their thinking strategies. • Teachers provide opportunities for learners to critically analyse their approaches and methods, and deepen their understanding of science, allowing them to be creative in finding solutions to problems. • Learners practise reasoning and critical thinking by testing assumptions, formulating hypotheses, interpreting data and drawing conclusions from the evidence provided.

Communicator
• Learners collaborate effectively with others and use a variety of modes of communication to express their ideas and opinions. • Teachers facilitate group work, encourage open discussions and the use of scientific language to provide models for successful communication. • Learners demonstrate effective communication skills as part of collaborative activities through listening to others and sharing ideas.

Principled
• Learners take responsibility for their work, promote shared values and act in an ethical manner. • Teachers can provide opportunities to model principled behaviour including acknowledging the work of others and citing sources. The collaborative sciences project provides opportunities for learners to take a principled stance.

Principled
• Learners appreciate the importance of integrity in data collection and consider all data, even that which does not match their original hypothesis.

Open-minded
• Open-minded learners accept that different perspectives, models or hypotheses exist, and these can be used to enhance scientific understanding. • Teachers can provide models that were at the time supported by data or observations, but through reasoning, deduction or falsification may be rejected or refined. • Learners need to be prepared to have their perspectives and ideas challenged through the study of science.

Caring
• Learners act to protect the environment and to improve the lives of others. • Teachers can draw attention to how daily choices have consequences by challenging learners to adopt sustainable practice and providing support to help fellow learners. Reference should be made to the *Sciences experimentation guidelines*. • Learners can connect curriculum content to global challenges such as healthcare, energy supply or food production. The collaborative sciences project provides an opportunity for learners to support each other to enable their group to achieve their goal successfully.

Risk-taker
• Risk-takers seek new opportunities to develop their learning and explore new approaches to solve problems. They actively thrive on challenges. • Teachers can provide support and guidance for learners, encouraging them to explore new techniques or methods of learning. This might include scaffolds for the use of language, the design of experiments and the analysis of data. As learners grow in confidence, these supports can be phased out giving them more freedom to choose their own approach. • Learners should be prepared for the next set of experimental data to falsify their ideas as uncertainty is a feature of science. They understand that this is a step forward in their understanding.

Balanced
• Balanced learners look holistically at all aspects of their development and ensure that various tasks are given appropriate attention without focusing on one to the detriment of others. • Teachers should encourage learners to consider a balanced perspective on scientific issues without bias. • Learners need to organize their own time effectively, giving themselves sufficient time to complete all parts of their learning without negatively impacting on the emotional and social aspects of their lives.

Reflective
• Reflective learners consider why and how they achieve success, and also how they could change their approach when learning is difficult. • Teachers provide opportunities for learners to continually review strategies, methods, techniques and approaches to problem-solving in order to improve their conceptual understandings in science.

Reflective
Assessment criteria or checklists can help learners to consider the quality of their work in a guided way. • Learners develop skills and concepts throughout the course, networking their knowledge by continually reflecting on their understanding.

Approaches to learning and approaches to teaching SEHS

The approaches to learning framework

What are approaches to learning skills and why do we teach them?

The approaches to learning framework seeks to develop in students affective, cognitive and metacognitive skills that will support their learning processes during and beyond their IB experience. The development of approaches to learning skills is closely connected with the IB learner profile attributes and therefore helps to advance the IB mission. The approaches to learning skills are an integral part of IB learning and teaching that should be developed across the whole programme—it is not expected that a single course should ever address all of them.

How are they organized?

The approaches to learning framework for IB programmes consists of five general skill categories: thinking skills, communication skills, social skills, research skills and self-management skills. Each of these categories covers a broad range, as shown by the examples presented in the table below. The approaches to learning skill categories are closely linked and interrelated and therefore individual skills may be relevant to more than one category.

How do we teach them?

Approaches to learning skills can be learned and taught, improved with practice and developed incrementally. The table below illustrates, through a number of examples, how the SEHS course can support approaches to learning skills development. The examples shown in the table are not exhaustive. Teachers are encouraged to adapt them for use in their school context and collaboratively identify further examples of approaches to learning skills development.

Further information on the approaches to learning framework and strategies for the development of the approaches to learning skills can be found in the *SEHS teacher support material* and the *Diploma Programme Approaches to teaching and learning website*.

Table 3

Approaches to learning skills and development

Skill category	Examples of approaches to learning skills development in the classroom
Thinking skills	• Being curious about the natural world • Asking questions and framing hypotheses based upon sensible scientific rationale • Designing procedures and models • Reflecting on the credibility of results • Providing a reasoned argument to support conclusions • Evaluating and defending ethical positions • Combining different ideas in order to create new understandings • Applying key ideas and facts in new contexts • Engaging with, and designing, linking questions • Experimenting with new strategies for learning • Reflecting at all stages of the assessment and learning cycle

Skill category	Examples of approaches to learning skills development in the classroom
Communication skills	• Practising active listening skills • Evaluating extended writing in terms of relevance and structure • Applying interpretive techniques to different forms of media • Reflecting on the needs of the audience when creating engaging presentations • Clearly communicating complex ideas in response to open-ended questions • Using digital media for communicating information • Using terminology, symbols and communication conventions consistently and correctly • Presenting data appropriately • Delivering constructive criticism appropriately
Social skills	• Working collaboratively to achieve a common goal • Assigning and accepting specific roles during group activities • Appreciating the diverse talents and needs of others • Resolving conflicts during collaborative work • Actively seeking and considering the perspective of others • Reflecting on the impact of personal behaviour or comments on others • Constructively assessing the contribution of peers
Research skills	• Evaluating information sources for accuracy, bias, credibility and relevance • Explicitly discussing the importance of academic integrity and full acknowledgement of the ideas of others • Using a single, standard method of referencing and citation • Comparing, contrasting and validating information • Using search engines and libraries effectively
Self-management skills	• Breaking down major tasks into a sequence of stages • Being punctual and meeting deadlines • Taking risks and regarding setbacks as opportunities for growth • Avoiding unnecessary distractions • Drafting, revising and improving academic work • Setting learning goals and adjusting them in response to experience • Seeking and acting on feedback

Experimental programme

Integral to the student experience of a SEHS course is the learning that takes place through scientific inquiry within the classroom, laboratory or in the field. Experimentation through a variety of forms can be used to introduce a topic, address a phenomenon, or allow students to consider and examine authentic questions and curiosities.

A school's experimental programme should allow students to experience the full breadth and depth of the course, develop scientific skills and demonstrate safe, competent and methodical use of a range of tools, techniques and equipment. Students should therefore be encouraged to develop investigations to support their learning through open-ended inquiry with a focus on laboratory and fieldwork experiments, databases, simulations and modelling.

Conceptual learning

Concept-based learning and teaching is encouraged across the continuum of IB programmes.

Concepts are mental representations of categories. They are constructed, modified and activated by the learner through learning experiences. Concepts do not exist in isolation but are interrelated. Conceptual understanding is always a work in progress—it is continually being developed and refined.

Conceptual understanding is therefore an outcome of a non-linear, ongoing process of evolving understandings, adapting previous understandings, and identifying and dispelling misconceptions. It consists of making connections between prior and new knowledge to construct and build an awareness of this network of knowledge.

Concepts vary in their level of abstraction and universality.

- They can be organizing ideas that are applicable in many contexts and have relevance both within and across subject areas.
- They can provide a deep understanding of specific knowledge fields (or fields of knowledge) and help to organize knowledge further, as well as reveal connections between different areas of the subject.

For example, consider the following sequence of three concepts, which shows the more specific focus of each concept.

Change → Training → Personality

In other words, personality is a component in understanding training, which in turn helps to develop an understanding of change in an athlete's performance. The sequence could be extended further to look at concepts such as openness, extraversion and neuroticism, all of which provide a basis for understanding personality.

Outcomes of a concept-based approach

Fostering critical thinking, the outcome of a concept-based approach is that students are able to:

- identify examples of a concept
- organize, reflect on, modify and expand their network of knowledge
- apply concepts to existing and future knowledge
- apply their conceptual understanding as a scientific thinking tool for predicting outcomes, justifying conclusions and evaluating knowledge claims.

Structure of the syllabus and conceptual understanding

The structure of this SEHS syllabus is intended to promote concept-based learning and teaching.

There are three broad organizing themes in the SEHS roadmap:

- exercise physiology and nutrition of the human body
- biomechanics
- sports psychology and motor learning.

Inherently, the three themes are highly intertwined. They can therefore be taught in any order to promote conceptual understanding and to suit the needs of students and teachers within their particular school's environment.

The content in each theme is further arranged into topics, each with a guiding question. The guiding question gives a sense of what is covered in the topic, but more importantly, it is a signpost to promote inquiry. Guiding questions are therefore not straightforward and are best answered once the associated understandings have been acquired. Teachers and students are encouraged to create their own guiding questions to capture the content of topics of study.

Several linking questions are associated with each subtopic throughout this guide. Linking questions strengthen students' understanding by making connections. They are intended to promote skills in the study of SEHS and the nature of science, and highlight links between the course understandings. They encourage students to look at an understanding from a different perspective, originating in a different part of the course. The ideal outcome of answering the linking questions is networked knowledge.

The linking questions in the guide are not exhaustive. Students and teachers may conceive of other connections between understandings and concepts in the syllabus, leading them to create their own linking questions.

Teaching SEHS in context

The study of SEHS enables constructive engagement with topical scientific issues. By contextualizing SEHS concepts, scientific knowledge claims can be evaluated more effectively, and informed choices on issues like human health can be made. Research has brought innovation and benefit to many fields and continues to be at the heart of seeking effective solutions to many global challenges. It is therefore important to explore applications of SEHS in our world while teaching the course to elicit interest, understanding and curiosity.

Teaching the content of the course in relation to specific contexts supports the pedagogical principle of teaching in local and global contexts as part of the approaches to teaching framework and offers a number of advantages. First, it helps students relate their learning to genuine applications of SEHS, highlighting the relevance to global issues as well as the significance in students' own contexts. Second, it develops an appreciation for the interaction between scientific solutions and their implications, be it ethical, environmental or economic. Third, it helps to illustrate some of the NOS features underpinning the course.

The *SEHS teacher support material* highlights possible areas that could be visited throughout the course and that may provide context for some topics to stimulate the application of ideas and problem-solving skills. Consideration of these and related areas may help provide ideas for the scientific investigation, the collaborative sciences project, TOK exhibition, CAS, or an EE in SEHS or world studies.

Engaging with sensitive topics

Students and teachers are encouraged to engage with exciting, stimulating and personally relevant topics and issues that may be, at times, sensitive or personally challenging. Teachers should be aware of this and provide guidance on how to engage with such topics in a responsible manner. Consideration should be given to the personal, political and spiritual values of others.

Prior learning

Past experience shows that students will be able to study SEHS at SL successfully with no background in, or previous knowledge of, science. Their approach to learning, characterized by the IB learner profile attributes, will be significant here.

However, for most students considering the study of SEHS at HL, while there is no intention to restrict access, some previous exposure to formal science education would be necessary. Specific topic details are not specified but students who have undertaken the IB Middle Years Programme (MYP) or studied an equivalent national science qualification or a school-based science course would be well prepared for an HL subject.

Links to the Middle Years Programme

The MYP sciences courses seek to promote skills and attitudes needed to apply scientific knowledge in theoretical, experimental and authentic contexts. A strong foundation is established for DP sciences in which learners will capitalize on—and continue advancing—their skills and attitudes to develop knowledge and understanding commensurate with pre-university level science.

The MYP offers a framework for learning and teaching while maintaining flexibility with curriculum content. The content in MYP sciences courses can therefore vary greatly from one school to another. Content in DP sciences courses is more prescribed, and this is one of the main differences teachers will notice when comparing the two programmes.

A connected, conceptual curriculum where learning is inquiry-based and contextualized are the pedagogical principles that underpin both programmes and indeed the entire IB continuum (International Baccalaureate, 2019).

Conceptual learning focuses on organizing ideas and their interconnections. A conceptual approach is encouraged in IB programmes because it promotes deep learning and facilitates the construction of further knowledge. Conceptual understanding aids the application of knowledge in unfamiliar and novel contexts. This skill is reflected in the aims and assessment objectives of both programmes.

Broad concepts frame MYP learning and teaching with the purpose of unifying ideas across subject areas. Discipline-specific related concepts are intended to provide disciplinary depth (International Baccalaureate, 2014). Key and related concepts are not required in the DP, although some teachers may find that they wish to continue developing a curriculum around them. In DP sciences, overarching concepts are manifested in the course roadmaps and the NOS. DP sciences seek to highlight the interconnectedness of the course understandings. The intention is to promote conceptual understanding and further the construction of learners' knowledge networks.

Both MYP and DP teaching involve inquiry-based approaches, which foster a high degree of student engagement, collaboration and interaction. The inquiry, design, experimental, analysis, evaluation and communication skills encouraged by criteria B and C will serve students well as they prepare to undertake the scientific investigation for the internal assessment (IA). In addition, MYP students will gain familiarity with criterion-related assessment and the use of assessment criteria, which will further support their understanding of the DP sciences IA criteria.

IB programmes encourage the exploration of scientific principles in connection to local and global contexts. Doing so helps students ground abstract concepts in more concrete local and global real-world situations as well as cultivating international-mindedness (see the "Approaches to teaching" section in *Diploma Programme Approaches to teaching and learning website*). Teachers should therefore weave opportunities for contextualization into the curriculum. MYP sciences criterion D analyses the real-world application of science. In the DP, sciences teachers are encouraged to frequently anchor their teaching in real-world applications that are invoked throughout the course of the programme.

In addition to equipping students with scientific knowledge and skills, the MYP and DP sciences courses share similar guiding principles that seek to develop in students the learner profile attributes.

Links to the Career-related Programme

In the Career-related Programme (CP), students study at least two DP subjects, a core consisting of four components and a career-related study, which is determined by the local context and aligned with student needs. The CP has been designed to add value to the students' career-related studies. This provides the context for the choice of DP courses. The SEHS course can assist CP students planning careers in a variety of professional fields where, for example, a sound understanding of science skills is important. These include healthcare and numerous careers in the sport industry, such as coaching. While SEHS helps students understand the underlying science in sport and health, it also encourages the development of strong problem-solving, critical thinking and ethical approaches that will assist students in the global workplace.

Collaborative sciences project

The collaborative sciences project is an interdisciplinary sciences project, providing a worthwhile challenge to DP and CP students, addressing real-world problems that can be explored through the sciences. The nature of the challenge should allow students to integrate factual, procedural and conceptual knowledge developed through the study of their disciplines.

Through the identification and research of complex issues, students can develop an understanding of how interrelated systems, mechanisms and processes impact a problem. Students will then apply their collective understanding to develop solution-focused strategies that address the issue. With a critical lens they will evaluate and reflect on the inherent complexity of solving real-world problems.

Students will develop an understanding of the extent of global interconnectedness between regional, national and local communities, which will empower them to become active and engaged citizens of the world. While addressing local and global issues, students will appreciate that the issues of today exist across national boundaries and can only be solved through collective action and international cooperation.

The collaborative sciences project supports the development of students' approaches to learning skills, including teambuilding, negotiation and leadership. It facilitates an appreciation of the environment, and the social and ethical implications of science and technology.

Full details of the requirements are in the *Collaborative sciences project guide*.

Aims

The course enables students, through the overarching theme of the NOS, to:

1. develop conceptual understanding that allows connections to be made between different areas of the subject, and to other DP sciences subjects
2. acquire and apply a body of knowledge, methods, tools and techniques that characterize science
3. develop the ability to analyse, evaluate and synthesize scientific information and claims
4. develop the ability to approach unfamiliar situations with creativity and resilience
5. design and model solutions to local and global problems in a scientific context
6. develop an appreciation of the possibilities and limitations of science
7. develop technology skills in a scientific context
8. develop the ability to communicate and collaborate effectively
9. develop awareness of the ethical, environmental, economic, cultural and social impact of science.

Assessment objectives

The assessment objectives for SEHS reflect those parts of the aims that will be formally assessed either internally or externally. It is the intention of this course that students are able to fulfil the following assessment objectives.

1. Demonstrate knowledge of:
    a. terminology, facts and concepts
    b. skills, techniques and methodologies.
2. Understand and apply knowledge of:
    a. terminology and concepts
    b. skills, techniques and methodologies.
3. Analyse, evaluate and synthesize:
    a. experimental procedures
    b. primary and secondary data
    c. trends, patterns and predictions.
4. Demonstrate the application of skills necessary to carry out insightful and ethical investigations.

Assessment objectives in practice

Assessments align with the course's aims, objectives and conceptual approach; the NOS, and subject-specific skills are also assessed. This allows students to demonstrate learning effectively through varied tasks that are reliably and accurately marked or moderated by subject-area educators and experts.

Assessment objective	Which component addresses this assessment objective?	How is the assessment objective addressed?
AO1 Demonstrate knowledge	Paper 1 Paper 2 Scientific investigation	Students respond to a range of multiple-choice, short-answer questions and extended-response questions. Students investigate and answer a research question that is their own.
AO2 Understand and apply knowledge	Paper 1 Paper 2 Scientific investigation	Students respond to a range of multiple-choice, short-answer, data-based and extended-response questions. Students investigate and answer a research question that is their own.
AO3 Analyse, evaluate and synthesize	Paper 1 Paper 2 Scientific investigation	Students respond to a range of multiple-choice, short-answer, data-based and extended-response questions. Students investigate and answer a research question that is their own.
AO4 Demonstrate the application of skills necessary to carry out insightful and ethical investigations	Scientific investigation	Students investigate and answer a research question that is their own.

Component	Approximate weighting of assessment objectives (%)	
	AO1 + AO2	AO3
Paper 1	50	50
Paper 2	50	50
Internal assessment	Covers AO1, AO2, AO3 and AO4	

Syllabus outline

Syllabus component	Teaching hours	
	SL	HL
Syllabus content	**110**	**180**
A. Exercise physiology and nutrition of the human body	47	69
B. Biomechanics	30	57
C. Sports psychology and motor learning	33	54
Experimental programme	**40**	**60**
Practical work	20	40
Collaborative sciences project	10	10
Scientific investigation	10	10
Total teaching hours	**150**	**240**

The recommended teaching time is 150 hours to complete courses at standard level (SL) and 240 hours to complete courses at higher level (HL), as stated in the general regulations (in *Diploma Programme Assessment procedures*).

Syllabus roadmap

The aim of the syllabus is to integrate concepts, topic content and the nature of science (NOS), through inquiry. Students and teachers are encouraged to personalize their approach to the syllabus according to their circumstances and interests.

Figure 2

SEHS roadmap via the interconnected organizing themes

A. Exercise physiology and nutrition of the human body

A.1 Communication

- A.1.1 Inter-system communication
- A.1.2 Maintaining homeostasis
- A.1.3 Transport

A.2 Hydration and nutrition

- A.2.1 Water and electrolyte balance
- A.2.2 Fuelling for health and performance
- A.2.3 Energy systems

A.3 Response

- A.3.1 Qualities of training
- A.3.2 Benefits to health of being active
- A.3.3 Fatigue and recovery

B. Biomechanics

B.1 Generating movement in the body

- B.1.1 Anatomical position, planes and movement
- B.1.2 Structure and function of connective tissues and joints
- B.1.3 Muscular function
- B.1.4 Levers in movement and sport

B.2 Forces, motion and movement

- B.2.1 Newton's laws of motion
- B.2.2 Fluid mechanics
- B.2.3 Movement analysis and its applications

B.3 Injury

- B.3.1 Causes of injury
- B.3.2 Interventions related to injury

C. Sports psychology and motor learning

C.1 Individual differences

- C.1.1 Personality
- C.1.2 Mental toughness

C.2 Motor learning

- C.2.1 Motor learning processes
- C.2.2 Attentional control

C.3 Motivation

- C.3.1 Achievement motivation
- C.3.2 Self-determination
- C.3.3 Motivational climate

C.4 Stress and coping

- C.4.1 Arousal and anxiety
- C.4.2 Coping

C.5 Psychological skills

- C.5.1 Goal setting
- C.5.2 Imagery

Syllabus format

Topic name

The **guiding question** frames the topic. By studying the topic, students will be able to answer the question with increasing depth.

Each topic is divided into numbered subtopics.

Standard level and higher level: 3 hours

Standard level and higher level must be covered for both SL and HL courses.

Each subtopic is divided into numbered **Understandings**. The first statement in **bold** is the content statement.

The second statement (and any further such statements) in normal text are the outcomes of learning and teaching.

They clarify the requirements and parameters of the skills and understandings students should acquire.

Additional higher level content is only for the HL course.

These are **linking questions** from this subtopic to another in SEHS, or to "Skills in the study of SEHS" or "Nature of science". The questions can be asked in either direction. They signpost related concepts and encourage problem-solving beyond the immediate content. Teachers and students are encouraged to create their own linking questions.

The **recommended hours** should be sufficient to teach this subtopic. They should also be sufficient for assessment of learning, and to cover material from "Skills in the study of SEHS" and "Nature of science".

The time allocated to the experimental programme is in addition to these recommended hours.

B.1 Generating movement in the body

Guiding question: How are the structure and function of the musculoskeletal system related to movement of the human body?

B.1.1 Anatomical position, planes and movement

Standard level and higher level: 3 hours

B.1.1.1—The human skeleton is divided into an axial component and an appendicular component. These have different primary functions.
Positional terminology is used to describe the relative positions of body parts. For example: superior, inferior, proximal, distal, anterior, posterior, medial, lateral and intermediate. A diagram of the skeletal system is found in the *SEHS data booklet*.

B.1.1.2—Movements occur in one or more planes, and rotations occur along one or more axes
Movements are described by a set of specific terms: flexion, extension, abduction, adduction, pronation, supination, protraction, retraction, opposition, reposition, inversion, eversion, elevation, depression, circumduction, rotation, plantarflexion, dorsiflexion, horizontal flexion and horizontal extension. A diagram of the major planes is found in the *SEHS data booklet*.

Linking question(s)

C.2.1—Can understanding and applying the correct anatomical terms of movement increase the rate of learning a skill?

Additional higher level 3 hours

B.1.1.3—Anthropometry, the measurement of body segments and proportions of the human body, has applications in many areas of sport and health science.
Anthropometric databases are used by equipment manufacturers for the design and sizing of equipment. Ergonomic design improves efficiency during performance.

Linking question(s)

B.3.2—How does the use of anthropometry assist with the design of protective equipment?

Skills in the study of SEHS

The skills and techniques students must experience through the course are encompassed within the tools. These support the application and development of the inquiry process in the delivery of the SEHS course.

Tools

- **Tool 1:** Experimental techniques
- **Tool 2:** Technology
- **Tool 3:** Mathematics

Inquiry process

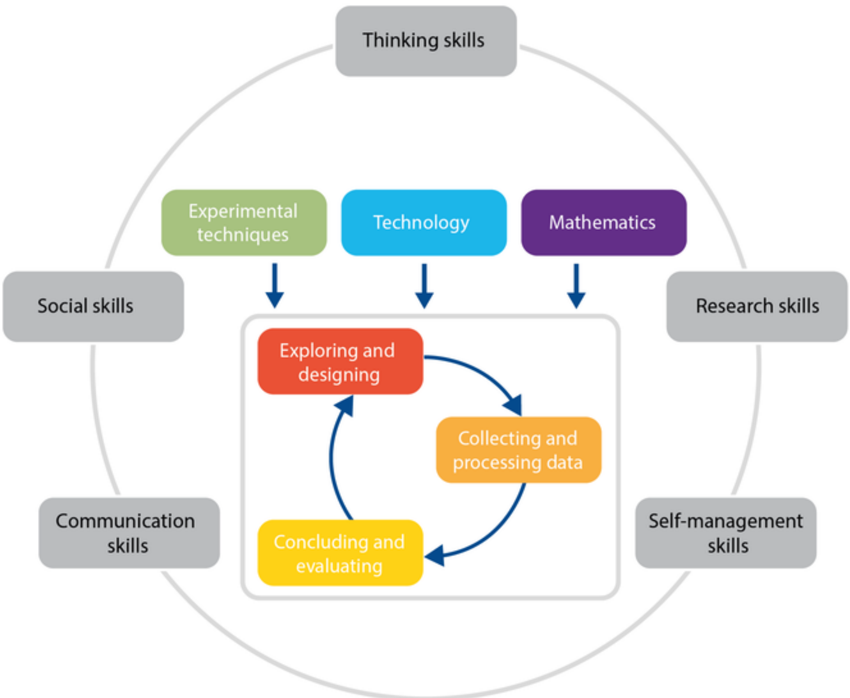
- **Inquiry 1:** Exploring and designing
- **Inquiry 2:** Collecting and processing data
- **Inquiry 3:** Concluding and evaluating

Teachers are encouraged to provide opportunities for students to encounter and practise the skills throughout the programme. Rather than being taught as stand-alone topics, they should be integrated into the teaching of the syllabus when they are relevant to the syllabus topics being covered. The skills in the study of SEHS can be assessed through internal and external assessment.

The approaches to learning provide the framework for the development of these skills.

Figure 3

Skills for SEHS



Tools

Tool 1: Experimental techniques

Skill	Description
Addressing safety of self, others and the environment	• Recognize and address relevant safety, ethical or environmental issues in an investigation.
Measuring variables	Understand how to accurately measure the following to an appropriate level of precision: • mass • volume • time • temperature • length • rate of physiological change (heat and respiration rates). Make careful observations, including: • counts • relevant qualitative observations • kinematic observations of motion.
Applying techniques	Show awareness of the purpose and practice of performance tests to measure individual components of fitness: • aerobic capacity • power • strength • muscular endurance • balance • body composition • flexibility • reaction • coordination • speed • agility. Methods to quantify perceived exertion. Use of questionnaires to quantify psychological constructs.

Tool 2: Technology

Skill	Description
Applying technology to collect data	• Use sensors. • Identify and extract data from databases. • Generate data from models and simulations.

Skill	Description
Applying technology to process data	• Use spreadsheets to manipulate data. • Represent data in a graphical form. • Use computer modelling. • Carry out image analysis.

Tool 3: Mathematics

Skill	Description
Applying general mathematics	• Use basic arithmetic and algebraic calculations to solve problems. • Carry out calculations involving decimals, fractions, percentages, ratios and reciprocals. • Calculate measures of central tendency: mean, median and mode. • Apply measures of dispersion: range, standard deviation, coefficient of variation (relative standard deviation), standard error and interquartile range. • Use and interpret scientific notation (for example, 3.5×10^6). • Use approximation and estimation. • Appreciate when some effects can be ignored and why this is useful. • Compare and quote values to the nearest order of magnitude. • Understand direct and inverse proportionality, as well as positive and negative correlations between variables. • Calculate and interpret percentage change and percentage difference. • Calculate and interpret percentage error and percentage uncertainty. • Distinguish between continuous and discrete variables. • Apply the *t*-test.
Using units, symbols and numerical values	• Apply and use International System of Units (SI) prefixes and units. • Identify and use symbols stated in the guide and the *SEHS data booklet*. • Express quantities and uncertainties to an appropriate number of significant figures or decimal places.
Processing uncertainties	• Understand the significance of uncertainties in raw and processed data. • Record uncertainties in measurements as a range (±) to an appropriate level of precision. • Express measurement and processed uncertainties—absolute, fractional (relative) or percentage—to an appropriate number of significant figures or level of precision. • Apply the coefficient of determination (R^2) to evaluate the fit of a trend line or curve. • Interpret values of the correlation coefficient (r), identify correlations as positive or negative, and compare the values to a critical value table.

Skill	Description
	• Apply and interpret appropriate tests of statistical significance (for example, the *t*-test) and understand the $p = 0.05$ level.
Graphing	• Sketch graphs, with labelled but unscaled axes, to qualitatively describe trends. • Construct and interpret tables, charts and graphs for raw and processed data, including bar and pie charts, histograms, scatter graphs, and line and curve graphs. • Plot linear and non-linear graphs showing the relationship between two variables with appropriate scales and axes. • Draw lines or curves of best fit. • Interpret features of graphs including gradient, changes in gradient, intercepts, maxima and minima, and areas. • Draw and interpret uncertainty bars. • Extrapolate and interpolate graphs.

Inquiry process

Inquiry 1: Exploring and designing

Skill	Description
Exploring	• Demonstrate independent thinking, initiative, and insight. • Consult a variety of sources. • Select sufficient and relevant sources of information. • Formulate research questions and hypotheses. • State and explain predictions using scientific understanding. • Understand null and alternative hypotheses.
Designing	• Demonstrate creativity in the designing, implementation and presentation of the investigation. • Develop investigations that involve hands-on laboratory experiments, databases, simulations and modelling. • Identify and justify the choice of dependent, independent and control variables. • Justify the range and quantity of measurements. • Design and explain a valid methodology. • Pilot methodologies.
Controlling variables	Appreciate when and how to: • reduce bias in study design: a. choose representative random samples b. single and double blinding c. cross-over study design including randomized allocation of participants to conditions d. placebo effect • reduce the confounding effects of human factors on physiological performance

Skill	Description
	• calibrate measuring apparatus.

Inquiry 2: Collecting and processing data

Skill	Description
Collecting data	• Identify and record relevant qualitative observations. • Collect and record sufficient relevant quantitative data. • Identify and address issues that arise during data collection.
Processing data	• Carry out relevant and accurate data processing.
Interpreting results	• Interpret qualitative and quantitative data. • Interpret diagrams, graphs and charts. • Identify, describe and explain patterns, trends and relationships. • Identify and justify the removal or inclusion of outliers in data (no mathematical processing is required). • Assess accuracy, precision, reliability and validity.

Inquiry 3: Concluding and evaluating

Skill	Description
Concluding	• Interpret processed data and analysis to draw and justify conclusions. • Compare the outcomes of an investigation to the accepted scientific context. • Relate the outcomes of an investigation to the stated research question or hypothesis. • Discuss the impact of uncertainties on the conclusions.
Evaluating	• Evaluate hypotheses. • Identify and discuss sources and impacts of random and systematic errors. • Evaluate the implications of methodological weaknesses, limitations and assumptions on conclusions. • Explain realistic and relevant improvements to an investigation.

Data booklet

The IB publishes an *SEHS data booklet* that contains relevant physical equations, constants and anatomy diagrams, specific to the course. Students must have access to a copy for the duration of the course, so that they can become familiar with its contents. Direct reference is made to the data booklet in the syllabus. This helps to maintain the emphasis on interpretation and application rather than memorization of data. A clean copy of the *SEHS data booklet* must also be made available to candidates for all examination papers at both SL and HL.

Syllabus content

A. Exercise physiology and nutrition of the human body

A.1 Communication

Guiding question: How does the body send and receive information about its internal environment to maintain optimal functioning conditions?

A.1.1 Inter-system communication

Standard level and higher level: 10 hours

A.1.1.1—The nervous system senses both internal and external conditions to coordinate the responses of the body's physiological systems effectively.
The nervous system is divided into the central nervous system and the peripheral nervous system. The efferent division is subdivided into the autonomic nervous system and the somatic nervous system. The autonomic nervous system is divided into the sympathetic and the parasympathetic nervous systems. Examples of the functions of each are required: • cardiac function, which includes an understanding of the role of extrinsic factors and how they work with the intrinsic mechanisms controlling heart rate • breathing and ventilation • temperature control. Proprioceptors, baroreceptors and chemoreceptors are specialized cells that respond to stimuli to initiate responses by the nervous system. The internal function of the various receptors is not assessed.

A.1.1.2—The endocrine system, made up of the body's glands and hormones, regulates all biological processes in the body.
Hormones are mediator molecules that are released in one part of the body but regulate the activity of cells in other parts of the body. Epinephrine and norepinephrine cause changes in blood pressure, heart rate and blood sugar levels. Insulin and glucagon regulate blood sugar concentration. Antidiuretic hormone regulates water retention in the kidney. Reproductive hormones impact health and athletic performance in the following ways: • progesterone—a thermogenic effect on thermoregulation and sleep quality, and an effect on fuel availability • oestrogen—effects on sparing glycogen and joint stiffness • testosterone—effects on bone formation, protein synthesis and erythropoietin.

Linking question(s)

B.1.3—How does coordination between the nervous system and the muscular system result in the ability to produce various types of movement?

Additional higher level: None for A.1.1

A.1.2 Maintaining homeostasis

Standard level and higher level: 6 hours

A.1.2.1—Homeostasis is any self-regulating biological process aiming to produce a relatively stable, constant internal environment for optimal functioning of the body. In response to changing internal and external conditions, various mechanisms work constantly towards homeostasis.
Homeostasis generally occurs via negative feedback mechanisms that reverse a change back to a controlled condition. Blood pH (hydrogen ion concentration) is influenced by carbon dioxide concentration. pH is monitored through the respiratory control centre of the brain and chemoreceptors throughout the body. Regulation of the heart is dependent on intrinsic and extrinsic excitation. A diagram of the heart's structure is found in the *SEHS data booklet*. Regulation of temperature (thermoregulation) relies on the cardiovascular, muscular, nervous and integumentary systems working together to maintain a core body temperature of 37 ± 1°C. Thermoregulation occurs via the sweat response, vasodilation, vasoconstriction, shivering and non-shivering thermogenesis. Factors that affect thermoregulation are training status, body composition, environment and sex differences (including hormonal phases). Regulation of blood glucose relies on insulin and glucagon. Exercise limits the release of insulin and facilitates the uptake of glucose to regulate blood sugar levels.

Linking question(s)

A.2.2 and A.2.3—How does the endocrine system interact with the energy systems to maintain appropriate blood glucose levels?

Additional higher level: 5 hours

A.1.2.2—The body has acute and possible long-term responses to the environment in which it functions.
Short-term responses and long-term adaptations in the body can vary in response to the external environment (temperature, humidity, altitude). The extent to which the environment impacts performance of an activity depends on the nature of the activity. Different strategies can be used to support performance of an activity and acclimatize the body to varying environments.

Linking question(s)

C.1.2—How do the challenges of performing in varied environments influence mental toughness and learning?

Tool 1, Inquiry 2—How effective are experimental methods in creating double-blind experiments in varied environments?

A.1.3 Transport

Standard level and higher level: 7 hours

A.1.3.1—The cardiovascular system transports nutrients, hormones, gases, heat and waste to perform necessary bodily functions.
Heart rate, stroke volume, cardiac output, blood pressure and blood redistribution vary, and depend on factors such as age, sex differences, body size, level of fitness, type of activity and intensity of activity. A diagram of the cardiovascular system is found in the *SEHS data booklet*.

A.1.3.2—The respiratory system enables the exchange of gases between the external environment and the body, to facilitate cellular respiration.
Minute ventilation, tidal volume and change in respiration rate can vary, and depend on factors such as age, sex differences, body size, level of fitness, type of activity and intensity of activity. A diagram of the respiratory system is found in the *SEHS data booklet*.

Linking question(s)

A.3.1—How do specific qualities in long-term training influence the structures and functions of the cardiovascular system?

Tool 1, C.4.1—To what extent do cardiorespiratory measurements indicate stress and arousal levels?

Additional higher level: None for A.1.3

A.2 Hydration and nutrition

Guiding question: How do nutritional and hydration status influence the body's ability to perform a variety of activities?

A.2.1Water and electrolyte balance

Standard level and higher level: 3 hours

A.2.1.1—Water and electrolyte balance is necessary for effective functioning of the body and is influenced by the environment.
Water and electrolyte intake occurs via the large intestine. Loss of fluids and electrolytes occurs via evaporation through the skin and the respiratory tract, and excretion via osmosis. Dehydration, hypernatremia and hyponatremia are three states that can occur if water and electrolyte balance is not maintained. This will affect health and performance. Water and electrolyte balance can be measured in a variety of ways, including body weight, urine colour and osmolarity. Electrolyte balance is regulated by the hypothalamus, pituitary gland and kidneys. Knowledge of the function of the nephron and the structure of the kidneys are not assessed. Cardiovascular drift is caused by water loss from the body or an increase in core body temperature during a prolonged steady state of submaximal (or aerobic) exercise in thermoneutral and hot environments.

Linking question(s)

NOS, A.1.1—How reliable is the sensation of thirst as an indicator of dehydration?

A.1.2 HL—What is the relationship between the external environment and electrolyte balance?

Tool 1, Inquiry 2 and 3—Which techniques are most suitable for generating valid and reliable data on the internal conditions of the body during exercise?

Additional higher level: None for A.2.1

A.2.2 Fuelling for health and performance

Standard level and higher level: 6 hours

A.2.2.1—Macronutrients (carbohydrates, proteins and lipids) provide sources of energy to maintain bodily functions during growth, rest and physical activity.
Relative contributions of macronutrients to bodily functions depend on an individual's body composition, age, sex differences and activity level. The availability of macronutrients and their metabolization within our body influences health and performance.

Nutritional strategies related to macronutrient consumption prior to and during exercise can affect gastrointestinal comfort and performance. These can be adjusted for the specific demands of the activity and the sportsperson's sex differences, age and activity level. Low energy availability (LEA) is a state in which the body has insufficient energy to support physiological functions needed for optimal health. Relative energy deficiency in sport (RED-S) is a consequence of prolonged LEA.

Linking question(s)

A.3.1—How should nutritional periodization be linked to training programmes?

Inquiry 1—How can variables be controlled effectively when designing experiments on nutrition for exercise and health?

A.3.1 HL—How can an athlete manage fuel and liquid intake during an event to minimize the onset of fatigue?

Additional higher level: 4 hours

A.2.2.2—Micronutrients play highly specific roles in facilitating energy transfer and tissue synthesis.
Iron is a component of haemoglobin and myoglobin, and helps both of them to transport oxygen for aerobic respiration. Calcium is a component of bone and connective tissue and plays a role in muscle contraction. Sodium and potassium are electrolytes that are essential to maintain water balance and proper muscle and nerve function. Vitamins support tissue synthesis and act as regulators of metabolic reactions, which release energy. Specific knowledge of individual vitamins is not assessed.

A.2.2.3—The gut microbiome influences the health and performance of an individual.
Genetics, diet, medications and lifestyle influence the microbiome. The gut microbiome affects the availability and uptake of nutrients, and therefore health and performance.

Linking question(s)

C.4.2—How does anxiety affect the gut microbiome?

A.2.3 Energy systems

Standard level and higher level: 7 hours

A.2.3.1—The body relies on the phosphagen, glycolytic and oxidative systems for energy production to sustain life and physical activity.
The energy systems have different fuel sources for ATP production, recovery capabilities, benefits and limitations during physical activity. The energy continuum aids in describing the relative contribution of each energy system depending on the nature of the activity. While at rest, and during extended periods of submaximal intensity, the oxidative system is the dominant supplier of ATP to support the body's activities. During both short- and high-intensity periods, and sudden increases of intensity, anaerobic ATP production (phosphagen and anaerobic glycolysis) supports the body's functions. Knowledge of biochemical details of the Krebs's cycle and the electron transport chain are not assessed.

A.2.3.2—Maximal oxygen consumption (VO_2 max) is influenced by an individual's age, sex differences, body composition, lifestyle factors and level of fitness.
Endurance performance is affected by VO_2 max and efficiency of movement, e.g. running economy.

Linking question(s)

C.1.2—How does a person's level of aerobic fitness affect their mental toughness?

B.1.3—How does a lack of ATP affect muscular contraction?

Additional higher level: 2 hours

A.2.3.3—The lactate inflection point is the maximum intensity at which the body can metabolize lactate at the same rate as its production.

A.2.3.4—Excess post-exercise oxygen consumption (EPOC) is required for the body to return to homeostasis and is dependent on the oxygen deficit incurred during exercise. EPOC is typically divided into two subsections: fast and slow.

Linking question(s)

A.1.2—How might exercising in hot, humid conditions for extended periods of time influence the predominant energy system used and the lactate inflection point?

C.1.2—Is there a relationship between mental toughness and the lactate inflection point?

A.3 Response

Guiding question: How does our body respond to exercise or training?

A.3.1 Qualities of training

Standard level and higher level: 6 hours

A.3.1.1—The quality of training design and programme design are essential elements in developing a safe and effective programme for improving health or performance.
Common training principles direct programme design. These are: specificity, progressive overload (frequency, intensity and duration), recovery (rest principle), variety, reversibility and periodization. Measuring baseline values and progress are important components of design. Macrocycles, mesocycles and microcycles impact athletic performance. An athlete's adaptive responses to training will depend on the intensity and methods (anaerobic and aerobic) of training utilized, and well as inter-individual differences such as genetics (responders versus non-responders). Training programmes need to consider: • the individual's current level of fitness • age and sex differences (including reproductive status) • hormonal changes during the menstrual cycle, based on an arbitrary natural 28-day cycle (a diagram of the menstrual cycle is found in the *SEHS data booklet*) • the phase of the macrocycle. Overreaching and overtraining are possible consequences of poorly designed or poorly maintained programmes.

Linking question(s)

C.3, C.4, Tool 2—How can monitoring inform an athlete's readiness for training?

B.3.2—How do the training principles of prehabilitation and appropriate warm-up protocols support injury reduction?

Additional higher level: None for A.3.1

A.3.2 Benefits to health of being active

Standard level and higher level: 2 hours

A.3.2.1—An active lifestyle supports physical well-being.
A healthy level of physical activity for an individual varies with factors such as age and sex differences. The basic components of energy balance include energy intake, energy consumption and energy storage. Physical activity can positively or negatively affect muscular and immune system function. The risk of developing osteoporosis, obesity, hypertension, cardiovascular diseases and type 2 diabetes can be reduced through an active lifestyle. Knowledge of ossification and osteoblasts is not assessed.

Additional higher level: 2 hours

A.3.2.2—Prescribing exercise for health and sporting performance needs careful consideration and planning.
Exercise intensity should progress appropriately to avoid injury risk. For physical and mental health, the appropriateness of certain exercises for specific target groups needs to be considered. These include children and adolescents, older adults and individuals who are pregnant.

Linking question(s)

A.2.2.1—How might dietary intake impact perceived exertion and mental health?

C.4.2—How might exercise be part of a coping strategy for a pregnant or menopausal sportsperson?

A.3.3 Fatigue and recovery

Additional higher level: 9 hours

A.3.3.1—Fatigue can originate at different levels of the motor or energy pathway, possibly combining a variety of sources.
Central and peripheral neuromuscular mechanisms are responsible for fatigue. Peripheral neuro-muscular mechanisms—including imbalance in pH, lack of hydration and insufficient fuel availability—can all contribute to fatigue. Suboptimal availability of calcium, sodium and potassium can also contribute to fatigue.

A.3.3.2—Recovery from exercise.
Signs of recovery from exercise include: • physiological indicators—for example, reduced blood lactate concentration • symptomatic indicators—for example, reduced muscle soreness • psychological indicators—for example, improved preparedness for the next session or competition. Evaluation of nutritional strategies for recovery. These can include consumption of: • macronutrients—including protein, water and carbohydrates—which depend on the activity goal • creatine monohydrate • polyphenol-rich foods. Evaluation of recovery techniques such as myofascial release, wearing compression garments and thermotherapy. Evaluation of sleep for recovery. • The quality of sleep can affect both recovery and performance. The amount of sleep required beyond general recommendations is dependent on the training load.

• Travel, both across and within time zones, may affect sleep quality. There are methods that describe practices for adjusting sleep habits.

Linking question(s)

B.1.3—What is the impact of fatigue on muscular contraction?

C.3—What is the relationship between motivation and fatigue?

Inquiry 1—Do placebos positively affect recovery?

B. Biomechanics

B.1 Generating movement in the body

Guiding question: How are the structure and function of the musculoskeletal system related to movement of the human body?

B.1.1 Anatomical position, planes and movement

Standard level and higher level: 3 hours

B.1.1.1—The human skeleton is divided into an axial component and an appendicular component. These have different primary functions.
Positional terminology is used to describe the relative positions of body parts. For example: superior, inferior, proximal, distal, anterior, posterior, medial, lateral and intermediate. A diagram of the skeletal system is found in the *SEHS data booklet*.

B.1.1.2—Movements occur in one or more planes, and rotations occur along one or more axes.
Movements are described by a set of specific terms: flexion, extension, abduction, adduction, pronation, supination, protraction, retraction, opposition, reposition, inversion, eversion, elevation, depression, circumduction, rotation, plantarflexion, dorsiflexion, horizontal flexion and horizontal extension. A diagram of the major planes is found in the *SEHS data booklet*.

Linking question(s)

C.2.1—Can understanding and applying the correct anatomical terms of movement increase the rate of learning a skill?

Additional higher level: 3 hours

B.1.1.3—Anthropometry, the measurement of body segments and proportions of the human body, has applications in many areas of sport and health science.
Anthropometric databases are used by equipment manufacturers for the design and sizing of equipment. Ergonomic design improves efficiency during performance.

Linking question(s)

B.3.2—How does the use of anthropometry assist with the design of protective equipment?

C.2.1—Can the ergonomic design of sporting implements aid in skills acquisition?

B.1.2 Structure and function of connective tissues and joints

Standard level and higher level: 3 hours

B.1.2—The structure of connective tissues and joints are related to their function in enabling movement.

Connective tissues—bone, ligaments, cartilage, fascia and tendons—have functions that increase stability and permit movement. The three main types of articulations—fibrous, cartilaginous and synovial—have different structures and functions. The various types of joints, and classes of synovial joints, vary in the amount of stability and movement they provide. Knowledge at the cellular level is not assessed.

Linking question(s)

A.3.1—How does training affect the stability and movement of connective tissue?

Additional higher level: None for B.1.2

B.1.3 Muscular function

Standard level and higher level: 4 hours

B.1.3.1—The body uses different types of muscular contractions to create movement and stability. Each type of contraction has a different function.
Muscles are organized in functional groupings called motor units that contract using the "all-or-none" principle. Muscular contraction requires the metabolism of ATP within the muscle cells. Motor units are differentiated by fibre type and neuron diameter: types I, IIa and IIx. Their recruitment patterns vary depending on the activity. Hypertrophy and atrophy of muscle can cause alterations in a motor unit recruitment pattern. Contractions can be described in four different ways: isometric, isotonic concentric, isotonic eccentric and isokinetic. Muscles usually function in pairs, and act with reciprocal inhibition: their pairings are agonist and antagonist.

Linking question(s)

A.2.2—How does malnutrition affect muscular function?

B.1.4, B.2.1—How do different types of muscle fibre affect our ability to exert forces in a sporting environment?

Additional higher level: 2 hours

B.1.3.2—The sliding filament theory describes the interaction between myofilaments and the molecules responsible for sarcomere or muscle contraction.
Calcium, ATP and the proteins actin, myosin, troponin and tropomyosin have specific roles. Diagrams of a cross-bridge cycle, a sarcomere and a muscle fibre are found in the *SEHS data booklet*.

Linking question(s)

A.2.2.1, A.2.2.2—How can knowledge of the sliding filament theory be applied to optimize nutrient intake and timing, to enhance muscle function, recovery and performance in athletes and active individuals?

NOS, Tool 2—How can technology be utilized to support our understanding of microscopic phenomena?

B.1.4 Levers in movement and sport

Standard level and higher level: 2 hours

B.1.4.1—Three different classes of levers, both within and outside the human body, work to create movements.

The relative positions of the effort, fulcrum and load determine the class, and the mechanical advantage and disadvantage, of the lever. Levers inside the body work to create movement. They can be used to project an object outside the body or be used as an implement. Levers outside the body can be used to enhance the functionality of movement in a physical activity or to enhance performance.

Linking question(s)

C.2.1—How can changing external levers (e.g. the pole length in a pole vault) affect skills acquisition?

Additional higher level: None for B.1.4

B.2 Forces, motion and movement

Guiding question: How can the laws of motion be applied to explain the movement of bodies in sport and exercise, and be used to improve performance?

B.2.1 Newton's laws of motion

Standard level and higher level: 5 hours

B.2.1.1—Linear and angular motion can be analysed using Newton's laws of motion.
The motion of an object can be described using speed, velocity and acceleration. The resultant motion of an object is determined by the sum of the forces acting on it. The following principles relate to applications of Newton's laws. • Stability—factors affecting stability include the height of the centre of mass relative to the supporting surface, the size of the support base, the position of the line of gravity relative to the support base and the mass. • The principle of summing joint forces. • Linear motion—the greater the impulse applied, the greater the change in momentum. • The principle of impulse direction. • Angular motion—this is produced by the application of a force acting at a distance from the centre of mass: an eccentric force. • Angular momentum is conserved when an athlete or object is free of additional eccentric forces. The equations for speed, linear velocity, angular velocity, acceleration and linear momentum are found in the *SEHS data booklet*. The equation for force and weight is found in the *SEHS data booklet*. The use of trigonometry is not assessed. Calculations are limited to three terms for SL and to four terms for HL.

Linking question(s)

B.2.1—How can coaches use Newton's laws to improve the performance of their athletes?

Additional higher level: 12 hours

B.2.1.2—A collision results in a change in momentum in the colliding bodies.
The change in momentum is equal to the impulse applied to the object. Collisions involving a ball are affected by its coefficient of restitution. The equation of coefficient of restitution is found in the *SEHS data booklet*. Calculations in assessment will be limited to one dimension.

B.2.1.3—The force of friction is determined by the coefficient of friction.

The coefficients of static and dynamic friction depend on the materials in contact. Frictional force can be modified to improve sports performance. Equations for the coefficients of static and dynamic friction are found in the *SEHS data booklet*.

B.2.1.4—Work results from the application of a force over a distance.
When work is done, energy is transformed from one form to others. Power is a measure of the rate at which work is done. Measuring power output can therefore be a measure of work intensity. Power output can be optimized through correct technique and the effective design of sports equipment. Equations for work and power are found in the *SEHS data booklet*.

Linking question(s)

NOS, B.2.2—Can the use of heated runners in bobsleigh, or a sharkskin swimsuit in a swimming pool, be considered an unfair advantage?

B.2.2 Fluid mechanics

Standard level and higher level: 3 hours

B.2.2.1—The path of a projectile through air is determined by different factors and forces.
A projectile's flight path is primarily determined by the initial velocity and angle of projection. An object's desired flight path is affected by the height of release relative to the target. An object's flight path is influenced by the ratio of weight to air resistance.

Linking question(s)

NOS, Tool 3, Inquiry 3—How can graphs provide evidence of systematic and random errors?

Additional higher level: 8 hours

B.2.2.2—Environmental conditions such as temperature, humidity, air pressure, wind, salinity of water and altitude affect the external forces acting on an object.

B.2.2.3—The forces, buoyancy, lift and drag acting on a body as it moves through a fluid (air or water) have a measurable effect on its path. **A projectile travelling through a fluid may be affected by Bernoulli's principle, the angle of attack and the Magnus effect.**
Buoyancy is dependent on the density of the fluid and the volume of the fluid displaced. Drag includes surface drag, form drag and wave drag, and can be altered by manipulating the environment and the moving object. There can be sporting, ethical and regulatory implications of these effects.

Linking question(s)

A.1.3—How can friction and drag be used to enhance training?

B.2.3 Movement analysis and its applications

Standard level and higher level: 3 hours

B.2.3.1—A "phases of movement" approach is used to break down and describe movements.
The phases are preparatory, force production and critical instant, with a phase called "follow through" for discrete skills and "recovery" for continuous skills.

Movement analysis can identify areas for improvement applicable to health, safety and sporting performance. These include, but are not limited to, rehabilitation and accessibility.

Linking question(s)

A.3.1, B.3.1, B.3.2—How does movement analysis help a coach design a training programme, or a physiotherapist design a rehabilitation programme?

Additional higher level: None for B.2.3

B.3 Injury

Guiding question: What are the primary causes of musculoskeletal injury, and how can they be prevented and treated?

B.3.1 Causes of injury

Standard level and higher level: 3 hours

B.3.1.1—The complex interaction of internal and external risk factors can predispose and make an individual susceptible to injury.
Internal factors—such as age, sex differences, pregnancy, the effects of training, congenital factors and previous injury—are considered individual variables. External factors, such as the use of personal protective equipment, are considered environmental variables.

B.3.1.2—An acute trauma is caused by a sudden or excessive application of force, or by a force from an unexpected direction. A cumulative trauma is caused by the repeated application of force.
Trauma can lead to injuries of connective tissue, muscle, bone, skin and the brain. Only functional concussion-like injury will be assessed for the brain.

Linking question(s)

A.3.1—Can overtraining lead to altered gait, in turn leading to injury?

A.3.1—How does training or participation in sport and exercise affect rates of injury?

Additional higher level: 2 hours

B.3.1.3—Chronic or overuse injuries are often related to technique.
Correcting biomechanical maladaptations can decrease the risk of injury.

Linking question(s)

C.2.1—How can the constraint-led approach to skills acquisition be applied to identify and correct biomechanical maladaptation?

B.3.2 Interventions related to injury

Standard level and higher level: 4 hours

B.3.2.1—Methods of lowering the risk of injury attempt to minimize the abnormal application of forces and maximize the ability of the body to absorb any such application of force.
Protective equipment can lower the risk of injury, including the risk of concussion. Sporting equipment can be selected or adjusted to suit users of different body sizes and shapes. Flexibility training, proper warm-up and prehabilitation exercises can lower the risk of injury. Learning and using correct technique and using developmentally appropriate rules are also effective.

B.3.2.2—The initial stages of injury treatment often involve mitigation of inflammation. **Serious injuries that involve complete tears or major fractures will sometimes require surgical repair.** **In the healing process, therapeutic modalities (some managed by para-professionals) are provided to promote healing and a safe return to activity.**
Compression, elevation, ice and non-steroidal anti-inflammatory drugs (NSAIDs) are examples of treatments for inflammation. A balance is usually struck between the healing benefits of inflammation and the amelioration of pain.

B.3.2.3—Treatment of concussion varies based on the specifics of the injury. The pace of recovery is not always linear.
A return to normal daily activities, learning or sport is generally a staged process involving increasing levels of cognitive and physical demand.

Linking question(s)

C.1.2—To what extent may mental toughness affect recovery from injury?

C.3.2—How does the type of motivational climate (e.g. mastery oriented, performance oriented) impact the recovery process?

Additional higher level: None for B.3.2

C. Sports psychology and motor learning

C.1 Individual differences

Guiding question: What characteristics explain how and why some individuals succeed and experience well-being in sport and health contexts more than others?

C.1.1 Personality

Standard level and higher level: 2 hours

C.1.1.1—Personality refers to individual differences in characteristic patterns of thinking, feeling and behaving. Personality is typically understood to be an interaction between genetic traits and the environment.
Trait-based approaches present personality traits as relatively enduring, stable characteristics. Traits are assessed using validated self-report questionnaires. A common approach to assessing personality traits is through “the big five”. • Openness to experience describes an individual’s willingness to try to new things, their ability to be vulnerable and their capacity for original thinking. • Conscientiousness describes the tendency to control impulses, act in socially acceptable ways and act in ways that facilitate goal-directed behaviour. • Extraversion (or its opposite, introversion) describes the extent to which individuals draw energy from interacting with other people (or find it draining). • Agreeableness describes how well individuals relate to others and act in a way that will preserve relationships. • Neuroticism, or its opposite, emotional stability, describes the extent to which individuals perceive situations as distressing, or maintain emotional balance.

Linking question(s)

C.3—How do personality factors affect an individual’s motivation?

NOS, Inquiry 1—What are the confounding variables when investigating the impact of personality type on performance outcomes for players of team sports?

Additional higher level: 2 hours

C.1.1.2—Social learning theory is a situational approach to understanding behaviour.
Individuals learn behaviours, attitudes and behavioural consequences from other individuals in their social environment. Behaviours are learned from observation and imitation. The regard with which the role model (the person being observed) is held by the follower determines the extent of replication of behaviours.

C.1.1.3—Personality can change over a long period of time.
Personality can be modified over a significant period of time through experience, coaching and reflection. There is no personality profile that predicts sport performance. Observed behaviours are an interaction of personality traits and social learning.

Linking question(s)

Inquiry 1—How can observer bias be controlled when undertaking interviews and observations?

C.1.2 Mental toughness

Standard level and higher level: 2 hours

C.1.2.1—Mental toughness is an aspect of personality that partly explains how individuals manage challenging and pressurized situations.
Mental toughness encompasses appraisal of challenges, commitment, confidence, perceived control and resilience. Mental toughness contributes to successful sporting performance in high-pressure situations. Mental toughness is a malleable personality trait. Studies suggest that mental toughness may be partly related to genetic traits, that in turn lead to personality traits. Studies also suggest that it can be developed further through training. Mental toughness is difficult to observe, as it requires self-reported assessment.

Linking question(s)

C.4.2—How do mentally tough individuals cope with stress?

Inquiry 1—How can utilizing single- and double-blind experiments support causal claims of how mental toughness affects coping with stress?

Additional higher level: 4 hours

C.1.2.2—The theory of the "self-fulfilling prophecy" in sporting success suggests that a sportsperson's perceived self-confidence results in greater persistence and effort, leading to an increased probability of eventual success.
"Learned helplessness" is associated with an individual's self-perceived lack of control over their future.

C.1.2.3—Mental toughness is positively associated with better health outcomes, including fewer depressive symptoms, fewer burnout symptoms and improved sleep quality.

C.1.2.4—Attribution theory illustrates how the locus of control and stability can impact subsequent confidence.

Linking question(s)

A.2.3, A.3.1—Do mentally tough performers last longer on a maximal test after they reach their theoretical maximum?

A.2.3, A.3.1—How can the strength of relationships between mental toughness and performance in maximal physiological tests be determined?

C.2 Motor learning

Guiding question: How are skills acquired, practised and perfected?

C.2.1 Motor learning processes

Standard level and higher level: 10 hours

C.2.1.1—Learning, including motor learning, is a relatively permanent change in behaviour brought about by experience, whereas performance is a temporary occurrence, fluctuating over time.
Two competing models of motor learning are the information processing model and the ecological model. These models are respectively exemplified by schema theory and by ecological dynamics theory. Motor learning theories include non-linear pedagogy and traditional linear pedagogy. Non-linear pedagogy is exemplified by: • ecological systems theory and dynamical systems theory—these theories include the concepts of performance variability, degrees of freedom, perception–action coupling and self-organization • a constraints-led approach to skills acquisition: types of constraints and practical examples. Linear pedagogy is exemplified by: • open-loop and closed-loop theory • schema theory • generalized motor patterns and subordinate motor patterns • phases of learning that include cognitive, associative and autonomous phases • the practical implications of coaching learners in each phase.

C.2.1.2—The psychological refractory period is the time in which response to a second stimulus is significantly slowed because a first stimulus is still being processed.
The psychological refractory period is commonly exploited in sport. An example is the use of deception, e.g. in movement: taking advantage in a second move of the time it took an opponent to react to a first "false" move.

C.2.1.3—Transfer of learning refers to the influence of previous experience performing a skill on the learning of a new skill.
Types of transfer include skill to skill, practice to performance, abilities to skills, bilateral, stage to stage and principles to skills.

Linking question(s)

A.3.1—To what extent do the training programmes developed by coaches reflect the stages of learning?

Tool 2, B.2.3—How can video technology be used to monitor or influence progress in acquiring a skill?

Additional higher level: None for C.2.1

C.2.2 Attentional control

Standard level and higher level: 2 hours

C.2.2.1—The proficient execution of specific skills requires the correct attentional focus.

Attention can be internal or external, and broad or narrow. Concentration is said to be "lost" when attention is directed away from relevant tasks. This is known as distraction. • External distractors can be visual or auditory. • Internal distractors are cognitions that are either negative or unrelated to the goal-directed behaviour. Controlled distraction is a method used by athletes to improve attentional control. Attentional narrowing occurs when an individual is in a high-arousal situation. Self-talk and goal setting are frequently used to control attentional focus.

Linking question(s)

C.1.2—How can mental toughness training prevent attentional narrowing?

A.3.1—How do mentally tough individuals respond to overreaching?

Additional higher level: None for C2.2

C.3 Motivation

Guiding question: What are the psychological processes that drive human behaviour, and how can these be influenced?

C.3.1 Achievement motivation

Standard level and higher level: 3 hours

C.3.1.1—Need achievement theory posits that personality and situational factors interact to produce resultant factors, which create emotional factors, which drive behavioural factors.
Coaches, sport scientists and health professionals can change situational factors to encourage individuals to approach achievement situations.

C.3.1.2—Goal orientation theory assumes that individuals strive to feel successful.
The perception of success can be referenced to self (task-oriented) or norms (ego-oriented). High task orientation is associated with greater perseverance and effort.

Linking question(s)

C.3.3—How can an athlete's achievement orientation be manipulated by a motivational climate?

Inquiry 1—How can scientists use control groups to claim causation between achievement orientation and motivational climate?

C.3.2—How is goal orientation associated with self-determination?

Tool 2—To what extent can technology be used to enhance motivation?

Additional higher level: 2 hours

C.3.1.3—High ego orientation can be problematic if task orientation is low.
High ego orientation is non-problematic when the individual believes that others perceive their ability as high. However, high ego is likely to lead to anxiety, dropout or excuses if the individual believes others perceive their ability as low. Individuals will seek to protect their ego and therefore become defensive if it is challenged.

Linking question(s)

B.3.1.1—How does an individual's perceived ability impact their risk of injury?

C.3.2 Self-determination

Standard level and higher level: 3 hours

C.3.2.1—Self-determination theory hypothesizes that humans strive to satisfy needs of autonomy, competence and relatedness.

C.3.2.2—Motivation can be placed along a continuum from amotivation to controlled motivation to autonomous motivation.
Amotivation is the absence of motivation. This occurs when there is no perceived contingency between effort and reward. Controlled motivation is extrinsic, i.e. when engaging in an activity is a means to an end. Autonomous motivation is intrinsic (self-determined) when engaging in an activity is an end in itself. This could be motivation to know, to accomplish or to experience stimulation. Intrinsic motivation is positively associated with enjoyment, self-regulation and persistence, while extrinsic motivation is positively associated with anxiety.

Linking question(s)

C.3.3—How can motivational climate affect self-determination?

A.1.2 HL—To what extent can the constraints posed by environmental conditions impact motivation?

Inquiry 1—How do psychologists decide on an appropriate sample size when investigating the relationships between rewards and motivation?

Additional higher level: 6 hours

C.3.2.3—Self-determination theory is a meta-theory comprising six mini-theories, each explaining a facet of individual motivation.
Cognitive evaluation theory explains how informational rewards support intrinsic motivation. Rewards aimed at influencing motivation can undermine intrinsic motivation, creating the overjustification effect and making the motivation become more extrinsic. Organismic integration theory explains the increasing internalization of controlled motivation through four subtypes of extrinsic motivation. • Extrinsic regulation is when behaviours are regulated by a sense of little or no choice (“I must”). • Introjected regulation is when behaviours are regulated by preventing feelings of guilt (“I should”). • Identified regulation is when behaviours are regulated by a desire to do something but as a means to an end, i.e. contingent on a reward (“I want to”). • Integrated regulation is when the motivation has been largely internalized by aligning with personal goals, values or beliefs, but is still contingent on a reward. Causal orientations theory identifies three types of causal orientations. • Autonomy orientation—the individual acts out of interest in and valuing what is occurring. • Control orientation—the focus is on rewards, gains and approval. • Amotivation—this is characterized by anxiety concerning competence. Basic psychological needs theory suggests that psychological well-being and optimal functioning are predicated on autonomy, competence and relatedness. • Well-being and performance are predicted by the extent to which these basic psychological needs are met or thwarted. Goal contents theory distinguishes between extrinsic and intrinsic goals. Intrinsic goals are associated with greater well-being. Relationships motivation theory argues that some amount of positive interpersonal interactions are not only desirable but essential for well-being.

Linking question(s)

C.3.3—How do the types of rewards help shape the motivational climate?

C.3.3 Motivational climate

Standard level and higher level: 2 hours

C.3.3.1—Motivational climate describes the psychological environment that the coach creates by designing sessions that provide instructions and feedback, which will help to motivate the athletes in training or competition.
There are two contrasting recognized motivational climates: mastery and ego. • A mastery climate emphasizes individual or team development, supporting and recognizing effort, cooperation and improvement. • An ego climate emphasizes winning at all costs, competition and comparison with others. Mastery climates are most effective for enjoyment, teamwork and maximizing performance over time. Ego climates are anxiety-inducing and are typically only effective in the short term. Coaches and psychologists often use the TARGET (task, authority, recognition, grouping, evaluation and time) approach to foster a mastery motivational climate.

Linking question(s)

C.4.1—Why might an ego motivational climate be anxiety-inducing?

C.1.2—Can the motivational climate lead to overtraining?

Additional higher level: None for C.3.3

C.4 Stress and coping

Guiding question: How do stress and anxiety manifest themselves and affect performance and health? How can specific coping strategies be used to manage this?

C.4.1 Arousal and anxiety

Standard level and higher level: 3 hours

C.4.1.1—Arousal refers to the level of physical and psychological activation. This impacts on sport performance in the way that individuals attempt to manage their levels of intensity.
Traditional unidimensional theories of psychological arousal are drive theory and inverted U theory. According to inverted U theory, athletes have their own individual zone of optimal functioning (IZOF). This is the zone where their psychological arousal is personally optimal for their sporting performance.

C.4.1.2—When anxiety is low, individuals experience positive emotions, such as excitement, desire and elation. High levels of anxiety induce negative emotions such as fear, worry and despondency.
Multidimensional approaches to anxiety recognize that activation level alone is insufficient to explain anxiety's effects on performance. Catastrophe theory suggests that when both cognitive and somatic anxiety are high, performance declines rapidly or is ended prematurely. Anxiety can be measured via subjective measures, e.g. self-reporting, or objective measures, e.g. variation in heart rate and blood pressure and galvanic skin response.

Linking question(s)

C.5.1—How can anxiety be managed through psychological skills training?

A.1.1, A.1.2—How do internal physiological regulatory processes impact anxiety or arousal?

C.1.1, C.3.2—Are certain personalities more likely to be anxious?

Additional higher level: None for C.4.1

C.4.2 Coping

Standard level and higher level: 2 hours

C.4.2.1—A stressor causes psychological strain. This can be positive, such as looking forward to an opportunity, or negative, such as fearing an outcome.
Individuals seek to manage stressors through coping strategies. These are categorized as: • problem focused—strategies that seek to alter the stressor and include problem solving, removing the source of stress or information seeking • emotion focused—strategies that do not alter the stressor but regulate the negative emotional response to it; they include relaxation, seeking emotional social support and self-talk • avoidance focused—strategies that attempt to prevent the negative impact of a stressor by physically or psychologically distancing oneself from it; they include ignoring, procrastinating and quitting. Self-talk is a simple coping technique that can be problem focused or emotion focused. • Unintentional self-talk can be negative or positive. • Practical mechanisms for self-talk include: recalling how positive experiences in the past felt, using an acronym of helpful phrases and describing a physical movement in a simple word. Relaxation skills can be developed for greater control of heart rate.

Linking question(s)

C.1.1, C.1.2—Are certain personalities more likely to adopt specific stress responses?

A.1.2, Tool 1, Inquiry 1—What physiological measurements can we use to measure stress?

Additional higher level: 2 hours

C.4.2.2—Stressors can be considered as either controllable or uncontrollable.
Problem-focused coping is more effective for controllable stressors. Emotion-focused coping is more effective when the stressor is uncontrollable.

C.4.2.3—Many coping strategies have been shown to be effective for athletes, although the effectiveness of each is specific to the individual and the situation.
Seeking support has been shown to be the most effective type of coping strategy for athletes. Seeking support can be a problem-focused or emotion-focused coping strategy, depending on whom support is sought from. Logical analysis, relaxation, mental imagery, thought control and effort expenditure are common effective coping strategies used by athletes. Distraction can be a useful short-term emotion-focused coping strategy, but it is not effective for reaching goals. Coping strategies involving disengagement, such as mental or physical withdrawal, venting unpleasant emotions and self-blame are maladaptive strategies.

Linking question(s)

A.1.1, A.3.1—How do effective coping strategies enable more proficient kinematic aspects of movements?

Inquiry 1—How can psychological interventions be made reliable?

C.5 Psychological skills

Guiding question: How can sport psychology interventions enhance sporting performance?

C.5.1 Goal setting

Standard level and higher level: 4 hours

C.5.1.1—Goal setting directs attention to a specific task. It is regularly used to enhance motivation in sport, exercise and health.
Outcome goals are norm-referenced and use an objective result as the target. Learning-focused goals include performance goals and process goals. Performance goals are self-referenced and specify a measurable target, representing an improvement in performance. Process goals are self-referenced and focus on the technique or strategy required to execute a skill successfully. The effectiveness of each type of goal depends on the individual and their achievement motivation.

Linking question(s)

C.1.1—How might individual differences mean that goal setting is less effective for some people?

Additional higher level: 2 hours

C.5.1.2—The goal-setting paradox explains that elite athletes often feel less satisfied when a higher goal is achieved than an easier goal. This is thought to be the result of feelings of deflation after success.
Goal adjustment is considered more important than goal setting. Research suggests that some individuals perform best with “do-your-best” goals or “open” goals.

Linking question(s)

A.3.1—How does goal setting affect success in periodized training?

C.5.2 Imagery

Additional higher level: 3 hours

C.5.2.1—Imagery is an experience that mimics real experience. It involves using a combination of different sensory modalities in the absence of actual perception.
The purpose of imagery can be cognitive or motivational, specific or general. The PETTLEP model—physical, environment, task, timing, learning, emotion, perspective—is used in sport to create the most functionally equivalent image possible. Paivio’s imagery framework can be used to determine the appropriate function of imagery.

Linking question(s)

A.3.1—How can imagery be used to reduce the risk of overtraining?

Tool 1, Inquiry 1, C.4.1, A.1.1, A.1.2—To what extent can an athlete use training in psychological skills to regulate their heart rate?

Assessment in the Diploma Programme

General

Assessment is an integral part of learning and teaching. The most important aims of assessment in the Diploma Programme (DP) are that it should support curricular goals and encourage appropriate student learning. Both external and internal assessments are used in the DP. IB examiners mark work produced for external assessment, while work produced for the internal assessment (IA) is marked by teachers and externally moderated by the IB.

There are two types of assessment identified by the IB.

- Formative assessment informs both learning and teaching. It is concerned with providing accurate and helpful feedback to students and teachers on the kind of learning taking place, and the nature of students' strengths and weaknesses, in order to help develop students' understanding and capabilities. Formative assessment can also help to improve teaching quality, as it can provide information to monitor progress towards meeting the course aims and objectives (0404-01).
- Summative assessment gives an overview of previous learning and is concerned with measuring student achievement at, or towards the end, of the course of study (0404-04).

A comprehensive assessment policy is viewed as being integral with teaching, learning and course organization. For further information, see the IB *Programme standards and practices* publication.

The approach to assessment used by the IB is criterion-related, not norm-referenced. This approach to assessment judges students' work by their performance in relation to identified levels of attainment, and not in relation to the work of other students. For further information on assessment within the DP please refer to the publication *Assessment principles and practice—Quality assessments in a digital age.*

To support teachers in the planning, delivery and assessment of the DP courses, a variety of resources can be found on the Programme Resource Centre (PRC) or purchased from the IB Store (store.ibo.org). Additional publications such as specimen papers and markschemes, teacher support material (TSM), subject reports and grade descriptors can also be found on the PRC. Past examination papers as well as markschemes can be purchased from the IB store.

Methods of assessment

The IB uses several methods to assess work produced by students.

Assessment criteria

Assessment criteria are used when the assessment task is open-ended. Each criterion concentrates on a particular skill that students are expected to demonstrate. An assessment objective describes what students should be able to do, and assessment criteria describe how well they should be able to do it. Using assessment criteria allows discrimination between different answers and encourages a variety of responses. Each criterion comprises a set of hierarchically ordered level descriptors. Each level descriptor is worth one or more marks. Each criterion is applied independently using a best-fit model. The maximum marks for each criterion may differ according to the criterion's importance. The marks awarded for each criterion are added together to give the total mark for the piece of work.

Markbands

Markbands are a comprehensive statement of expected performance against which responses are judged. They represent a single holistic criterion divided into level descriptors. Each level descriptor corresponds to a range of marks to differentiate student performance. A best-fit approach is used to ascertain which particular mark to use from the possible range for each level descriptor.

Analytic markschemes

Analytic markschemes are prepared for those examination questions that expect a particular kind of response and/or a given final answer from students. They give detailed instructions to examiners on how to break down the total mark for each question for different parts of the response.

Marking notes

For some assessment components marked using assessment criteria, marking notes are provided. Marking notes give guidance on how to apply assessment criteria to the particular requirements of a question.

Inclusive access arrangements

Inclusive access arrangements are available for candidates with access requirements. Standard assessment conditions may put candidates with assessment access requirements at a disadvantage by preventing them from demonstrating their attainment level. Inclusive access arrangements enable candidates to demonstrate their ability under assessment conditions that are as fair as possible.

The IB document *Access and inclusion policy* provides details on all the inclusive access arrangements available to candidates. The IB document *Learning diversity and inclusion in IB programmes: Removing barriers to learning* outlines the position of the IB with regard to candidates with diverse learning needs in the IB programmes. For candidates affected by adverse circumstances, the publication *Diploma Programme Assessment procedures* (updated annually), which includes the general regulations, provides details on access consideration.

Responsibilities of the school

The school is required to ensure that equal access arrangements and reasonable adjustments are provided to candidates with learning support requirements that are in line with the IB documents *Access and inclusion policy* and *Learning diversity and inclusion in IB programmes: Removing barriers to learning*.

Assessment outline—SL

First assessment 2026

Assessment component	Weighting
External assessment (3 hours)	**76%**
Paper 1 (1 hour and 30 minutes) Paper 1A—Multiple-choice questions Paper 1B—Data-based questions (Total 55 marks)	36%
Paper 2 (1 hour and 30 minutes) Short-answer and extended-response questions (Total 50 marks)	40%
Internal assessment (10 hours)	**24%**
The internal assessment consists of one task: the scientific investigation. This component is internally assessed by the teacher and externally moderated by the IB at the end of the course. (Total 24 marks)	

Assessment outline—HL

First assessment 2026

Assessment component	Weighting
External assessment (4 hours and 15 minutes)	**76%**
Paper 1 (1 hour and 45 minutes) Paper 1A—Multiple-choice questions Paper 1B—Data-based questions (Total 65 marks)	36%
Paper 2 (2 hours and 30 minutes) Short-answer and extended-response questions (Total 80 marks)	40%
Internal assessment (10 hours)	**24%**
The internal assessment consists of one task: the scientific investigation. This component is internally assessed by the teacher and externally moderated by the IB at the end of the course. (Total 24 marks)	

External assessment

Detailed markschemes specific to each examination paper (paper 1 and paper 2) are used to assess students.

Examinations may require a general understanding and application of the nature of science (NOS).

External assessment details—SL

Paper 1

Duration: 1 hour and 30 minutes

Weighting: 36%

Marks: 55

Paper 1 is presented as two separate booklets.

Paper 1A—30 marks

- 30 multiple-choice questions on standard level material only.
- No marks are deducted for incorrect answers.

Paper 1B—25 marks

- Data-based questions.
- Questions on experimental work.

Paper 1A and paper 1B are to be completed together without interruptions.

The questions on paper 1 test assessment objectives 1, 2 and 3.

The use of calculators is permitted. See the *Calculators guidance for examinations booklet* on the PRC.

Each student must have access to a clean copy of the *SEHS data booklet* during the examination. It is the responsibility of the school to download a copy from the International Baccalaureate Information System (IBIS) or the PRC, and to ensure that there are sufficient copies available for all students.

Paper 2

Duration: 1 hour and 30 minutes

Weighting: 40%

Marks: 50

- Short-answer and extended-response questions on standard level material only.

The questions on paper 2 test assessment objectives 1, 2 and 3.

The use of calculators is permitted. See the *Calculators guidance for examinations booklet* on the PRC.

Each student must have access to a clean copy of the *SEHS data booklet* during the examination. It is the responsibility of the school to download a copy from IBIS or the PRC and to ensure that there are sufficient copies available for all students.

External assessment details—HL

Paper 1

Duration: 1 hour and 45 minutes

Weighting: 36%

Marks: 65

Paper 1 is presented as two separate booklets.

Paper 1A—40 marks

- 40 multiple-choice questions on standard level and additional higher level material.
- No marks are deducted for incorrect answers.

Paper 1B—25 marks

- Data-based questions.
- Questions on experimental work.

Paper 1A and paper 1B are to be completed together without interruptions.

The questions on paper 1 test assessment objectives 1, 2 and 3.

The use of calculators is permitted. See the *Calculators guidance for examinations booklet* on the PRC.

Each student must have access to a clean copy of the *SEHS data booklet* during the examination. It is the responsibility of the school to download a copy from IBIS or the PRC, and to ensure that there are sufficient copies available for all students.

Paper 2

Duration: 2 hours and 30 minutes

Weighting: 40%

Marks: 80

- Short-answer and extended-response questions on standard level and additional higher level material.

The questions on paper 2 test assessment objectives 1, 2 and 3.

The use of calculators is permitted. See the *Calculators guidance for examinations booklet* on the PRC.

Each student must have access to a clean copy of the *SEHS data booklet* during the examination. It is the responsibility of the school to download a copy from IBIS or the PRC and to ensure that there are sufficient copies available for all students.

Internal assessment

Purpose of internal assessment

The IA is an integral part of the course and is compulsory for both SL and HL students. It enables students to demonstrate the application of their skills and knowledge, and to pursue their personal interests, without the time limitations and other constraints that are associated with written examinations. The IA should, as far as possible, be woven into normal classroom teaching and not be a separate activity conducted after a course has been taught.

The IA requirements at SL and at HL are the same.

Guidance and authenticity

The scientific investigation (SL and HL) submitted for the IA must be the student's own work. However, it is not the intention that students should decide upon a title or topic and be left to work on the IA component without any further support from the teacher. The teacher should play an important role during both the planning stage and the period when the student is working on the internally assessed work. It is the responsibility of the teacher to ensure that students are familiar with:

- the requirements of the type of work to be internally assessed
- the *Sciences experimentation guidelines* publication
- the assessment criteria; students must understand that the work submitted for assessment must address these criteria effectively.

Teachers and students must discuss the internally assessed work. Students should be encouraged to initiate discussions with the teacher to obtain advice and information, and students must not be penalized for seeking guidance. As part of the learning process, teachers should read and give advice to students on one draft of the work. The teacher should provide oral or written advice on how the work could be improved, but not edit the draft. The next version handed to the teacher must be the final version for submission.

It is the responsibility of teachers to ensure that all students understand the basic meaning and significance of concepts that relate to academic integrity, especially authenticity and intellectual property. Teachers must ensure that all student work for assessment is prepared according to the requirements and must explain clearly to students that the internally assessed work must be entirely their own. Where collaboration between students is permitted, it must be clear to all students what the difference is between collaboration and collusion.

All work submitted to the IB for moderation or assessment must be authenticated by a teacher, and must not include any known instances of suspected or confirmed malpractice. Each student must confirm that the work is their authentic work and constitutes the final version of that work. Once a student has officially submitted the final version of the work, it cannot be retracted. The requirement to confirm the authenticity of work applies to the work of all students, not just the sample work that will be submitted to the IB for the purpose of moderation. For further details, refer to the IB publications *Academic integrity policy*, *Diploma Programme: From principles into practice* and the relevant general regulations (in *Diploma Programme Assessment procedures*).

Authenticity may be checked by discussion with the student on the content of the work, and by scrutiny of one or more of the following:

- the student's initial proposal
- the first draft of the written work
- the references cited

- the style of writing compared with work known to be that of the student
- the analysis of the work by a web-based plagiarism detection service such as www.turnitin.com.

The same piece of work cannot be submitted to meet the requirements of both the IA and the EE.

Time allocation

The IA is an integral part of the SEHS course, contributing 20% to the final assessment in the SL and the HL courses. This weighting should be reflected in the time that is allocated to teaching the knowledge, skills and understanding required to undertake the work, as well as the total time allocated to carry out the work.

It is recommended that a total of approximately 10 hours (SL and HL) of teaching time should be allocated to the work. This should include:

- time for the teacher to explain to students the requirements of the IA
- class time for students to work on the IA component and ask questions
- time for consultation between the teacher and each student
- time to review and monitor progress, and to check authenticity.

Safety requirements and recommendations

It is the responsibility of everyone involved in science education to make an ongoing commitment to safe and healthy practical work.

The working practices and protocols should be effective in safeguarding students and protecting the environment. Schools are responsible for following national or local guidelines, which differ from country to country. The *SEHS teacher support material* provides some further guidance.

Using assessment criteria for internal assessment

For internal assessment, a number of assessment criteria have been identified. Each assessment criterion has level descriptors describing specific achievement levels, together with an appropriate range of marks. The level descriptors concentrate on positive achievement, although for the lower levels failure to achieve may be included in the description.

Teachers must judge the internally assessed work at SL and at HL against the criteria using the level descriptors.

- The same assessment criteria are provided for SL and HL.
- The aim is to find, for each criterion, the descriptor that conveys most accurately the level attained by the student, using the best-fit model. A best-fit approach means that compensation should be made when a piece of work matches different aspects of a criterion at different levels. The mark awarded should be one that most fairly reflects the balance of achievement against the criterion. It is not necessary for every single aspect of a level descriptor to be met for that mark to be awarded.
- When assessing a student's work, teachers should read the level descriptors for each criterion until they reach a descriptor that most appropriately describes the level of the work being assessed. If a piece of work seems to fall between two descriptors, both descriptors should be read again and the one that more appropriately describes the student's work should be chosen.
- Where there are two marks available within a level, teachers should award the upper marks if the student's work demonstrates the qualities described to a great extent; the work may be close to achieving marks in the level above. Teachers should award the lower marks if the student's work demonstrates the qualities described to a lesser extent; the work may be close to achieving marks in the level below.
- Only whole numbers should be recorded; partial marks (fractions and decimals) are not acceptable.
- Teachers should not think in terms of a pass or fail boundary but should concentrate on identifying the appropriate descriptor for each assessment criterion.

- The highest level descriptors do not imply faultless performance but should be achievable by a student. Teachers should not hesitate to use the extremes if they are appropriate descriptions of the work being assessed.
- A student who attains a high achievement level in relation to one criterion will not necessarily attain high achievement levels in relation to the other criteria. Similarly, a student who attains a low achievement level for one criterion will not necessarily attain low achievement levels for the other criteria. Teachers should not assume that the overall assessment of the students will produce any particular distribution of marks.
- It is recommended that the assessment criteria be made available to students.

Internal assessment details—SL and HL

The scientific investigation

Duration: 10 hours

Weighting: 24%

The IA, worth 24% of the final assessment, consists of one task—the scientific investigation.

The scientific investigation is an open-ended task in which the student gathers and analyses data in order to answer their own formulated research question.

The outcome of the scientific investigation will be assessed through the form of a written report. The maximum overall word count for the report is 3,200 words.

The following are not included in the word count:

- charts and diagrams
- data tables
- equations, formulae and calculations
- citations/references (whether parenthetical, numbered, footnotes or endnotes)
- bibliography
- Headers.

The following details should be stated at the start of the report:

- title of the investigation
- IB candidate code (alphanumeric, for example, xyz123)
- IB candidate code for all group members (if applicable)
- number of words.

There is no requirement to include a cover page or a contents page.

Facilitating the scientific investigation

The research question should be of interest to the student, but it is not necessary that it encompasses concepts beyond those described by the understandings within the guide.

The scientific investigation undertaken must have sufficient extent and depth to allow for all the descriptors of the assessment criteria to be meaningfully addressed.

The investigation of the research question must involve the collection and analysis of quantitative data that should be supported by qualitative observations where appropriate.

The scientific investigation allows a wide range of techniques for data gathering and analysis to be employed. The approaches that could be used in isolation or in conjunction with each other are as follows.

- Hands-on practical laboratory work
- Fieldwork
- Use of a spreadsheet for analysis and modelling
- Extraction and analysis of data from a database

- Use of a simulation

The *SEHS teacher support material* contains further guidance on these possible approaches.

Teachers must:

- ensure that students are familiar with the assessment criteria
- ensure that students are able to investigate their individual research question
- counsel the students on whether their proposed methodology is feasible in consideration of available time and resources
- ensure that students have given appropriate consideration to safety, ethical and environmental factors before undertaking the action phase
- remind students of the requirements for academic integrity and the consequences of academic malpractice; the difference between collaboration and collusion must be made clear.

Developing the research question

Each student is expected to formulate, investigate and answer a unique research question, seeking advice from their teacher.

A student must not present the same set of raw data as another student.

Methodology for individual work

Each student develops their own methodology to answer their individual research question. The student investigates by:

- manipulating an independent variable

or

- selecting variables during fieldwork

or

- selecting different data from external databases.

The student might seek support from peers when collecting data.

Methodology for collaborative work

Collaborative work is optional and where it is facilitated the groups formed must be no larger than three students. Students may organize their own groups. The teacher must provide guidance to ensure that all students are fully engaged in the collaborative activity. Students must clearly understand the requirement to conduct an individual investigation.

The methodology developed to answer their individual research question may be in part the outcome of collaborative activity. A student within the group investigates their individual research question by manipulating:

- a different independent variable to those selected by other group members

or

- the same independent variable with a different dependent variable to those selected by other group members

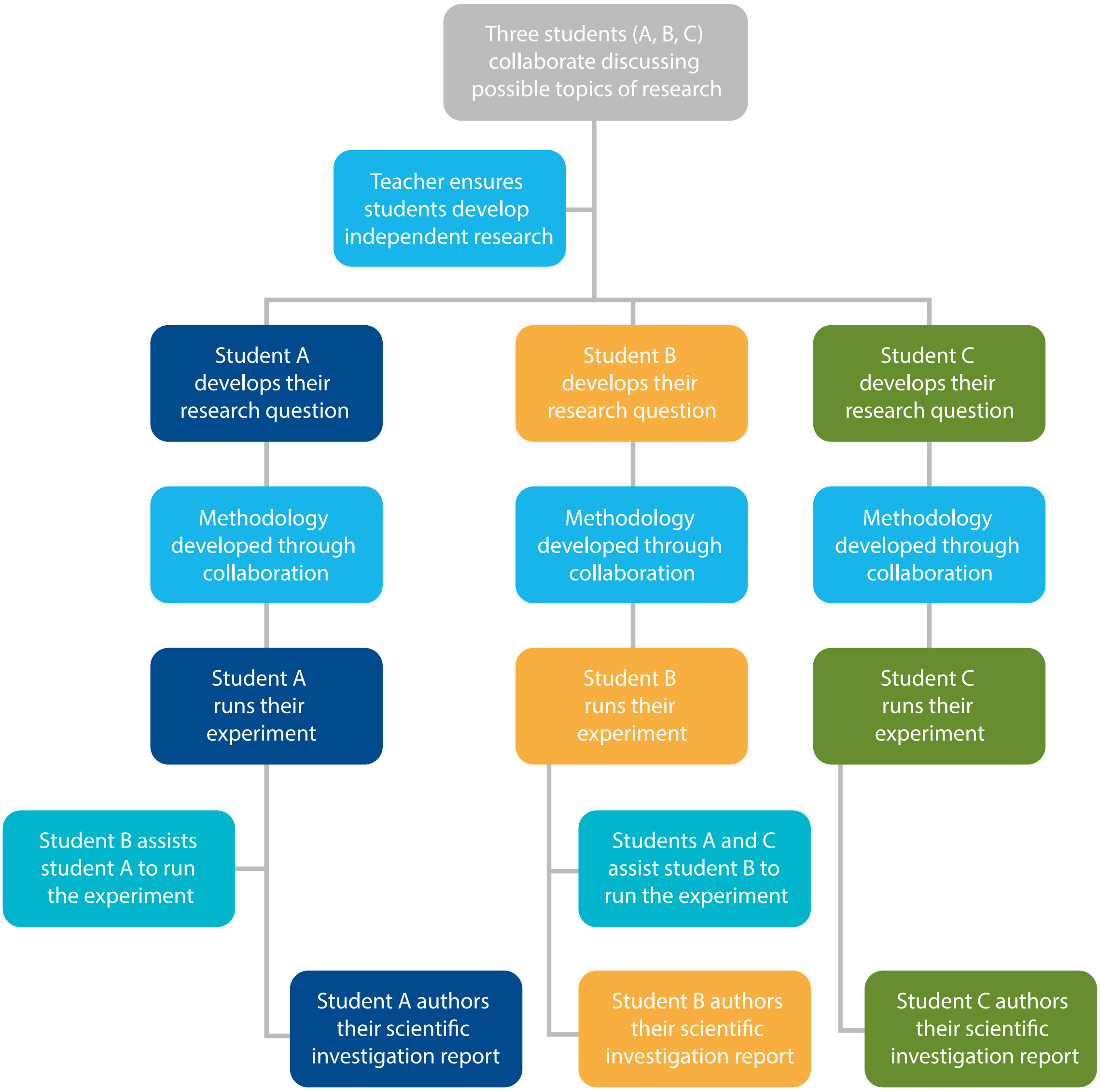
or

- different data to that selected by other group members from within a larger communally acquired data set.

In this context, collaborative work is permitted under the understanding that the final report presented for assessment is that of the individual student. A report by the group is not permitted. All authoring, including the description of the methodology, must be done individually. This diagram illustrates a possible route through the IA process where students collaborate.

Figure 4

A possible route through collaborative work



Class collaboration to set up a database

A school may take part in a large-scale activity collecting data to generate a database using standardized protocols. If a student decides to utilize this database in order to answer their research question, then the investigation must be treated as a database investigation. In such a case the methodology should be focused on the way the data are filtered and sampled from the whole database in the same way as if the data was wholly acquired from an external source.

Assessing the scientific investigation

The performance in the IA at both SL and HL is marked against common assessment criteria, with a total mark out of 24. Student work is internally assessed by the teacher and externally moderated by the IB.

The four assessment criteria are as follows:

- research design
- data analysis

- conclusion
- evaluation.

Each assessment criterion has level descriptors describing specific achievement levels, together with an appropriate range of marks. The level descriptors concentrate on positive achievement, although for the lower levels failure to achieve may be included in the description.

Teachers must judge the internally assessed work at SL and at HL against the same criteria using the level descriptors and aided by the clarifications. The criteria must be applied systematically using a best-fit approach—when a piece of work matches different aspects of a criterion at different levels the mark awarded should be one that most fairly reflects the balance of achievement against the criterion. It is not necessary for every single aspect of a level descriptor to be met for that mark to be awarded. The highest level descriptors do not imply faultless performance.

Where there are two or more marks available within a level, teachers should award the upper mark if the student's work largely satisfies the qualities described; the work may be close to achieving marks in the level above. Teachers should award the lower marks if the student's work demonstrates the qualities described to a lesser extent; the work may be close to achieving marks in the level below.

Only whole numbers must be recorded; partial marks (fractions and decimals) are not acceptable.

The criteria should be considered independently. A student who attains a high achievement level in relation to one criterion will not necessarily attain high achievement levels in relation to the other criteria. Similarly, a student who attains a low achievement level for one criterion will not necessarily attain low achievement levels for the other criteria. Teachers should not assume that the overall assessment of the students will produce any particular distribution of marks.

Where command terms are used in the level descriptors, they are to be interpreted as indicated in the "Glossary of command terms" section of this guide. These command terms indicate the depth of treatment required. Command terms used within the descriptors are provided in the following table.

Assessment objective	Command term	Descriptor
AO1	State	Give a specific name, value or other brief answer without explanation or calculation.
AO2	Identify	Provide an answer from a number of possibilities.
AO2	Outline	Give a brief account or summary.
AO2	Describe	Give a detailed account.
AO3	Explain	Give a detailed account including reasons or causes.
AO3	Justify	Give valid reasons or evidence to support an answer or conclusion.

Referencing and academic integrity

Appropriate referencing to sourced information used in the report of the scientific investigation is expected. Omitted or improper referencing will be considered to be academic malpractice.

Students must ensure their assessment work adheres to the IB's academic integrity policy and that all sources are appropriately referenced. A student's failure to appropriately acknowledge a source will be investigated by the IB as a potential breach of regulations that may result in a penalty imposed by the IB Final Award Committee. See the "Academic integrity" section of this guide for full details.

Internal assessment criteria—SL and HL

There are four IA criteria for the scientific investigation. The marks and weightings are as follows.

Criterion	Maximum number of marks available	Weighting (%)
Research design	6	25
Data analysis	6	25
Conclusion	6	25
Evaluation	6	25
Total	**24**	**100**

Research design

This criterion assesses the extent to which the student effectively communicates the methodology (purpose and practice) used to address the research question.

Marks	Level descriptor
0	The report does not reach the standard described by the descriptors below.
1–2	• The research question is stated without context. • Methodological considerations associated with collecting data relevant to the research question are stated. • The description of the methodology for collecting or selecting data lacks the detail to allow for the investigation to be reproduced.
3–4	• The research question is outlined within a broad context. • Methodological considerations associated with collecting relevant and sufficient data to answer the research question are described. • The description of the methodology for collecting or selecting data allows for the investigation to be reproduced with few ambiguities or omissions.
5–6	• The research question is described within a specific and appropriate context. • Methodological considerations associated with collecting relevant and sufficient data to answer the research question are explained. • The description of the methodology for collecting or selecting data allows for the investigation to be reproduced.

Clarifications for research design
A research question with context should contain reference to the dependent and independent variables or two correlated variables, include a concise description of the system in which the research question is embedded, and include background theory of direct relevance. Methodological considerations include: • the selection of the methods for measuring the dependent and independent variables • the selection of the databases or model and the sampling of data • the decisions regarding the scope, quantity and quality of measurements (e.g. the range, interval or frequency of the independent variable, repetition and precision of measurements) • the identification of control variables and the choice of method of their control • the recognition of any safety, ethical or environmental issues that needed to be taken into account. The description of the methodology refers to presenting sufficiently detailed information (such as specific materials used and precise procedural steps) while avoiding unnecessary or repetitive information, so that

Clarifications for research design
the reader may readily understand how the methodology was implemented and could in principle repeat the investigation.

Data analysis

This criterion assesses the extent to which the student's report provides evidence that the student has recorded, processed and presented the data in ways that are relevant to the research question.

Marks	Level descriptor
0	The report does not reach a standard described by the descriptors below.
1–2	• The recording and processing of the data is communicated but is neither clear nor precise. • The recording and processing of data shows limited evidence of the consideration of uncertainties. • Some processing of data relevant to addressing the research question is carried out but with major omissions, inaccuracies or inconsistencies.
3–4	• The communication of the recording and processing of the data is either clear or precise. • The recording and processing of data shows evidence of a consideration of uncertainties but with some significant omissions or inaccuracies. • The processing of data relevant to addressing the research question is carried out but with some significant omissions, inaccuracies or inconsistencies.
5–6	• The communication of the recording and processing of the data is both clear and precise. • The recording and processing of data shows evidence of an appropriate consideration of uncertainties. • The processing of data relevant to addressing the research question is carried out appropriately and accurately.

Clarifications for data analysis
Data refers to quantitative data or a combination of both quantitative and qualitative data. **Communication** • Clear communication means that the method of processing can be understood easily. • Precise communication refers to following conventions correctly, such as those relating to the annotation of graphs and tables or the use of units, decimal places and significant figures. Consideration of uncertainties is subject specific and further guidance is given in the *SEHS teacher support material*. Major omissions, inaccuracies or inconsistencies impede the possibility of drawing a valid conclusion that addresses the research question. Significant omissions, inaccuracies or inconsistencies allow the possibility of drawing a conclusion that addresses the research question but with some limit to its validity or detail.

Conclusion

This criterion assesses the extent to which the student successfully answers their research question with regard to their analysis and the accepted scientific context.

Marks	Level descriptor
0	The report does not reach a standard described by the descriptors below.
1–2	• A conclusion is stated that is relevant to the research question but is not supported by the analysis presented. • The conclusion makes superficial comparison to the accepted scientific context. • Practical implications of the findings are stated.
3–4	• A conclusion is described that is relevant to the research question but is not fully consistent with the analysis presented. • A conclusion is described that makes some relevant comparison to the accepted scientific context. • Practical implications of the findings are outlined.
5–6	• A conclusion is justified that is relevant to the research question and fully consistent with the analysis presented. • A conclusion is justified through relevant comparison to the accepted scientific context. • Practical implications of the findings are explained.

Clarifications for conclusion
A conclusion that is fully consistent requires the interpretation of processed data including associated uncertainties. Scientific context refers to information that could come from published material (paper or online), published values, course notes, textbooks or other outside sources. The citation of published materials must be sufficiently detailed to allow these sources to be traceable. Practical implications refer to real-world applications related to health or performance.

Evaluation

This criterion assesses the extent to which the student's report provides evidence of evaluation of the investigation methodology and has suggested improvements.

Marks	Level descriptor
0	The report does not reach a standard described by the descriptors below.
1–2	• The report states generic methodological weaknesses or limitations. • Realistic improvements to the investigation are stated.
3–4	• The report describes specific methodological weaknesses or limitations. • Realistic improvements to the investigation that are relevant to the identified weaknesses or limitations are described.
5–6	• The report explains the relative impact of specific methodological weaknesses or limitations. • Realistic improvements to the investigation that are relevant to the identified weaknesses or limitations are explained.

Clarifications for evaluation
"Generic" is general to many methodologies and not specifically relevant to the methodology of the investigation being evaluated.

Clarifications for evaluation
"Methodological" refers to the overall approach to the investigation of the research question as well as procedural steps. "Weaknesses" could relate to issues regarding the control of variables, the precision of measurement or the variation in the data. "Limitations" could refer to how the conclusion is limited in scope by the range of the data collected, the confines of the system or the applicability of assumptions made.

Glossary of command terms

Command terms for SEHS

Students must be familiar with the following key terms and phrases used in examination questions, which are to be understood as described in this section. Although these terms will be used frequently in examination questions, other terms may be used to direct students to present an argument in a specific way. These command terms indicate the depth of treatment required.

Assessment objective 1

Command term	Definition
Label	Add labels to a diagram.
List	Give a sequence of brief answers with no explanation.
State	Give a specific name, value or other brief answer without explanation or calculation.

Assessment objective 2

Command term	Definition
Annotate	Add brief notes to a diagram or graph.
Apply	Use an idea, equation, principle, theory or law in relation to a given problem or issue.
Calculate	Obtain a numerical answer showing the relevant stages in the working.
Describe	Give a detailed account.
Distinguish	Make clear the differences between two or more concepts or items.
Estimate	Obtain an approximate value.
Outline	Give a brief account or summary.

Assessment objective 3

Command term	Definition
Analyse	Break down in order to bring out the essential elements or structure.
Compare	Give an account of the similarities between two (or more) items or situations, referring to both (all) of them throughout.
Contrast	Give an account of the differences between two (or more) items or situations, referring to both (all) of them throughout.
Deduce	Reach a conclusion from the information given.
Determine	Obtain the only possible answer.

Command term	Definition
Discuss	Offer a considered and balanced review that includes a range of arguments, factors or hypotheses. Opinions or conclusions should be presented clearly and supported by appropriate evidence.
Evaluate	Make an appraisal by weighing up the strengths and limitations.
Explain	Give a detailed account including reasons or causes.
Interpret	Use knowledge and understanding to recognize trends and draw conclusions from given information.
Predict	Give an expected result.
Sketch	Represent by means of a diagram or graph (labelled as appropriate). The sketch should give a general idea of the required shape or relationship, and should include relevant features.
Suggest	Propose a solution, hypothesis or other possible answer.