

Scheme of work – Unit F186 – Medical physics

About this scheme of work

Our new AAQ Cambridge Advanced National in Applied Science is for first teaching from September 2025.

This resource:

- is **unit-specific** and has a **lesson by lesson** approach by area of study and allocated guided learning hours (GLH)
- has a **simple** and **editable** Word format
- highlights each lesson's **key words/terms** and **learning outcomes**
- contains **ideas** for teaching and learning with useful **links**
- provides additional **subject knowledge support by area of study**.

Assumptions for teachers

- You will adapt the SOW and lesson content to match your own timetabling arrangements
- You are aware that this SOW is just one approach to how the specification could be taught and the use of any resources highlighted is optional
- Students can access some resources outside of lessons for any online homework or extension tasks
- You will refer to the Cambridge Advanced National in [Applied Science specification](#) as the key document for detailed insight into the qualification's content and assessment requirements.

In this scheme of work we have made suggestions for useful resources both for in class activities and for teacher subject knowledge enhancement. Where we have included a reference to endorsed products such as the Cambridge Advanced National textbook, this indicates that a resource is suitable to support delivery of an OCR specification, but it does not mean that the endorsed resource is the *only* suitable resource to support delivery, or that it is required or necessary to achieve the qualification. Unlike endorsed resources, the other listed resources have not been subject to review and so we cannot offer recommendations or guarantee the quality. We leave this to your professional judgment. These resources are suggestions and are not the only ones suitable to support delivery, neither are they required or necessary to achieve the qualification.

Performance objectives

Here is a reminder of the performance objectives in Unit F186 – Medical physics

Performance Objectives	
PO2	Apply knowledge and understanding
PO3	Analyse and evaluate knowledge, understanding and performance
PO4	Demonstrate and apply skills and processes relevant to the subject.

Further personal development support

For further training and professional development support, find out about our [upcoming training events](#). You'll be able to choose and book on to live online and face-to-face professional development.

Area of study: Topic Area 1.1 Magnetic Resonance Imaging (MRI)

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
1	1.1 Magnetic Resonance Imaging (MRI)	2	By the end of the lesson students should understand: • how an MRI stimulates H atoms • how altering the radio frequency can distinguish between tissue types • the advantages and disadvantages of MRI.	Using mini whiteboards, assess students prior knowledge of the key principles of waves. Ask students to define a transverse and longitudinal wave and to label a diagram of a wave with amplitude and wavelength and to define frequency. Discussion/teacher led section describing how images are generated using MRI. Students should understand the protons within hydrogen nuclei within water molecules and fat align with the applied magnetic field then are excited by a radio frequency pulse. Their return to the low energy state (relaxation) generates an electrical signal. Students can be given a diagram in order to label the key features of the machine (superconducting coils, gradient coils, radiofrequency coils, computer system) and explain their roles. Students' understanding of the process could be assessed by giving them the randomised steps of the process of image generation to put into the correct order.	Magnetic Resonance Imaging (MRI) (nibib.nih.gov) This page describes the basics of MRI, its uses and risks. To inform the teacher led section of the lesson.	Save My Exams (savemyexams.com) This website could be used by students independently for consolidation, flipped learning and revision. Cancerquest: MRI (cancerquest.org) This page could be helpful for students when researching the advantages and disadvantages of MRI on a patient level.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				Give students a short quiz to check their understanding, particularly of the key terms resonance and relaxation. Discussion/teacher led section explaining the difference in relaxation times in different tissues and the application of multiple radiofrequency pulses to emphasise particular tissues. Complete a table to evaluate the advantages and disadvantages of the technique in terms of the quality of the images provided, the variety of conditions likely to be identified through MRI, the cost and availability of the equipment. This is an opportunity for students to research these factors independently.		
2	1.1 Safety considerations and professionals involved	1	By the end of the lesson students should understand: - the safety considerations and risks to patients and staff - the professional roles involved in production and interpretation of MRI scans.	Provide students with patient case studies to evaluate the appropriateness of MRI for each patient and potential risks involved - to include consideration of age of patient, tolerance of noise, conflicting issues such as claustrophobia and some metal implants and pacemakers and when use of sedatives may be appropriate. The use of gadolinium-based contrast agents could be researched by students: when their use is appropriate and what the associated risks are. Using the NHS roles in imaging web page, discussion/teacher led section detailing the	NHS roles in healthcare science: Imaging (non-ionising) (healthcareers.nhs.uk)	MRI: Benefits and Risks (fda.gov) This resource could be used by students to aid their decision making in the patient case studies activity.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				roles and responsibilities within the healthcare field associated with MRI and how these roles fit into overall patient well-being.		

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	In order to effectively engage with lessons on Magnetic Resonance Imaging techniques, students should already have a foundation understanding of some key concepts in both physics and biology. This is the prerequisite knowledge and understanding for this area of study: Magnetic fields: students need an understanding of magnetic fields, including the position of magnetic field lines and a description of where the magnetic field is strongest, along with the difference between induced and permanent magnetism. Atomic structure: students need to be familiar with the numbers and positions of the subatomic particles within a hydrogen atom. Basic anatomy: students should have a familiarity with basic human anatomy in addition to the specific structure of the heart in order to fully understand the medical applications of the technique.
Common misconceptions	A common misconception throughout the topic area is that the risks for each technique are due to ionising radiation which potentially causes harm to the patient rather than low risk non-ionising diagnosis techniques. There is potentially confusion between Magnetic Resonance Imaging and computerised tomography (CT) scanning, which is a computerised X-ray imaging technique, along with an assumption that MRI is only applicable to the brain or head rather than multiple anatomical regions.
Key concepts	Magnetic Resonance Imaging: students should know the key features of an MRI machine (powerful magnet, radio frequency coil and scanner) and how the images are generated through alignment of the protons with the magnetic field, stimulation by radio waves followed by energy release and detection.

Subject knowledge enhancement	Details
Subject knowledge enhancement for teachers	Video: See-Thru Science: How MRI machines work (youtube.com) Book: MRI made easy (rads.web.unc.edu) Throughout this unit, discussions about cancer. Many people or their families are affected by cancer at some point in their lives: Cancer Research UK guidance on talking about cancer to children (cancerresearchuk.org) Macmillan Cancer Support guidance on talking about cancer to children (macmillan.org.uk) Macmillan Cancer Support also has links to teen cancer organisations and information and support for young carers (macmillan.org.uk) Other support for teenagers: Mind's Useful contacts for 11-18 year olds (mind.org.uk)

Area of study: 1.2 Diagnostic ultrasound

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
3	1.2 Ultrasound image generation	2	By the end of the lesson students should understand: - the role of the transducer and boundaries between tissues in generating an image - how to decide which type of transducer to use - the relationships between frequency, gain, wavelength, penetration and resolution - the difference between anatomical and doppler ultrasound.	Give students a short quiz to assess their prior knowledge of sound waves. For example, ask students to identify whether sound waves are transverse or longitudinal. Use an online tone generator to demonstrate the range of human hearing and define ultrasound. Online Tone Generator (onlinetonegenerator.com) Discussion/teacher led section explaining how an ultrasound transducer works focusing on the role of piezoelectrics producing both sound waves and electric current from reflected waves from the boundaries between tissues in order to generate an image. Make an annotated diagram showing the path of the sound waves from the transducer and the reflected waves from the tissue boundaries. Using mini whiteboards assess students prior understanding of the terms	Ultrasound (nibib.nih.gov) This page describes the basics of medical ultrasound, along with uses and risks. Can be used to inform the discussion/teacher led sections. Doppler, Venous, and Arterial Ultrasound (uk.scan.com) A comparison of different ultrasound scans from a medical perspective, this is also useful for informing the teacher led section.	A Beginner's Guide to Ultrasound (geekymedics.com) This resource is a starting point for the students to research the different transducer types and the terms frequency, gain, penetration and resolution. Students could review F180 section 3.1.5 using their textbook to prepare for the topic.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				frequency in relation to waves, and resolution (from KS4 microscopy). Students carry out research to identify the differences between the 3 main types of transducer used: convex, linear and phased. The main facts to find out are: how the images from each transducer are different and what are the different applications? Students could present their findings to the rest of the group. Discussion/teacher led section to explain the difference between anatomical and functional (Doppler) ultrasound, a video could be used: How Functional Ultrasound Works (youtube.com) Explain how changing frequency, gain and wavelength impacts the penetration of the tissue, giving examples of where each setting would be most appropriately used. Alternatively this could be presented as a flipped learning task which can be consolidated in the following lesson. Flipped learning: students can research the relationship between frequency, gain and wavelength and how this impacts the penetration of tissue and resolution of images. The Beginner's Guide to		

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				Ultrasound is a good starting point for this research.		
4	1.2 Role of ultrasound gel and safety considerations	1	By the end of the lesson students should understand: - the role of ultrasound gel and how to select the most appropriate gel - the advantages and disadvantages of ultrasound including the safety considerations to patients and staff - the professional roles involved in production and interpretation of scans and the management and the ultrasound machine.	Recap students' understanding of the process of ultrasound image generation, for example by asking them to put the steps of the process into order. Discussion/teacher led section outlining the role of ultrasound gel, the different types available (high, medium and low viscosity) and the risk of infection with its use. Complete a table with examples of scans produced using each of the types of ultrasound gel. Students can evaluate the advantages and disadvantages of ultrasound in terms of the quality of the images provided, the cost and availability of the equipment. There is an opportunity here for students to research factors such as cost and availability independently and to complete a table of advantages and disadvantages. Discussion/teacher led section detailing the roles and responsibilities within the healthcare field associated with ultrasound image generation and analysis.	Types of ultrasound (stanfordhealthcare.org) Details on the different types of diagnostic ultrasound scans and the tools (gel) involved. Ultrasound scans pros and cons (thehealthsuite.co.uk) An evaluation of the advantages and disadvantages of ultrasound scanning.	General Ultrasound (radiologyinfo.org) Information about having an ultrasound scan performed from a patient perspective, including the disadvantages and risks. This is a good resource for students to evaluate the pros and cons independently.

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	In order to effectively engage with lessons on ultrasound imaging techniques, students should already have a foundation understanding of some key concepts in both physics and biology. This is the prerequisite knowledge and understanding for this area of study: Waves: students need to have a basic understanding of the fundamental principles of waves, including the parameters wavelength, frequency and amplitude. There also needs to be an understanding of the difference between transverse and longitudinal waves (including the categorisation of radio, sound and light waves) and familiarity with the electromagnetic spectrum, in particular the range of frequencies and wavelengths of radio waves. Similarly to the underlying knowledge for MRI, the students require a basic knowledge of anatomy.
Common misconceptions	There is a common misconception that ultrasound imaging is used solely during pregnancy to monitor development of the foetus. Although this is a common application of the technique it is also used to diagnose conditions in the heart, abdomen, muscles and blood vessels. Later on students will learn about the therapeutic use of ultrasound so it may be useful to avoid planting the misconception that they are only used for diagnostic purposes in these lessons.
Key concepts	Students should understand that diagnostic ultrasound uses a transducer to emit sound waves above the limit of human hearing (>20kHz) and also to detect the ultrasound waves reflected back through the use of piezoelectrics. 2D images are generated through measuring the time of each echo sound wave which reflects from a boundary between tissues. Students should also have an understanding of the difference between anatomical and functional (Doppler) ultrasound which visualises blood flow and the role of ultrasound gel in facilitating image generation.
Subject knowledge enhancement for teachers	Website: Ultrasound Imaging (fda.gov) Video: Ultrasound physics - Image generation (youtube.com)

Area of study: 1.3 Endoscopy

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
5	1.3 Endoscopy	1	By the end of the lesson students should understand: - the structure of modern endoscopes including the use of non-coherent fibres and capsule endoscopy - how to decide which type of endoscopy to use.	Give students a short quiz to assess their prior learning of light waves, including their understanding of reflection and refraction. Address any gaps in knowledge or misconceptions- students should understand the terms reflection and refraction along with the law of reflection. Discussion/teacher led section describing the structure of an endoscope and the roles of the core and the cladding, along with an explanation of the roles of coherent and non-coherent bundles. Students should be shown examples of different types of endoscopy with an explanation of which area is being examined, where the scope is inserted and which conditions may be diagnosed with this technique Students can then complete a table summarising the information to include the area examined, where the scope is inserted and the doctor who performs the surgery for each type of endoscopy.	Endoscope (cyberphysics.co.uk) Notes on fibre optic technology and endoscopy which can be used to inform the teacher led section.	Fibre Optics and Endoscopy (studysmarter.co.uk) Revision flashcards for the medical physics topics within the A Level Physics specifications. This can be used for consolidation or revision. What are the types of endoscopy? (healthline.com) Information on the different types of endoscopy procedures which can be used by the students as a starting point for the research task.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
6	1.3 Benefits and risks	1	By the end of the lesson students should understand: - the advantages and disadvantages of endoscopy as an imaging technique including the quality of the image, cost and availability - the safety considerations and risks to patients - the professional roles involved in production and interpretation of images.	Students use the patient stories and other resources to evaluate the benefits and risks of the procedure, including researching the cost, image quality and availability of the equipment. Discussion/teacher led section detailing the roles and responsibilities within the healthcare field associated with endoscopy and how these roles fit into overall patient well-being.	Day in the life of endoscopy healthcare assistants (gatesheadhealth.nhs.uk)	Patient Stories 1 (ramsayhealth.co.uk) Patient Stories 2 (bhrhospitals.nhs.uk) Advantages and disadvantages of endoscopy (curasia.com) The resources can be used by the students to inform their evaluation of the advantages and disadvantages of the procedure.

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	In order to effectively engage with lessons on endoscopic techniques, students should already have a foundation understanding of some key concepts in both physics and biology. This is the prerequisite knowledge and understanding for this area of study: Waves: similarly to MRI, students need to have a basic understanding of the fundamental principles of waves, including the parameters wavelength, frequency and amplitude. There also needs to be an understanding of the behaviour and categorisation of light waves. Similarly to the underlying knowledge for previous imaging techniques, the students require a basic knowledge of anatomy.
Common misconceptions	There are misconceptions around the uses of endoscopy and the technique is often considered to be solely for identifying gastrointestinal conditions whereas it can be used to investigate other parts of the body such as the respiratory system. Try to avoid confusion with laparoscopy which involves making incisions through the skin and muscle to see organs that cannot be visualised using an endoscope through a body orifice. Endoscopy is also often only considered to be used for diagnostic procedures but the technique can also be used therapeutically for procedures such as polyp removal.
Key concepts	Students should be able to describe the basic structure of an endoscope: a core along which light is transmitted surrounded by cladding with a slightly lower refractive index which allows light in the core to be totally internally reflected. There should be an understanding of the difference between coherent and non-coherent fibres and the role of each within an endoscope.
Subject knowledge enhancement for teachers	Video: How does an endoscope work? (youtube.com) Article: Endoscopy: the scientific principle behind a medical application (gs-physics-journals.github.io)

Area of study: 1.4 Electrocardiogram (ECG)

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
7	1.4 Structure of the heart	1	By the end of the lesson students should understand: • how the structures of the heart coordinate to create a heartbeat • the common issues with the heart which can be detected by an ECG.	Using mini whiteboards assess students' prior knowledge of the structure and function of the heart from KS4 Biology. Address/discuss any gaps in knowledge or misconceptions and describe the structures found within the heart, including chambers, nodes and valves. Give students a diagram of the heart to label the chambers (including differences between left and right sides), valves and major blood vessels. Discussion/teacher led section explaining the progression of a heartbeat initiated in the sino-atrial node through the atria, atrio-ventricular node and ventricles. This should be introduced alongside an ECG trace in order to demonstrate the relationship between the depolarisation of the atria and ventricles and the features of the trace (P wave, QRS wave, PR interval, ST segment). Summarise the sequence of events in the cardiac cycle in a flow chart, using the resource as a scaffold.	Structure of the Heart (studymind.co.uk) Study notes on the structure and function of the heart which can be used for consolidation or for independent study. Understanding an ECG (geekymedics.com) Step-by-step interpretation of an ECG trace, useful for aligning the cardiac cycle to the ECG trace in the teacher led section.	The Cardiac Cycle (savemyexams.com) Detailed study notes on the heart and cardiac cycle to support the summarising of the cardiac cycle events. Structure and function of the heart (bbc.co.uk/bitesize) Notes, videos and quizzes for self testing on the structure of the heart and the cardiac cycle.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				Student to label a 'normal' ECG trace with an explanation of each of the key segments. Student understanding can be assessed with a short quiz on the parts of the heart, their function and the sequence of the cardiac cycle.		
8	1.4 Electrocardiogram (ECG)	1	By the end of the lesson students should understand: - the position of electrodes and their role in measuring potential difference and the difference between positive and negative deflections - how to identify P waves, QRS waves and heart rate - how to interpret simple ECGs including irregular heart rhythms and heart attack - the advantages and disadvantages of	Show a video demonstrating how to place the leads correctly for a 12 lead ECG, if training materials are available students could practice on a CPR training dummy or similar. How to perform a 12 lead ECG (youtube.com) Recap the cardiac cycle from the previous lesson alongside a normal ECG trace to identify the P wave, QRS wave, PR interval, and ST segment. Give students a range of ECGs which feature different heart conditions (from ECG Reviews) alongside a normal ECG and ask them to identify the differences in the traces associated with each condition – specifically including heart attack and irregular rhythms.	ECG Reviews (healio.com) ECG findings generated from 12 lead ECG. ECG Examples and Quiz (oxfordmedicaleducation.com) Medical scenarios involving ECG traces for students to discuss and identify the issues.	ECG abnormalities (almostadoctor.co.uk) Students can use this resource as a reference point for identifying differences in abnormal ECG traces.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
			ECG, including risks to the patient • how ECGs can be used to improve CT scans.	Students can evaluate the advantages and disadvantages of ECG as a diagnostic technique, including the risk to patients undergoing ECG. Describe how an ECG can be used to improve CT scans (for example using ECG gating to reduce the cardiac motion which blurs CT images).		

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	In order to effectively engage with lessons on ECG, students require this prerequisite knowledge and understanding for this area of study: The heart: an understanding of the role of the heart and the different types of heart conditions which can occur. Electrical circuits: in order to understand the terminology used to describe the process of 12 lead ECG students will need to be familiar with terminology such as potential difference, current and resistance.
Common misconceptions	The ECG technique is commonly considered to be able to identify all heart conditions but in reality is not a reliable diagnostic tool for valve disease, heart failure or coronary heart disease. Patients can therefore have a normal ECG trace even though they have a current cardiac condition. Additionally an abnormal ECG trace is not always indicative of a serious heart condition.
Key concepts	The heart: there needs to be an understanding of the anatomy of the heart: the structure and function of each of the chambers of the heart and the position (and role) of the sino-atrial (SA) node and the atrioventricular (AV) node. Additionally students need to understand the coordination of the electrical activity of the heart beginning in the SA node, travelling through the atria, AV node and ventricles. Electrocardiogram: students should be familiar with the key measurements taken from an ECG trace (PR interval, QT interval and QRS interval) and identification of the key features which indicate common issues with the heart which can be identified by an ECG.
Subject knowledge enhancement for teachers	Video: How to read an ECG (youtube.com) Article: Teaching the electrical origins of the electrocardiogram: An introductory physics laboratory for life science students (pubs.aip.org) Website: Cardiac cycle (open.oregonstate.edu)

Area of study: 2.1 X-ray imaging

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
9	2.1.1 Plain X-ray Image: X-ray tube structure and production of X-rays	2	By the end of the lesson students should understand: • how X-ray settings can be optimised for patient safety and image quality • the common uses of X-ray imaging • the use of image contrast enhancement in X-ray imaging • how to position patients to optimise images and reduce artifacts • the use of collimators and filters to improve image quality.	Give students a short quiz on how ionising radiation causes damage to cells and what can be done to protect yourself from different types of ionising radiation. Show video introducing how X-rays are generated: How Do X-rays Work? (youtube.com) Discussion/teacher led section describing the basic structure of an X-ray tube and how X-rays are produced. Information to be included in the discussion, X-ray tube components: • cathode: emits electrons when heated. • anode: made of tungsten; electrons collide with it to produce X-rays. • vacuum tube: allows electrons to travel without colliding with air particles. An explanation of effective radiation dose and how it is calculated should also be included in the discussion.	X-rays (arpansa.gov.uk) Notes on X-ray image generation to inform teacher led section. What is radiation dose? (radiologyinfo.org) Notes on different ways to measure radiation dose. X-ray collimators (mediccloud.co.au) Notes on the use of collimators to support the teacher led section.	X-rays (nibib.nih.gov) X-ray (nhs.uk) Resources to support students with the independent research task. Students could review topic 3.1 X-rays from F180 using their textbook to prepare for the topic.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				Independent research task: students to research the clinical uses for X-rays and how the images can be optimised. For scaffolding, students could be given questions to answer: • What are the diagnostic applications of X-rays? • What are the key settings that can be optimised for image quality? • How does changing the settings change the X-ray production? • How should patients be positioned to optimise the images and reduce artifacts? Information from the research task can be shared with the rest of the class. Discuss the use of collimators to reduce scatter radiation to improve image sharpness and limit radiation exposure to surrounding tissues, and filters to remove low energy X-rays that don't contribute to the image, reducing patient dose. Divide students into groups and provide each group with a scenario. Examples: • Scenario 1: Chest X-ray for suspected pneumonia in an adult. • Scenario 2: Dental X-ray for cavity detection in a child.		

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				- Scenario 3: Wrist X-ray for a suspected fracture. For each scenario the group should: - determine the optimal X-ray tube settings (kVp, mA, exposure time) for the scenario - suggest the correct patient positioning - recommend whether to use a contrast agent or not - indicate how collimators and filters would be used to enhance image quality and reduce dose.		
10	2.1.1 Plain X-rays: Radiation dose and safety considerations	1	By the end of the lesson students should understand: - the effective radiation dose from different types of X-ray scan - the advantages and disadvantages of X-ray - the safety procedures to protect patient and staff - who manages the equipment, conducts the procedure and interprets the images.	Start by asking students what are the challenges when balancing dose and image clarity when generating X-ray diagnostic images? Discussion/teacher led section defining effective dose. Show students a radiation dose comparison chart to compare X-ray doses with background radiation. Students use resources to evaluate the advantages and disadvantages of X-ray imaging as a diagnostic technique. Discuss the safety principles for X-ray imaging:	Radiation dose comparison chart (fwradiology.com) Radiation chart to give to students for comparison to other imaging techniques. X-rays and their safety (bir.org.uk) Resource to support the teacher led section on safety.	Careers in radiology (bir.org.uk) Resource to support students independent research task.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				• ALARA principle • use of lead shielding for patients and staff • use of collimators and filters • safe distance from the X-ray source for staff • regular calibration and maintenance of X-ray equipment to ensure proper functioning. Show students a variety of patient scenarios and ask them to design a radiation safety protocol addressing patient and staff safety. Example scenarios: • Paediatric patient undergoing a chest X-ray for suspected pneumonia. • Pregnant patient requiring an abdominal X-ray for suspected kidney stones. • An elderly patient with suspected hip fracture needing an X-ray. Discussion / teacher led section describing the roles involved in the generation of X-rays: • Radiographer • Radiologist		

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				- Medical physicist - Radiation protection specialist		
11	2.1.2 Computerised tomography (CT) scans: structure and function of a CT machine and use of contrast media	2	By the end of the lesson students should understand - how a CT scan is used to image the body - the use of a contrast media to form an image including examples such as barium meal, including the risks - how specific health problems are diagnosed using these methods.	Discussion/teacher led section describing the basic structure of a CT machine and image formation. Structural features to include are: gantry: the doughnut-shaped frame containing the X-ray tube and detectors. patient table: moves through the gantry during the scan. control console: operated by the technologist to set scan parameters. Show the video describing how a CT scan image is generated. How Does a CT Scan Work? (youtube.com) Students use the image to write a paragraph explaining how CT scans are generated. List the conditions which can be diagnosed with CT scanning: - brain injuries, strokes, tumours - coronary artery disease - appendicitis, kidney stones, liver tumours.	CT Scan (my.clevelandclinic.org) Resource to inform the initial teacher led section. CT scan images (istockphoto.com) Examples of CT scan images to give to students to view.	Contrast media (insideradiology.com) Resource to support students with the contrast media task.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				Show students CT images obtained with and without the use of contrast media (barium sulfate and iodine-based) and ask them to describe the differences between the images and what could have caused the differences. Discuss the use of contrast media to absorb X-rays and appear brighter in images: • iodine-based: used for blood vessels, organs, and soft tissues • barium sulfate: used for imaging the digestive system. Divide students into small groups. Give each group a case study involving a patient needing a CT scan with contrast media, e.g. a patient with abdominal pain and suspected appendicitis. Each group answers the questions: • Why is contrast media needed in this case? • Which type of contrast media would be used? • What safety measures should be taken?		

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				Groups present their findings to the class, highlighting the benefits and risks of using contrast media.		
12	2.1.2 Computerised tomography (CT) scans and contrast media: radiation dose and safety considerations	1	By the end of the lesson students should understand: - the effective radiation dose from CT scans - the safety considerations to protect patients and staff - who manages the equipment, conducts the procedure and interprets the images.	Recap the previous lesson by asking students to describe the generation of CT images on a whiteboard. Give students the Radiation dose comparison chart. Discuss how CT scan radiation doses compare to other imaging methods and natural background radiation, e.g. chest X-ray = ~0.1 mSv. compared to chest CT = ~7 mSv. Provide the CT Scan Safety Checklist with points such as: - Is the patient a young child? - Is the patient pregnant? - Are the kidneys functioning normally? (For contrast media use.) - Is lead shielding appropriate? - What is the lowest effective dose of radiation? Discuss why each of these points are on the checklist. Give the students sample patient scenarios and ask them to analyse	Radiation dose comparison chart (fwradiology.com) Radiation chart to give to students for comparison to other imaging techniques.	CT patient safety and care (ncbi.nlm.nih.gov) Guidelines for CT patient care to support the patient scenario activity. The Guide to CT Scans (teleoshinmedicalsystems.com) Resource to support the evaluation of advantages and disadvantages of CT.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				their patient scenario and identify the safety considerations, and propose specific actions to minimise radiation exposure and ensure patient safety. Example patient scenarios: • Scenario 1: A six-year-old child with suspected head trauma. • Scenario 2: A 45-year-old diabetic patient requiring a contrast-enhanced abdominal CT. • Scenario 3: A pregnant woman with suspected pulmonary embolism. • Scenario 4: An 80-year-old patient with chronic kidney disease undergoing CT angiography. Students complete a table of comparison of the advantages and disadvantages of CT scanning (including the advantages of combining it with MRI scanning for some conditions). Students should consider the quality of the image, cost and availability in their evaluation. Give students a summary of the key roles in CT scanning: • Radiographer • Radiologist		

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				• Medical physicist • Referring physician • Nurse • Patient care assistant. Ask students why teamwork is essential in CT scanning and what could go wrong if roles are unclear or not followed. Students summarise the roles and responsibilities of key personnel in CT scanning.		

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	In order to effectively engage with lessons on X-ray imaging, students require this prerequisite knowledge and understanding for this area of study: Electromagnetic spectrum: students should be able to recall the position of X-rays on the electromagnetic spectrum from key stage 3 physics. Students also need to have an understanding of why ionising radiation is dangerous to cells, i.e. the impact on DNA within the nucleus.
Common misconceptions	There is an assumption that all X-ray tubes are the same whereas different X-ray systems (e.g. digital, portable, dental) are designed for specific applications and have varying radiation outputs. It can sometimes be assumed that X-rays are harmless but in reality while the radiation dose from a single X-ray is low, cumulative exposure over time can increase the risk of radiation-related health issues, such as cancer.
Key concepts	The basic structure of an X-ray tube should be understood, along with understanding how optimisation of the settings will affect image quality and safety for different patients. Students should be able to list the common uses of X-ray imaging and understand how contrast enhancement, patient position, collimators and filters can improve image quality. It should be understood how a CT scan is used to image the body, including the use of contrast media such as barium sulfate to provide brighter areas to improve the image. The risks involved with contrast media use and with CT scanning in general should be understood, and the safety procedures in place to protect patients and staff. Students should understand the conditions for which CT scanning is used in order to aid diagnosis and the circumstances under which it is combined with MRI scanning. The advantages and disadvantages of CT scanning should be understood, including the quality of the image, cost and availability. The radiation doses for each technique in comparison to other ionising radiation exposure should be understood along with the safety procedures in place to protect patients and staff. Students should also know the relevant roles and responsibilities of staff managing the equipment, conducting the procedure and interpreting the images.
Subject knowledge enhancement for teachers	Article: Basic physics of diagnostic X-ray imaging (radcommons.org) Website: Computed Tomography (fda.gov) Videos: CT (Computed Tomography) Scans: A Level Physics, Introduction to X-ray production (youtube.com)

Area of study: 2.2 Radionuclides

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
13	2.2.1 Radiopharmaceuticals : tracers	1	By the end of the lesson students should understand: - the structure and use of the gamma camera - the function of radiopharmaceuticals in the body as a tracer - the dose level from different types, considering half life and radiation type - how to select the type of tracer to use based on delivery method, age, health and lifestyle of patient and its elimination from the body.	Start by showing a video to introduce the gamma camera. Gamma camera Components & Function Visual explanation (youtube.com) Discussion/teacher led section explaining that the gamma camera is a tool which visualises gamma emitting radioisotopes, used to visualise internal organs. Describe the components of the gamma camera. Collimator: filters gamma rays. Scintillation crystal: converts gamma rays into visible light. Photomultiplier tubes: convert light into an electrical signal. Electronics system: processes the signals to generate an image. Students can label a diagram of a gamma camera with a brief description of the role of each of the parts. Give students information sources on the different radioactive tracers used with the gamma camera. Students should use the	The Gamma Camera (cyberphysics.co.uk) Information on the structure and function of the gamma camera to inform the teacher led section. Gamma Camera Diagram (quizlet.com) Blank diagram for students to annotate.	Gamma Camera A level physics (savemyexams.com) Notes which can be used for consolidation and independent study. Gamma Camera (radiologycafe.org) Resource which can be used as an information source for students for the radioactive tracers task

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				information to find answers to the following questions: - Which radioisotopes are used? - What are the half-lives of the isotopes? - What patient factors are considered when choosing a tracer? - What level of radiation is the patient exposed to?		
14	2.2.1 Radiopharmaceuticals : roles and safety considerations	1	By the end of the lesson students should understand: - the safety procedures to protect patient and staff from ionising radiation - the health and safety legislation linked to the use of radioactive materials - who prescribes and administers the radiopharmaceutical and monitors the patient - the advantages and disadvantages of	Ask students to use their information from the previous lesson to construct a flow chart explaining the process of image generation by a gamma camera. If required students could be provided with a scaffold: gamma emission scintillation amplification intensity mapping image construction. Discussion/teacher led section describing the applications of the gamma camera. Include the common uses in medical diagnostics: - Bone: detect bone abnormalities like fractures or cancer metastasis. - Thyroid: evaluate thyroid function.	ARSAC (gov.uk) Information on the legislation covering the use of radiodiagnostics to inform the discussion. Advantages and disadvantages of nuclear imaging (twi-global.com) A resource to support the evaluation of advantages and	Guidelines for ALARA (cdc.gov) Notes to support students with the summarising task. Careers in nuclear medicine (bnms.org.uk) Information on the roles and responsibilities within nuclear medicine to support students with the group task.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
			radiopharmaceuticals for diagnosis.	- Cardiac imaging: assess blood flow and heart function. - Kidney: monitor kidney function. Introduce the ALARA principle with regard to radiation safety. Give students a copy of the guidelines for ALARA and ask them to summarise the main points which relate to patient and staff safety when using radiopharmaceuticals Summarise the main points and correct any misconceptions the students have at this point then explain the relevant legislation (ARSAC Administration of Radioactive substances advisory committee). The explanation should include: - Ionising Radiation (Medical Exposure) Regulations (IR(ME)R) - Environmental permitting regulations. Divide students into groups and assign each group a role: - radiation oncologist - nuclear medicine technologist - medical physicist - radiopharmacist.	disadvantages of nuclear imaging.	Students could use their textbook to revise sections 3.2.4 and 3.2.2 in F180 which covers dose, half life and effective half life, types and properties of radiation, function as tracer.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				Have each group outline their responsibilities and safety procedures in a mock gamma camera imaging session. Present scenarios (e.g. accidental spillage of radioactive tracer) for groups to respond to. Students complete a table to compare the advantages and disadvantages of gamma camera imaging. Quality of images should be compared to risk from ionising radiation.		
15	2.2.2 Positron emission tomography (PET): Basic principles of a PET scan	1	By the end of the lesson students should understand: - the basic principles of a PET scan - how PET is able to visualise the body, including the role of fluorodeoxyglucose (FDG) - why PET scans are used.	Show a colourful, labelled PET scan image of a human brain or heart and ask students to describe what they think it represents and how it was generated. Show video explaining how PET scans are generated. How Does a PET Scan Work? (youtube.com) Give students the steps of PET image generation to put into order. - Injection of radioactive tracer, e.g. FDG. - FDG is used by rapidly metabolising cells. - Tracer emits positrons as it decays.	Positron Emission Tomography (PET) (hopkinsmedicine.org) Information on the process of image generation using PET.	PET Scan (webmd.com) Notes to assist students with putting the steps of PET image generation in order. PET/CT (radiologyinfo.org) Resource to assist students in the completion of the

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				- Positrons collide with electrons in the body, resulting in annihilation events that produce gamma rays. - Gamma rays are detected by the PET scanner. Give students a short quiz to assess their recall of respiration from Key stage 4 biology, focusing on the role of glucose within metabolism. Address gaps in understanding of how glucose is utilised by metabolising cells. Describe the role of FDG in image generation. Key points to include in the discussion: - FDG is a glucose analog labelled with fluorine-18. - It accumulates in cells with high metabolic activity, e.g. cancer cells. - Tissues with high FDG content appear brighter on PET scan. Show students examples of images that demonstrate the different applications of PET scanning (for example heart function assessment, neurological imaging, cancer diagnosis, detection of infection and inflammation).		table of applications of PET scanning

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				Get students to summarise the information in a table containing the following information: - List the conditions for which PET scanning is used to visualise tissues. - Explain why it is used in preference to other imaging techniques. - Explain why PET scans are combined with CT scans to accurately locate a tumour.		
16	2.2.2 Positron emission tomography (PET): Advantages and disadvantages and safety considerations	1	By the end of the lesson students should understand: - the advantages and disadvantages of PET scans, including the quality of the image, cost and availability - why combining PET with a CT scan is sometimes necessary to locate a tumour - the safety considerations to protect patients and staff	Start by asking students to list the advantages and disadvantages of PET scanning. The students can be provided with resources to assist them with the task or use their information from the previous lesson Give students a short quiz to recap the ALARA principle and safety considerations from gamma radiation. Discuss answers to the quiz and the relevance of safety regulations to PET scanning. Discussion/teacher led section on the roles involved in administering PET scans. The discussion should involve:	PET (msdmanual.com) Notes on the procedure and uses of PET scanning.	Advantages and applications of PET (pmc.ncbi.nlm.nih.gov) What are the benefits and risks of PET scans (oncarecancer.com) Resources to support students with the starter task evaluating the advantages and disadvantages of PET scanning.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
			who administers the FDG and who performs the PET scan.	Nuclear medicine technologists: operate the PET scanner and ensure proper imaging protocols are followed. Radiopharmacists: prepare and handle radioactive tracers. Medical physicists: ensure the safety and calibration of the PET scanner. Radiologists or Nuclear medicine physicians: interpret PET scan images and provide diagnostic reports. Radiation safety officers (RSOs): oversee compliance with radiation protection standards.		

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	In order to effectively engage with lessons on radionuclides, students require this prerequisite knowledge and understanding for this area of study: Respiration: in order to understand the role of FDG in image generation students need to have an understanding of the role of glucose in the biochemical process of respiration within metabolising cells. Similarly to the underlying knowledge for previous imaging techniques, the students require a basic knowledge of anatomy.
Common misconceptions	It can be thought that PET scans are the same as MRI and CT scans rather than understanding that PET scans measure metabolic activity using radioactive tracers, while CT and MRI scans provide structural and anatomical details. PET is often combined with CT or MRI to provide complementary information. It is sometimes thought that the radioactive tracer cause allergic reactions or severe side effects. In reality adverse reactions to PET tracers are extremely rare. Most patients experience no side effects from the procedure. Students may believe that patients are radioactive and therefore dangerous to be around. It should be made clear in discussions around “lifestyle” that the use of radioactive tracers can be problematic for people who work with pregnant people or young children, and for someone who is breastfeeding. Generally, however, very low doses are used with short half-lives or good elimination times.
Key concepts	Students need to understand the basic structure of the gamma camera and the role of radiopharmaceuticals as tracer molecules within the process of image generation. The selection of the tracer based on delivery method and patient statistics and a comparison of radiation dose level from different types should also be understood. There needs to be an understanding of the basic principles of a PET scan, including the role of fluorodeoxyglucose (FDG) and how PET is able to visualise the body, along with clinical applications of the technique with and without an accompanying CT scan. The safety procedures in place to protect staff, patients and the environment for each technique along with relevant health and safety legislation linked to the use of radioactive materials should be understood and students should be able to describe the relevant healthcare roles involved in the procedures.
Subject knowledge enhancement for teachers	Video: Introduction to Positron Emission Tomography (youtube.com) Articles: Radiation protection during PET/CT (iaea.org) Positron Emission Tomography (sciencedirect.com)

Area of study: 3.1 Treatment with external source

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
17	3.1 Radiotherapy using X-rays and gamma	1	By the end of the lesson students should understand: - the penetration and relative energy of X-rays and gamma radiation - the accuracy of each treatment type in treating damaged cells and the associated risks - the conditions for which different types of external source are required and contraindications.	Begin by assessing students' baseline understanding of radiotherapy: what is it used for, what type of radiation is used, what are the risks. A short quiz could be used. Discussion/teacher led section describing the similarities and differences in properties of X-rays and gamma radiation in terms of: - both are photons of energy (gamma > X-rays) penetration: gamma > X-rays - origin: inside nucleus or processed outside - both are ionising. Define external beam radiotherapy Give students a list of conditions for which each external source is used, for example cancer, hyperthyroidism, benign eye conditions. For each condition the students should answer the following questions (using resources for support if necessary): - Which conditions are treated with each type of external source?	Radiation basics (epa.gov) Provides information on the different types of ionising radiation to inform the teacher led section. External beam radiation therapy (cancer.gov) Notes to inform the teacher led section.	Radioactivity (bbc.co.uk/bitesize) Notes, videos and quizzes for students to independently revisit Key stage 4 physics radioactivity. Getting external beam radiation therapy (cancer.org) This resource can be used by students to assist them with the independent task.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				- What are the contraindications? - How is the accuracy of the source maintained?		
18	3.1 Radiotherapy using X-rays and gamma: advantages and disadvantages	1	By the end of the lesson students should understand: - the advantages and disadvantages of each treatment type including cost and availability - the safety procedures to protect patients and staff from ionising radiation - who manages the equipment and conducts the procedure.	In groups, provide students with case studies (use the SAM as a guide) to decide whether to use X-rays or gamma rays for treatment, explaining their reasoning. Use the Macmillan – Understanding radiotherapy resource to explain how external beam radiotherapy is used and the side effects. Discuss the safety procedures in place to protect the patient and staff from ionising radiation. Flipped learning opportunity: students research the roles in the healthcare sector within the radiotherapy department.	Macmillan Cancer Support – External beam radiotherapy (macmillan.org.uk) This webpage provides detail on what this is, types, why it is used and how it is given. Radiation therapy safety (cancer.org) This resource can be used to inform the discussion about the safety measures.	Macmillan – Understanding radiotherapy (pages 35-46 and pages 59-79). Students can use this resource to learn more about how external source radiotherapy is used and the side effects. Note that this content includes references to sex (pages 41 and 72-3). Roles within radiotherapy (wmcanceralliance.nhs.uk) The resource can be used as a starting point for the flipped learning opportunity.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
19	3.1 UV skin treatment	1	By the end of the lesson students should understand: - the penetration and relative energy of UV skin treatment - the accuracy of UV treatment in treating damaged cells and the associated risks - the conditions for which UV is required and contraindications - the advantages and disadvantages of UV treatment including cost and availability - the safety procedures to protect patients and staff from ionising radiation - who manages the equipment and conducts the procedure.	Flipped learning: students present their findings from the flipped learning task in previous lesson focusing on roles within the healthcare sector within the radiotherapy department. Give students a short quiz to assess their prior understanding of ultraviolet (UV) waves. This could include their relative wavelength and frequency, risks, what is sunburn and clinical uses. Discuss misconceptions or gaps in understanding of UV radiation. Key points to consider are: - categorisation as UVA, UVB or UVC - effect of UV on skin, e.g. sunburn - dangers of UV radiation, e.g. increased risk of skin cancer. Independent learning task - split the class into groups and each group research the background to the use of UV radiation in each medical condition: - phototherapy - vitiligo - psoriasis - acne - neonatal jaundice.	UV Radiation (pmc.ncbi.nlm.nih.gov) Notes on the physics and clinical impact of UV radiation.	UV radiation and the skin (pmc.ncbi.nlm.nih.gov) General information on the effect of UV on skin for independent learning and consolidation Beneficial effects of UV radiation (pmc.ncbi.nlm.nih.gov) Information for students to use for the independent learning task.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				For scaffolding the following questions can be given to the students to find answers: • How does UV radiation help? • What are the risks or side effects? • What precautions are necessary?		
20	3.1 Proton beam	1	By the end of the lesson students should understand: • the penetration and relative energy of proton beam therapy • the accuracy of proton beam in treating damaged cells and the associated risks • the conditions for which proton beam is required and contraindications • the advantages and disadvantages of proton beam therapy including cost and availability • the safety procedures to protect patients and	Start by showing a video explaining proton therapy in comparison to X-ray or photon radiotherapy. Proton Beam Therapy (youtube.com) Discussion/teacher led section explaining how proton beam therapy works and the particular applications of the technique. Include an explanation of: • the Bragg peak (depositing energy at a specific depth) • source of the protons (hydrogen atoms) • basic structure of synchrotron particle accelerator. Give students a list of hypothetical tumours and their locations. Students can identify which tumours are suitable for proton therapy based on their location near sensitive tissues. Example hypothetical tumours:	Proton beam therapy (england.nhs.uk) Details of the NHS UK proton beam therapy programme from a patient perspective. Proton Therapy (hopkinsmedicine.org) Detailed notes to inform the teacher led section, videos are embedded to aid understanding.	Side effects of proton beam therapy (thebraintumourcharity.org) Students can read this resource to prepare for the discussion on advantages and disadvantages.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
			staff from ionising radiation who manages the equipment and conducts the procedure.	- paediatric brain tumour, temporal lobe near to optic nerve - spinal cord tumour (cervical region) - prostate tumour, near bladder and rectum - ocular melanoma, near the retina. Discuss the advantages and disadvantages of proton beam therapy. Guiding questions: - What happens if the proton beam is not accurately targeted? - How does safety compare to X-rays? - What safety precautions are necessary? Students should summarise this information in a table of advantages and disadvantages. Explain the role and responsibilities within proton beam therapy, including overlap with the professional roles involved in the other types of treatment with external source.		

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	In order to effectively engage with lessons on external source radiotherapy, students require this prerequisite knowledge and understanding for this area of study: Waves: an understanding of the electromagnetic spectrum, including the relative energies and wavelengths of UV radiation, X-rays and gamma radiation. Radioactive decay: students need a background knowledge of ionising radiation including an explanation of ionisation and the relative penetration and energy of the different types of radioactive decay. Similarly to previous topic areas, students require a basic understanding of anatomy along with a more detailed understanding of the structure (layers) of the skin.
Common misconceptions	Common misconceptions with external source radiotherapy are that radiotherapy is always painful whereas it is commonly painless with some discomfort over time. It is also not true that radiotherapy always causes infertility or increases the risk of secondary tumours; there is only a slight risk of this due to long-term radiation exposure and infertility is unlikely unless the external source is being delivered to the pelvic region or reproductive organs. It is also often considered to be a standalone treatment, commonly as a last resort but radiotherapy is usually delivered as part of a multidisciplinary approach alongside surgery and chemotherapy.
Key concepts	Students should be able to describe the penetration of each type of external source through the body and the relative energy which is delivered to the cells during treatment. There needs to be an understanding of the accuracy required with each type of treatment and the conditions for which the different types of therapy are recommended (along with possible contraindications). The advantages and disadvantages of each type of external source should be understood and the safety procedures required for the protection of the patients and staff involved.
Subject knowledge enhancement for teachers	Video: Advantages and disadvantages of different types of radiotherapy (youtube.com) Website: Types of external radiotherapy (cancerresearchuk.org) Article: In brief: External radiotherapy (ncbi.nlm.nih.gov)

Area of study: 3.2 Treatment with internal source

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
21	3.2 Radionuclide therapy	1	By the end of the lesson students should understand: - the types of radionuclide sources used for different treatments - the use of internal source instead of external source in some situations - the conditions for which different types of internal source are required along with contraindications - how to select the type of therapy.	Start by asking students to summarise on whiteboards the disadvantages of treatment with an external radioactive source. Discussion/teacher led section defining internal radiotherapy and the advantage being the ability to deliver high-dose radiation directly to a tumour. List the commonly used radionuclide sources (gamma emitters): Ir-192: High-dose rate (HDR) brachytherapy. Cs-137: gynaecological cancers. I-125: Low-dose rate (LDR), commonly for prostate cancer. Pd-103: Prostate cancer seeds. Define a radioactive seed. Independent research task: in groups students to research the different types of internal radiotherapy: high-dose rate (HDR) brachytherapy low-dose rate (LDR) brachytherapy permanent seed implants. For scaffolding the student could be asked to research the answers to specific	Brachytherapy (radiologyinfo.org) Notes on brachytherapy to inform the teacher led discussion. Brachytherapy: the basics (oncolink.org)	Internal radiotherapy (cancerresearchuk.org) Notes on internal radiotherapy for students to use for the independent research task. Radiotherapy side effects (cancerresearchuk.org) Additional notes for the independent research task. Selective Internal Radiation Therapy (SIRT) (cancerresearchuk.org)

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				questions about each type of radiotherapy: - How is the radiation delivered? - Which isotopes and dose are used? - What conditions is it used for? - What are the side effects? Each group can present their findings to the rest of the class and misconceptions or gaps in knowledge can be addressed. Describe Selective Internal Radiation Therapy (SIRT), key points for the discussion: - What is it used for? - How does it differ from HDR and LDR brachytherapy? Students should summarise a comparison of SIRT and HDR and LDR brachytherapy, including an example of a condition for which each therapy is used.		Resource to support students if needed with the comparison of SIRT and brachytherapy.
22	3.2 Applications of brachytherapy	1	By the end of the lesson students should understand: - the advantages and disadvantages of each type of internal source therapy - the safety procedures in place	Discussion / teacher led section outlining the safety considerations of delivering brachytherapy: - patient safety: shielding healthy tissues, safety for others with long-term implants - staff safety: monitoring exposure with dosimeters, handling protocols	What is internal radiotherapy (cancerresearchuk.org) General resource on internal radiotherapy with links to safety information.	Radiation therapy: HDR brachytherapy Cancer treatment: Brachytherapy Brachytherapy for cancer of the cervix (youtube.com)

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
			to protect patients and staff from ionising radiation who prescribes and administers the radiation and monitors the patient.	- environmental safety: proper disposal. Describe the healthcare professional roles involved with brachytherapy: Radiation oncologist: Plans and directs treatment. Medical physicist: Ensures accurate dosimetry and safety. Radiation therapist: Administers the treatment. Nurses: Provide patient education and care. Split students into small groups and assign roles (oncologist, physicist, therapist, nurse, patient). Provide a case scenario (e.g., a patient with cervical cancer requiring HDR brachytherapy). Each group discusses and plans: - Radionuclide choice and its placement. - Safety measures for staff and the patient. - Patient care before, during, and after the procedure. Groups present their treatment plans to the rest of the class.		Videos explaining approaches to brachytherapy delivery to assist students with the group task. Brachytherapy (targettingcancer.com)

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	In order to effectively engage with lessons on internal source radiotherapy, students require this prerequisite knowledge and understanding for this area of study: Radioactive decay: students need a background knowledge of ionising radiation including an explanation of ionisation and the relative penetration and energy of the different types of radioactive decay. Similarly to previous topic areas, students require a basic understanding of anatomy in order to understand the relevance of the position of the tumour in making decisions regarding appropriate treatment.
Common misconceptions	One common misconception about internal source radiotherapy is that the patient will emit harmful radiation to those around them. In reality the radiation stays localised and even those receiving permanent implants emit only very low level doses of radiation. They do have to be careful of contact with pregnant people and young children, and if they are breastfeeding this also needs to be carefully considered. It is also considered to be a standalone treatment whereas brachytherapy is often combined with surgery, external radiation, or chemotherapy for comprehensive care.
Key concepts	Students should be able to describe the different isotopes used for internal radiotherapy (brachytherapy) and their preparation into 'seeds' for internal application. The conditions for which internal source therapy is used as an alternative to (and occasionally in addition to) external source radiotherapy should be known. Students should be able to explain the advantages and disadvantages of internal radiotherapy along with the safety procedures that are put into place to protect the patient, staff and the environment. There should be an understanding of the healthcare roles involved in delivering internal radiation therapy.
Subject knowledge enhancement for teachers	Article: Targeted radionuclide therapy (ncbi.nlm.nih.gov) Videos: Principles of brachytherapy Understanding internal radiation therapy for prostate cancer (youtube.com) Podcast playlist: The Cancer Research UK Cambridge Centre Podcast (youtube.com)

Area of study: 4.1 Lasers

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
23	4.1 Lasers: basic principles	1	By the end of the lesson students should understand: - the properties of laser light that makes it suitable for therapies - how different frequencies are used to cut, burn or repair different types of tissue selectively - the conditions and treatments for which lasers are beneficial along with contraindications.	Start by assessing students' prior knowledge of lasers: what is a laser, how is it different from 'normal' light, what are lasers used for (all applications, not just medical)? Discussion/teacher led section describing the properties of laser light and how this makes it suitable for therapeutic treatment by reducing damage to surrounding tissue and allowing penetration to specific depths (a laser pointer could be used here to demonstrate the behaviour of light in terms of reflection, absorption and transmission and the use of filters to demonstrate absorption of different wavelengths). Monochromatic: single wavelength of light, allowing precise targeting. Coherent: light waves are in phase, increasing focus and energy. Collimated: beams are narrow over distance, reducing energy spread.	What are the main properties of lasers? (youtube.com) A video which can be shown to aid the explanation of the properties of laser light. LASERS (cyberphysics.co.uk) A general resource on lasers to inform the teacher led section.	What are medical lasers and what do they do? (asclepionuk.com) Resource for students to use for the independent research task. Using laser or light source (savemyexams.com) A Level Physics notes on lasers for revision and consolidation.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				Give students examples of the medical uses of different laser frequencies (the Asklepion resource can be used for this): • infrared lasers • visible red lasers (low level laser therapy) • ultraviolet lasers. For each frequency students should summarise the conditions or treatments which they are used for and any relevant contraindications.		
24	4.1 Lasers: risks and benefits	1	By the end of the lesson students should understand: • the risks and benefits associated with each laser technique, including the beam power required for different procedures • why lasers are not ionising, even at high power, in terms of photon energy • the advantages and disadvantages of lasers for therapy • who manages the equipment and	Get students to use information from the independent task in the previous lesson to list the benefits and risks of laser therapies. Particularly consider the risks for skin with high levels of melanin. Discuss the importance of beam power (low, medium and high) in different applications of laser therapy and how this impacts safety considerations (including why laser are not ionising, even at high power).	Laser safety (bath.ac.uk) Guidance to control the risk to humans working with lasers. Laser therapy in skin of colour (DermNetnz.org) High power laser therapy (physio-pedia.com) Information on differences between beam power to inform the teacher led section.	Laser therapy (healthline.com) A resource on laser therapy to support students with the group task.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
			conducts the procedure.	Divide students into groups to design a treatment plan for a patient using laser therapy, considering the appropriate frequency, beam power, risks, and benefits. Example case studies: • Patient with chronic back pain needing LLLT. • Patient needing tumour ablation in the liver. • Dermatology patient needing laser treatment for a birthmark. • Patient undergoing eye correction surgery (LASIK). Each group creates a plan that includes: • Appropriate laser type and frequency. • Beam power required for the procedure. • Safety measures for both the patient and practitioner. • Risks, benefits and contraindications. Discuss how the response to these case studies might change depending on the individual: e.g. the age and skin colour of the patient. Discuss the roles and responsibilities within laser therapies.		

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	In order to effectively engage with lessons on laser therapy, students require this prerequisite knowledge and understanding for this area of study: The electromagnetic spectrum: Understanding where visible, ultraviolet, and infrared light fit in the spectrum. Students may be able to relate laser therapy with the removal of body hair or tattoos.
Common misconceptions	There is sometimes a misconception that laser therapy is ionising whereas lasers do not use ionising radiation (unlike X-rays) and are generally safe when used correctly. It is also commonly believed that lasers remove the need for surgery. While lasers can reduce the need for invasive surgery in some cases, they are not a substitute for all surgical procedures, especially for complex medical conditions. They may hold the misconception that lasers can be used on all skin types. However, people with high levels of melanin are at greater risk of post-inflammatory hyperpigmentation which can lead to permanent scarring.
Key concepts	The properties of laser light and why they make it suitable for therapies should be understood, along with how different frequencies of laser are used to cut, burn or repair different types of tissue selectively. The different conditions or treatments for which lasers are beneficial and the associated contraindications should be known and also the risks and benefits associated with each technique. There should be an understanding of how different beam power is required for different procedures but that even at high power lasers are non-ionising. Students should be able to evaluate the advantages and disadvantages of laser therapy and know who manages the equipment and conducts the procedure.
Subject knowledge enhancement for teachers	It may be valuable to discuss with students how diagnosis of skin conditions in minority ethnic groups can differ from those in white patients, upon which the literature is weighted. Examples of further reading for this conversation might include Why is psoriasis often misdiagnosed in skin of color? (psoriasis.org) or AI skin cancer diagnoses risk being less accurate for dark skin (theguardian.com). Video: Low Level Laser Therapy (LLLT) (youtube.com) Articles: Laser therapy (medlineplus.gov) Laser treatment (cancerresearchuk.org)

Area of study: 4.2 Photodynamic therapy (PDT)

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
25	4.2 Photodynamic therapy (PDT)	2	By the end of the lesson students should understand: - how PDT is performed and the role of phototoxicity - the conditions for which PDT is effective.	Ask students to list on a whiteboard the risks associated with ionising radiation (topic area 3). Discuss answers given and introduce photodynamic therapy (PDT) as an alternative therapy. Discussion/ teacher led section describing how PDT is administered. The discussion should include: - administration of photosensitising agent - agent localises in target cells, e.g. cancer cells - agent activated by light of a specific wavelength to produce reactive oxygen species - ROS damages cell membranes, proteins, and DNA, leading to cell death. Give students descriptions of medical conditions, e.g. actinic keratosis, basal cell carcinoma, acne, oesophageal cancer. For each condition students need to:	Photodynamic therapy (PDT) (youtube.com) Video which can be shown as part of the teacher led section. Photodynamic therapy (PDT) (my.clevelandclinic.org) Notes on PDT which can be used to inform the teacher led section.	Photodynamic therapy (nhs.uk) Photodynamic therapy to treat cancer (cancer.gov) Resources to support students with the independent task.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				- Explain why PDT is effective for the condition. - Identify the type of photosensitiser and light used. This could be carried out as a group task with each group researching a different condition and sharing their findings with the class.		
26	4.2 Photodynamic therapy (PDT): risks and benefits	1	By the end of the lesson students should understand: - the advantages and disadvantages of PDT over ionising techniques - the risks and benefits associated with PDT, including possible side effects and comparison to ionising therapies - who manages the equipment and conducts the procedure.	Students complete a comparison chart comparing PDT with ionising therapies. The categories for comparison should be: safety, effectiveness, side effects, cost, accessibility, and long-term outcomes. Discussion/teacher led section describing the professionals involved in PDT. Roles to be included in the discussion should be: Medical physicists ensure proper light delivery and calibration of equipment. Physicians (dermatologists, oncologists) oversee patient treatment and outcomes. Nurses assist in preparing patients and managing aftercare. Technicians handle equipment and ensure safety protocols are followed.	PDT: Radiotherapy for the 21st century (openaccessgovernment.org) Notes on advantages and risks of PDT.	PDT: Occupational hazards (pmc.ncbi.nlm.nih.gov) Notes on the occupational hazards and safety procedures to support the case study task.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				Give students case studies describing PDT procedures with associated risks, e.g. improper light calibration, patient photosensitivity, incomplete lesion targeting. Students analyse the case studies and identify what went wrong (including who was responsible) and propose safety measures to prevent similar issues.		

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	In order to effectively engage with lessons on laser therapy, students require this prerequisite knowledge and understanding for this area of study: Light: an understanding of the behaviour of light including the different wavelengths of light and how specific wavelengths will activate photosensitisers. Pharmacology: the different routes that drugs (photosensitising agents) are administered (oral, intravenous, or topical).
Common misconceptions	It should be understood that PDT is often used alongside surgery for certain conditions, and is not always an alternative to surgery. There can be a misconception that the light used in PDT is ionising and can cause cancer; however the light is non-ionising and does not directly damage DNA like ionising radiation. Instead, it activates the photosensitiser to target and destroy cancer cells. Students may hold the misconception that PDT can be used on all skin types. However, people with high levels of melanin are at greater risk of post-inflammatory hyperpigmentation which can lead to permanent scarring.
Key concepts	How photodynamic therapy is performed and the role of phototoxicity should be understood, along with the conditions for which PDT is effective. Students should understand the advantages and disadvantages of PDT over ionising therapies and the associated risks and possible side effects in comparison to other therapies. It should be understood who manages the equipment and conducts the procedure.
Subject knowledge enhancement for teachers	Article: Photodynamic therapy (bad.org.uk) Videos: Vascular-targeted photodynamic therapy (vjoncology.com) Principles of photodynamic therapy (youtube.com)

Area of study: 4.3 Artificial cardiac devices

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
27	4.3 Artificial cardiac devices: Pacemaker and ICD structure and function	2	By the end of the lesson students should understand: - the basic structure of a pacemaker and ICD including a comparison of the two types of device - how pacemakers and ICDs can affect heart rhythm - the conditions for which artificial cardiac devices are appropriate along with contraindications.	Start by giving students a short quiz to recall the structure of the heart and the cardiac cycle (from Topic Area 1.4). Address gaps in knowledge from the short quiz. Discuss how artificial cardiac devices (pacemakers and ICDs) interact with the cardiac cycle: - pacemaker deliver electrical impulses to maintain rhythm - ICDs deliver shocks or pacing to correct life-threatening arrhythmias. Give students a labelled diagram of the heart. Use markers to show how a pacemaker and ICD would interact with the heart's conduction system. Show video on pacemaker and ICD structure and placement: How pacemakers and implantable defibrillators are implanted and used (youtube.com) Give students diagrams of each device (or students draw diagrams) to label the basic structure: pacemaker components: Pulse generator (battery and circuitry), leads	How do pacemakers work? (nhlbi.nih.gov) Implantable cardioverter defibrillators (ICDs) (mayoclinic.org) Notes on pacemakers and ICDs to inform the discussion. Pacemaker or ICD - which do I need? (webmd.com) A resource to support teachers with creating case studies for students to use.	Pacemakers and ICDs (guysandstthomasspecialistcare.co.uk) Resource to support students in completion of the independent case study task. Benefits and risks: ICD (medtronic.com) Devices that may interfere with ICDs and pacemakers (heart.org) Resources to support students with the flipped learning task.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				ICD components: Similar to pacemaker but with defibrillator for shock delivery. Discussion/ teacher led section describing the conditions for which pacemakers and ICDs are appropriate: - pacemakers for bradycardia and atrioventricular block - ICDs for arrhythmias, e.g. ventricular fibrillation and ventricular tachycardia. Give students patient profiles describing symptoms, medical history, and test results. Ask students to decide whether a pacemaker or ICD is appropriate or contraindicated for each patient and justify the decision. Flipped learning task - students research the risks and benefits of each device.		
28	4.3 Artificial cardiac devices: safety considerations	1	By the end of the lesson students should understand: - the advantages and disadvantages of each device for treating different conditions - the risks and benefits associated with	Flipped learning task - students share information from research task. Summarise the benefits and risks of artificial cardiac devices. Recap the main differences between pacemakers and ICDs in terms of: Function: pacemakers regulate the heart rate; ICDs prevent sudden cardiac death.	Explore roles: NHS (healthcareers.nhs.uk) Notes on roles to inform the teacher led section.	The pros and cons of pacemakers (iuhealth.org) Resource to support students' completion of the table for the group task.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
			artificial cardiac devices • who manages the equipment and conducts the procedure.	• Components: ICDs have a capacitor for shock delivery, unlike pacemakers. • Usage: pacemakers are for slow heart rates; ICDs are for dangerous fast rhythms. Divide the class into groups. Give each group a blank comparison table to fill in the advantages, disadvantages, risks, and benefits of each device for patient scenarios. Groups must decide whether a pacemaker or an ICD is more appropriate and present their reasoning. Discussion/teacher led section describing the role and responsibilities within the area, to include: • Cardiologists/Electrophysiologists: Decide when a patient needs a device. • Surgeons: Perform the implantation procedure. • Cardiac technicians: Program and check device function. • Nurses: Provide post-operative care and patient education. • Biomedical engineers: Maintain and troubleshoot the equipment.	Pacemaker or ICD - which do I need? (webmd.com) A resource to support teachers with creating case studies for students to use.	

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	In order to effectively engage with lessons on artificial cardiac devices students require this prerequisite knowledge and understanding for this area of study: Structure and function of the heart: from Topic Area 1 students need to understand the structure of the heart and the cardiac cycle.
Common misconceptions	The most common misconception is that pacemakers and implantable cardioverter defibrillators (ICDs) are the same device whereas pacemakers regulate slow heart rhythms, while ICDs are primarily used to detect and stop arrhythmias (ventricular tachycardia or fibrillation) by delivering electric shocks. It is sometimes thought that the implantation of a pacemaker restricts the use of microwaves, mobile phones whereas in reality pacemakers and ICDs are well-shielded from interference caused by household electronics, however, strong electromagnetic fields, e.g. MRI can interfere with their function.
Key concepts	The conditions for which artificial cardiac devices are appropriate and relevant contraindications should be understood, along with how both pacemakers and ICDs can affect cardiac rhythm. Students should be able to compare pacemakers and ICDs in terms of the advantages and disadvantages of each device for different cardiac conditions, and associated benefits and risks. The roles and responsibilities within the management of the equipment and surgical procedures should be understood.
Subject knowledge enhancement for teachers	Article: Evolution of pacemakers and ICDs (pmc.ncbi.nlm.nih.gov) Video: Update on pacemakers and ICDs (youtube.com)

Area of study: 4.4 Ultrasound therapies

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
29	4.4 Ultrasound therapies: basic principles	2	By the end of the lesson students should understand: - the differences in procedure, technique and equipment compared with imaging - the conditions for which each therapy is effective along with contraindications - the required dose protocols for treating different types of condition.	Start with a short quiz covering the basic principles of diagnostic ultrasound (area of study 1.2). Address any gaps in knowledge and ensure there is clear understanding of the nature of ultrasound waves: frequency, wavelength, penetration of tissues. Explain that high frequency sound waves can be used for therapeutic rather than diagnostic purposes. Students complete a table comparing the features of diagnostic and therapeutic ultrasound. Features that should be compared are: - purpose - frequency range - intensity/dose - equipment - target tissue. Independent research task -group students and assign a type of ultrasound therapies to each group: high intensity focused ultrasound (HIFU)	Difference between diagnostic and therapeutic ultrasound (ultrasound.ie) Video which can be played to support students with completion of the comparison table.	Overview of therapeutic ultrasound applications (pmc.ncbi.nlm.nih.gov/) Notes to provide information for the independent research task.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				low intensity pulsed ultrasound (LIPUS) shock wave lithotripsy (SWL). Each group must create a short presentation covering: - the purpose of the therapy - the conditions treated - the procedure and dosage - advantages and disadvantages - who performs the procedure.		
30	4.4 Ultrasound therapies: risks and benefits	1	By the end of the lesson students should understand: - the risks and benefits of using different ultrasound therapies - the advantages and disadvantages of each technique for treating different conditions - who manages the equipment and conducts the procedure.	Students present their results of the group task on the different types of ultrasound therapies. Give students patient scenarios - their task is to use the information from the group task to decide which therapy is appropriate for the patient. The scenario from the SAM could be used. - Which ultrasound therapy is most appropriate? - What are the advantages of using this therapy? - Are there any contraindications or risks? Discussion/teacher led section describing the use of ultrasound in inducing localised	Hyperthermia (fusfoundation.org) Notes on induced hyperthermia to inform the teacher led section.	Hyperthermia to treat cancer (cancer.gov) Resource to support students with the independent task.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				hyperthermia to enhance drug delivery. Key points to include in the discussion: • how increasing tissue temperature promotes drug delivery • how ultrasound increases temperature • optimal temperature range. Provide students with a patient scenario requiring ultrasound induced hyperthermia. Key questions for students to discuss: • Ultrasound settings: What frequency and intensity should be used to reach therapeutic temperatures (as compared to diagnostic ultrasound)? • Treatment duration: How long should the ultrasound be applied? • Safety considerations: How will you avoid overheating surrounding tissues? • Expected benefits: Why is this technique better than systemic chemotherapy alone? • Potential risks and side effects.		

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	In order to effectively engage with lessons on ultrasound therapies students require this prerequisite knowledge and understanding for this area of study: Waves: students need to have a basic understanding of the fundamental principles of waves, including the parameters wavelength, frequency and amplitude. There also needs to be an understanding of the difference between transverse and longitudinal waves (including the categorisation of radio, sound and light waves) and familiarity with the electromagnetic spectrum, in particular the range of frequencies and wavelengths of radio waves.
Common misconceptions	A common misconception is that therapeutic ultrasound is the same as diagnostic ultrasound rather than diagnostic ultrasound being used for imaging, while therapeutic ultrasound is used for treatment, such as pain relief, tissue healing, or breaking down kidney stones.
Key concepts	The differences in procedure, technique and equipment for therapeutic ultrasound compared with imaging should be understood. The conditions for which the different types of therapeutic ultrasound (high intensity focused ultrasound, low intensity pulsed ultrasound and shock wave lithotripsy) are effective and associated contraindications should be known, along with the required dose protocols for treating different conditions. The risks and benefits, and advantages of each technique should be understood with an understanding of the personnel who manage the equipment and conduct the procedure.
Subject knowledge enhancement for teachers	Website: Ultrasound physical therapy (webmd.com) Video: Therapeutic ultrasound: how it works (youtube.com) Article: Ultrasound therapy (ncbi.nlm.nih.gov) Blog: Differences between diagnostic and therapeutic ultrasound (iuslondon.co.uk)

Area of study: 5.1 Diagnosis plan

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
31	5.1 Diagnosis plan: producing a plan Preparing for NEA Task 1 using SAM	2	By the end of the lesson students should understand: • how to write a logical diagnosis plan • how to assess the quality of a diagnosis plan • how to create a risk assessment that is linked to a diagnosis plan • how to create a presentation of the diagnosis plan that is appropriate for healthcare professionals.	Ask students to list what they think a diagnosis plan is. Discuss answers and define a diagnosis plan as: • A structured approach to identify, localise, and confirm a tumour in a patient. • Involves medical history, imaging, lab tests, and biopsy if necessary. Ask students to list the key features of a diagnosis plan. Collate answers to produce a list of components: • patient history and symptoms assessment • selection of imaging techniques (X-ray, MRI, CT, PET, ultrasound, etc.) • laboratory tests (blood markers, biopsy, etc.) • risk considerations and patient safety. Students work in pairs to create a structured diagnosis plan for the given patient scenario in the SAM.	Communicating with patients (england.nhs.uk) A resource to support discussion on how to communicate empathetically with patients. Sample assessment material (ocr.org.uk)	How cancer is diagnosed (cancer.gov) Notes summarising the tests used in the process of cancer diagnosis.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				For scaffolding, students should be given an outline of the features they may wish to include in a diagnosis plan for their scenario: 1. Patient history and physical examination: 2. What imaging tests are needed? 3. Are there any other diagnostic tests that might be suitable? 4. Are cost and availability a factor? Students should produce a logical step-by-step approach with justification for each test within the diagnosis plan. Once the diagnosis plan has been written, students should complete a risk assessment for the diagnosis plan using the template in the SAM. Groups exchange their diagnosis plans with another group. Using a rubric, students assess: • clarity and organisation • appropriateness of selected tests • consideration of risks and alternatives • what improvements could be made. For practice of NEA Task 4 students should summarise the feedback they are	Give students the Student guide to NEA assignments before they start the assessment. (ocr.org.uk)	

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				given and assess the strengths and weaknesses of their plan.		
32	5.1 Diagnosis plan: communicating a plan (preparing for NEA Task 3 using SAM)	2	By the end of the lesson students should understand: • how to communicate a diagnosis plan to healthcare professionals • the possible social, emotional and mental health effects to the patient before, during and after the plan • how to obtain and summarise feedback.	<i>NEA Task 3 requires students to deliver a presentation for either the diagnosis plan or the therapy plan, therefore this lesson may be either shortened or omitted if students have opted to deliver the therapy plan.</i> Ask students reasons why effective presentation matters to patients and healthcare professionals. Collate a class list: • Healthcare professionals need clear and precise communication. • Patients need simple, compassionate explanations of their diagnosis. • Poor communication can lead to misunderstanding, fear, or mismanagement of treatment. Students present their 5-minute presentations based on the SAM of their diagnosis plans. While information is being presented the rest of the class could take notes to give feedback and be encouraged to ask questions of the presenter in order to reach the M5 criterion . The Teacher Observation Record can also be used here to give	Oral presentation rubric (readwritethink.org) An alternative rubric focusing on oral presentation skills. Presentation skills (youtube.com) An optional video which could be shown to describe effective presentation skills.	People's experiences of diagnosis (nationalvoices.org.uk) Students could read the resource to inform the discussion on supporting patients.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				students feedback on their practice presentations. Students review their feedback and strengths and weaknesses and 3 key improvements to make to their presentations (practice of NEA Task 4)		

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	In order to be able to construct an appropriate diagnosis plan students need to have a clear understanding of the relevant ionising and non-ionising diagnosis techniques covered within the unit. There also needs to be an understanding of basic anatomy in order to apply the diagnostic techniques to the patient scenario.
Common misconceptions	Common misconceptions around patient diagnosis include: • one test will diagnose a condition, when in reality a complex diagnosis requires the results of multiple tests. • patients should be told their diagnosis immediately. The way a diagnosis is delivered affects mental and emotional well-being and information should be given gradually, with empathy and support. • diagnosis is only about identifying the disease. In reality a diagnosis should also include understanding the patient's lifestyle, emotions, and support needs.
Key concepts	The students should understand how to write a logical diagnosis plan with an associated risk assessment. It should be understood how to assess the quality of the diagnosis plan and create a presentation of the plan with appropriate language for healthcare professionals and patients. It should be understood how to obtain and summarise feedback on the diagnosis plan and how to prepare for questions that may be asked by healthcare professionals and patients. The possible social, emotional and mental health effects to the patient before, during and after the diagnosis plan should be understood.
Subject knowledge enhancement for teachers	Article: The diagnostic process (ncbi.nlm.nih.gov) Article: Improving diagnosis (nationalvoices.org.uk)

Area of study: 5.2 Therapy plan

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
33	5.2 Therapy plan: producing a plan (preparing for NEA Task 2 using SAM)	2	By the end of the lesson students should understand: • how to write a logical therapy plan • how to assess the quality of a therapy plan • how to create a risk assessment that is linked to a therapy plan • how to create a presentation of the therapy plan that is appropriate for healthcare professionals.	Get students to list what the key features of a therapy plan are. Collate a class list. Key features discussed should be: • patient background and diagnosis • treatment plan • expected outcomes and side effects • support and patient well-being • follow-up and monitoring plan. Students should work in pairs and are given a cancer patient scenario (from the SAM). They should write a therapy plan. Categories could be given for scaffolding, for example: • diagnosis information • treatment options with justifications • short-term and long-term goals • emotional and mental health support • follow-up care and monitoring. Groups exchange their practice therapy plans and assess them using a quality rubric. Students provide feedback to each other on clarity, effectiveness, and feasibility. Key points on which to assess the therapy plans should be: • clear, structures format	How is treatment planned and scheduled (cancer.org) Notes to support the construction of the therapy plan. Principles of cancer treatment (youtube.com) A video which can be shown to introduce the principles of cancer treatment. SAM available for practice. Check the current NEA to ensure sufficient time is allowed for assessment. (ocr.org.uk)	What does a cancer treatment plan include? (treatcancer.com) Resource for students to use for guidance completing the care plan.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				- accurate interpretation of diagnosis information - justification of treatment choices - consideration of patient well-being - realistic monitoring and follow-up plan. Students review their feedback and identify 3 key strengths and weaknesses in their plans (practice of NEA Task 4) Each group should review their therapy plan and write a risk assessment using the Risk assessment template in the SAM.		
34	5.2 Therapy plan: communicating a plan (NEA Task 3 using SAM)	2	By the end of the lesson students should understand: - how to communicate a therapy plan to healthcare professionals - the possible social, emotional and mental health effects to the patient before, during and after the plan.	<i>NEA Task 3 requires students to deliver a presentation for either the diagnosis plan or the therapy plan, therefore this lesson may be either shortened or omitted if students have opted to deliver the diagnosis plan.</i> Students present their 5-minute presentations of their therapy plans. While information is being presented the rest of the class should be encouraged to ask questions and the Teacher Observation Record should be used. Discuss the social, emotional and mental health effects to the patient before, during and after the therapy plan:	Communication in cancer care (cancer.gov) Notes to support the discussion of the impact of the therapy plan on the patient.	Tips for managing the Q and A of your presentation (edwebcontent.ed.ac.uk) Support for students in how to manage questions in a presentation effectively.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				• experience of fear, anxiety or depression when receiving a diagnosis • impact on family, work and social life • poor delivery of information leading to distress and poor compliance. Ask students to list ways in which support can be given to a patient before, during and after a therapy. • non-threatening language • access to mental health professionals • empathy • access to support groups • clear understanding of next steps. Students review their feedback and strengths and weaknesses and 3 key improvements to make to their presentations (practice of NEA Task 4)		
35	Delivery of NEA	15		It is estimated that the NEA assignment will take about 15 hours of supervised time and 8 hours of unsupervised time. Students should need approximately: 7 hours to complete Task 1 7 hours to complete Task 2 5 hours to complete Task 3 4 hours to complete Task 4		

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	In order to be able to construct an appropriate therapy plan students need to have a clear understanding of the relevant ionising and non-ionising diagnosis techniques covered within the unit. There also needs to be an understanding of basic anatomy in order to apply the therapeutic techniques to the patient scenario.
Common misconceptions	There may be a misconception that cancer treatment involves one therapy only rather than a multifunctional approach which is highly individualised to the patient. It may also be assumed that once treatment starts the plan cannot change, while in reality treatment plans are regularly reviewed and adjusted based on tumour response, side effects, and new medical findings.
Key concepts	The students should understand how to write a logical therapy plan with an associated risk assessment. It should be understood how to assess the quality of the therapy plan and create a presentation of the plan with appropriate language for healthcare professionals and patients. It should be understood how to obtain and summarise feedback on the therapy plan and how to prepare for questions that may be asked by healthcare professionals and patients. The possible social, emotional and mental health effects to the patient before, during and after the therapy plan should be understood.
Subject knowledge enhancement for teachers	Article: What does a cancer treatment plan include? (treatcancer.com) Website: Personalised care planning for people with cancer (learning.guyscanceracademy.co.uk)

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