

PWH/CUMC Training Log Book

1155174356 Chan Cheuk Ka

Date: 01/06/2022

Session: Department of Orthopaedics and Traumatology

1. Computer-aided orthopaedic surgery

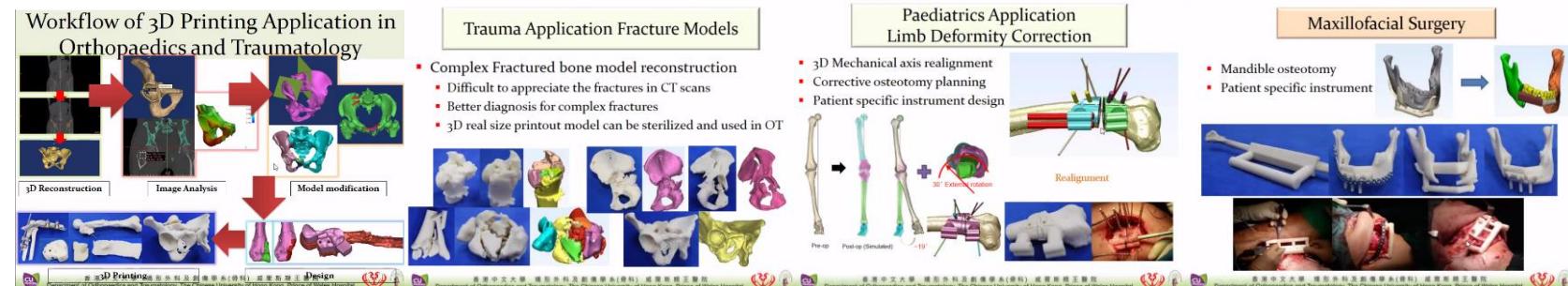
- Lecturer introduced the uses of real-time scanning (surgical navigation) during surgery to increase accuracy for implantation



b.

2. Computer-aided surgical modelling service

- Lecturer introduced the uses of 3D printing in medicine as best-fit replacements and implantations for bone structures



b.

3. DXA / HR-pQCT

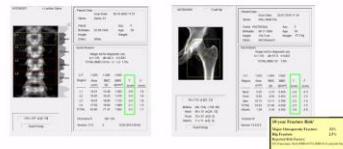
- Lecturer introduced the use of bone densitometry to analyse osteoporosis and fracture risks

Clinical Bone Densitometry

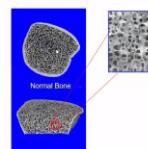
- DXA (Dual energy X-ray Absorptiometry)
 - Assessing bone mineral density
 - Diagnosis for osteoporosis (by WHO)
- HR-pQCT (High resolution peripheral QCT)
 - Assessing bone microarchitecture (*in vivo*)
 - Monitor the changes in volumetric BMD, trabecular microarchitecture

b. 

Spine and Hip



HR-pQCT Images



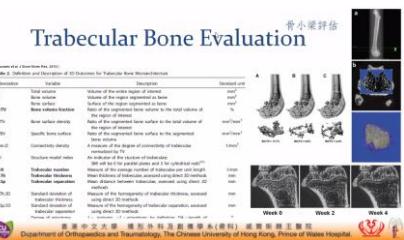
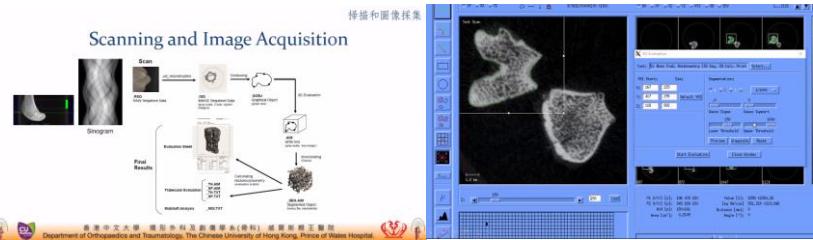
micro Finite Element Analysis (μFEA)

- Computational simulation technique
 - Investigate the mechanical properties of bone
- For HR-pQCT (XtremeCT)
 - Using SCANCO FE-solver in Image Processing Language (IPL) software
 - Validated by *in vitro* studies
 - FE Parameters:
 - Stiffness (N/mm)
 - Est. Failure Load (N)



4. MicroCT / VivaCT, digital x-ray for small animals

- a. Lecturer introduced the use of MicroCT to produce a fine detailed 3D model of bone for bone micro-architecture evaluation

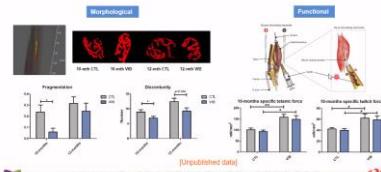


5. Vibration platform

- a. Lecturer introduced the use of vibration platform to combat bone density loss for bedridden patients as well as some insights into the product design process and relevant considerations



Research On-going: Effect on Neuromuscular Junction?



Discussion: Difficulties in Development?

- Count-up or count-down?  Count-up highly depend on your clients' preference; consult to familiar to the field.
- Safety issue?  Essential: Estimate young children's average head circumference
- Liability of industry?  Essential: SD card as black box to record activities; protect the industry
- Casing design?  Critical for sales: A specialized occupation to design casing for biomedical devices

b. 

Date: 01/06/2022

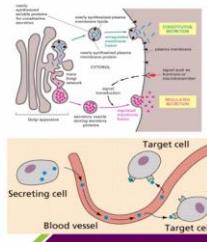
Session: Department of Medicine and Therapeutics - Division of Endocrinology & Diabetes

1. Principles of endocrine disorders and common endocrine conditions

- a. Lecturer helped us revise some important concepts of the hormonal system

Hormone Synthesis and Action

- synthesized within the cells and stored in special packets (called granules)
- secrete from cell into capillaries
- Distributed via capillaries to target cells
- Target cells have receptors for the hormone
- Hormone may stimulate or inhibit cellular functions after binding to receptors
- Target organ may secrete hormone that feeds back information to endocrine cells



b.  

2. Glucose homeostasis, hyperglycaemia, diabetes and complications, care

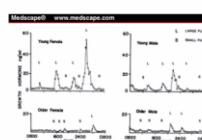
- a. Lecturer outlined the clinical procedures to the diagnosis for diabetes and precautions necessary to prevent mis-diagnosis

Clinical approaches



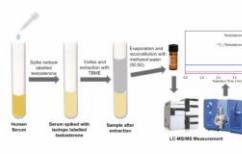
b.  

Pulsatile secretion and dynamic tests



- Hormones often secrete in a pulsatile manner
- High or low levels may be physiological or pathological
- Blood levels at any one time point may be misleading
- Stimulation test used to exclude deficiency
- Suppression test used to exclude over-secretion

LC-MS/MS measurement of Testosterone



- Benefits**
- Detection at Much lower limits
 - Can differentiate Between isoforms
 - Of other hormones

3. Examples of technology facilitating endocrine care

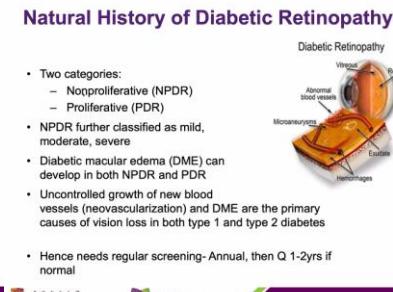
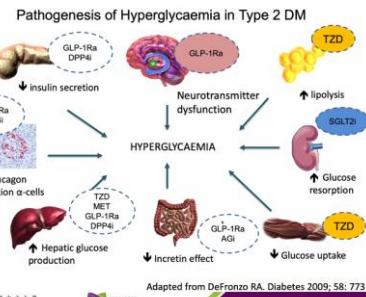
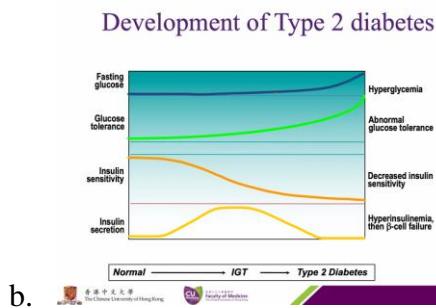
- a. Lecturer introduced different types of treatment for neuroendocrine tumour



b. 香港中文大學
The Chinese University of Hong Kong

4. Examples of technology facilitating diabetes care

a. Lecturer explained the diabetes types and their development as well as the suitability of different treatment approaches



Date: 01/06/2022

Session: Department of Medicine and Therapeutics - Division of Rheumatology

1. Rheumatological diseases and osteoporosis

- Lecturer introduced a few cases of rheumatological patients and their treatments

Gout (痛風)

- Hyperuricemia results in deposition of monosodium urate crystals
- Peak age of onset: 40-50 years old (males) and >60 years old (female)
- Abrupt onset, monoarticular, occur during the night or early morning when the joint is coolest
- Painful, warm, red and swollen joints
- Risk factors: Obesity, Alcohol, bleeding, exercise, drugs, high purine diet, fructose drink ingestion, renal impairment, dehydration

Case presentation III

- 20 years old, Claudio, a year 3 University student, good past health
- Complains of multiple small hand joints pain and swelling
- Also noted facial rash, photosensitivity, foamy urine



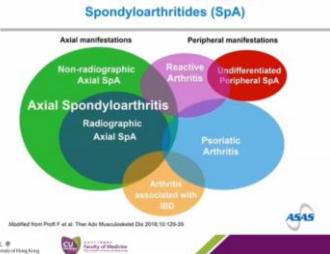
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b.

2. SpA

- Lecturer described the use of MRI to detect early stages of SpA

Spondyloarthritis (SpA)



Modified from Prof P et al. *Ther Adv Musculoskeletal Dis* 2018;10:129-38

X-Ray Radiograph

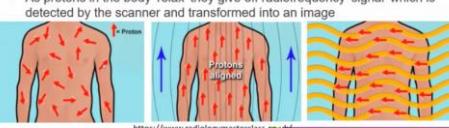


Normal or Early
Late
Too late

Figure 4. Radiographic evolution in the evolution of sacroiliac joints. Panel E: normal SI joint. Panel F: grade 1 sacroiliitis, with posterior process of sacrum and anterior process of ilium becoming bony. Panel G: grade 2 sacroiliitis with increased bony density. Panel H: grade 3 sacroiliitis with complete fusion of the sacroiliac joint. Panel I: grade 4 sacroiliitis with complete fusion of the sacroiliac joint.

Magnetic Resonance Imaging (核磁共振)

- MRI images are a map of proton energy within tissue of the body
- Produces repeating sequences of radiofrequency pulses to 'excite' protons in the body
- As protons in the body 'relax' they give off radiofrequency 'signal' which is detected by the scanner and transformed into an image

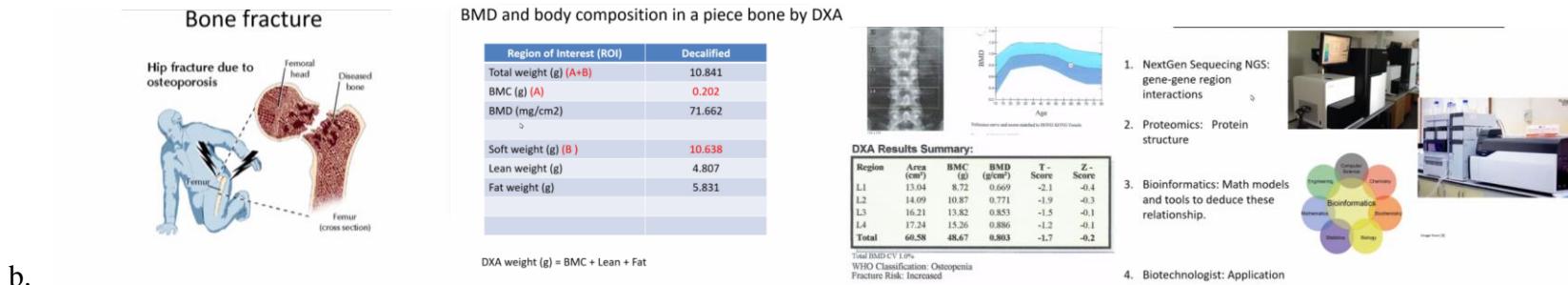


https://www.radiologymasterclass.co.uk/

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3. Bone anatomy and bone density assessment

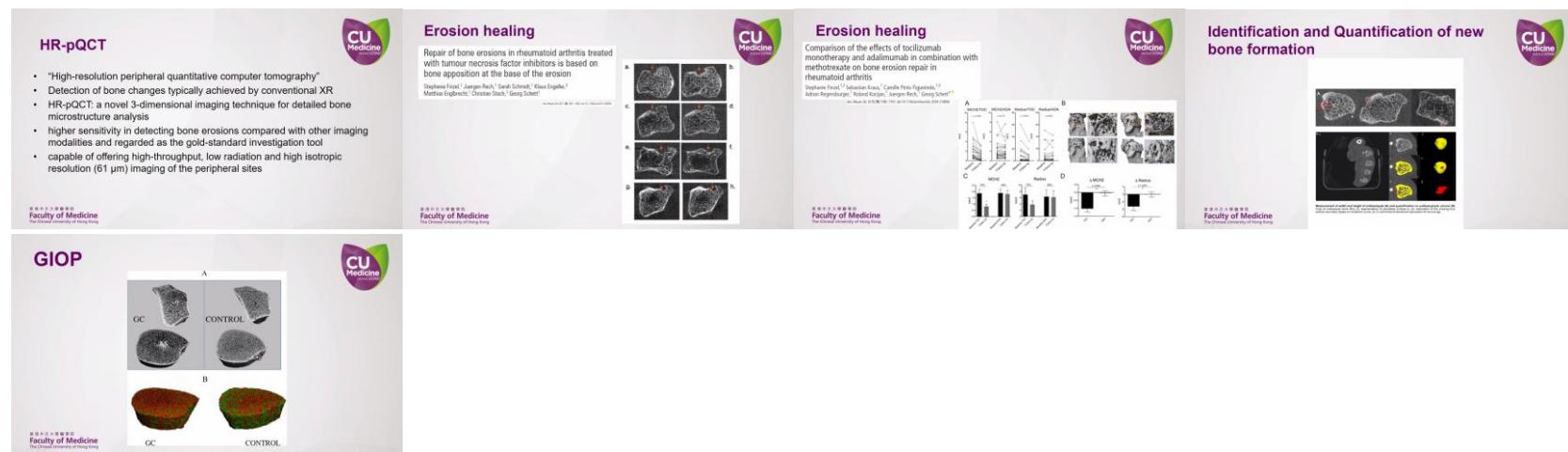
- Lecturer discussed the most common injuries and causes for osteoporosis as well as presenting some treatment options



b.

4. HR-pQCT

- a. Lecturer discussed the advantages of HR-pQCT imaging over traditional technology as well as how it facilitates bone treatment diagnosis



Date: 02/06/2022

Session: CU Medical Centre Training

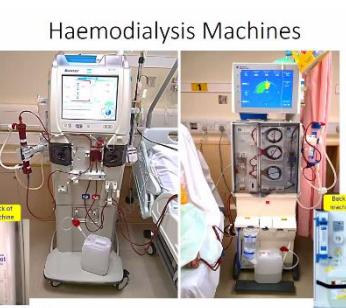
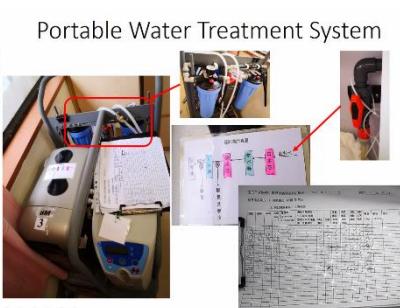
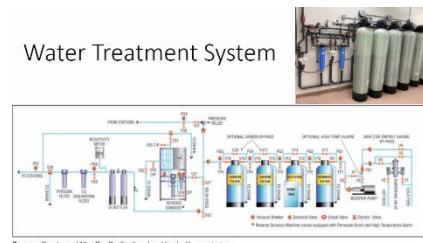
1. Live ACL reconstruction surgery
 - a. We had the opportunity to watch a live ACL reconstruction surgery done by the doctor. It was a minimally invasive surgical operation. The doctor first made three small incisions; he then extracted two tendons from the hamstrings and stitched them together to form a graft ligament. Two holes were then drilled into the femur and tibia, where the graft ligament was threaded through. Screws and a metallic button cap were used to secure the graft. He also did the mobility test before and after the graft installation, and we were able to see that the movement of the knee was successfully restrained after the graft was in place.
2. Pathology
 - a. We have toured the pathology department, where analysts performed tests on samples using various automated machines, including centrifuges, blood cell counters, coagulation testers, and antigen testers. We were also introduced to complementary machines such as freezers and the monitoring system that ensures appropriate lab conditions.
3. Radiology
 - a. We were briefly introduced to the capabilities of the Magnetic Resonance Linear Accelerator as well as to the control room. We were also briefed on the safety precautions necessary when approaching the machine.
4. Pharmacy
 - a. We were introduced to machines that sort, combine, and package different medications into a single uni-pill to allow patients to take their medication without mixups easily.
5. Surgery
 - a. We were introduced to the vital support machine used in surgery ventilations as well as its failsafes.
6. Sports Medicine and Rehabilitation
 - a. We briefly toured the exercise room for patients, where they can use a variety of machines and tools to aid their rehabilitation.

Date: 06/06/2022

Session: Department of Medicine and Therapeutics - Division of Nephrology

1. Haemodialysis

- a. Lecturer introduced the complementary facilities and machines necessary for haemodialysis

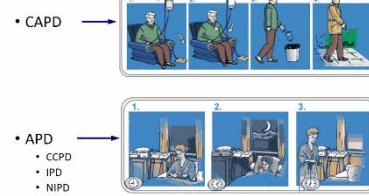


b.

2. Peritoneal dialysis

- a. Lecturer briefly introduced different designs for peritoneal dialysis

Types of peritoneal dialysis



b.

Baxter CAPD systems

Ultrabag 優卓系統

- Ultrabag (UB) has special design features that enhance flush.



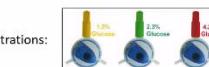
Types of PD fluid:

- Dianeal: 1.5%, 2.5% & 4.25% dextrose
- Extraneal: 7.5% icodextrin
- Nutrineal: 1.1% amino acid

Fresenius CAPD systems

StaySafe - Balance system 腹安寶

- PIN and DISC technology
- Double-chamber dialysate bag
- Made of PVC-free Biofine material.



Evolution of APD Machines



APD Machines in HK

Ramco C, Cicalioli C, Rosner MH (eds) Remote Patient Management in Peritoneal Dialysis. Contrib Nephrol, Basel, Karger, 2015, vol 197, pp 9–16 (DOI: 10.1159/000496302)

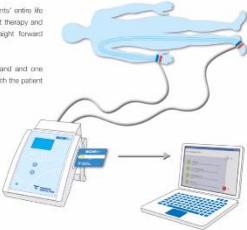
3. Body composition measurement, Pulse velocity measurement

- a. Lecturer briefly introduced these measurement metrics

Body Composition Measurement

Application is possible during the patients' entire life cycle from CKD 1 to renal replacement therapy and transplantation¹. Handing is very straight forward involving:

- Placement of electrodes on one hand and one foot at the same side of the body with the patient in a supine position
- Connection of the patient cable
- Entry of height and weight
- Initiation of measurement
- Results are available within 2 min and are stored on a PatientCard automatically. Data can be transferred directly ([via a secure connection](#)) to the Fluid Management Tool (FMT) for further analysis.



Applications of BCM in Renal Patients

The BCM - Body Composition Monitor ...

- ... is the first device on the market that measures overhydration on an individual basis
- ... improves management of hypertension and fluid status
- ... provides relevant nutritional information
- ... determines "V" for dialysis dose assessment
- ... measures non-invasively, rapidly with easy application

Key parameters	Unit
Overhydration (OH) (pre-/postdialysis)	lL
Liver tissue index (LT)	[kg/m ²]
Fat tissue index	[kg/m ²]
Extracellular water (EW)	lL
Intercellular water (IW)	lL
EW / IW	-
Liver tissue mass	[kg] and (%)
Fat mass	[kg] and (%)
Adipose tissue mass	[kg]
Body Cell Mass	[kg]

Aortic PWV is a strong independent predictor of cardiovascular diseases (CVD)



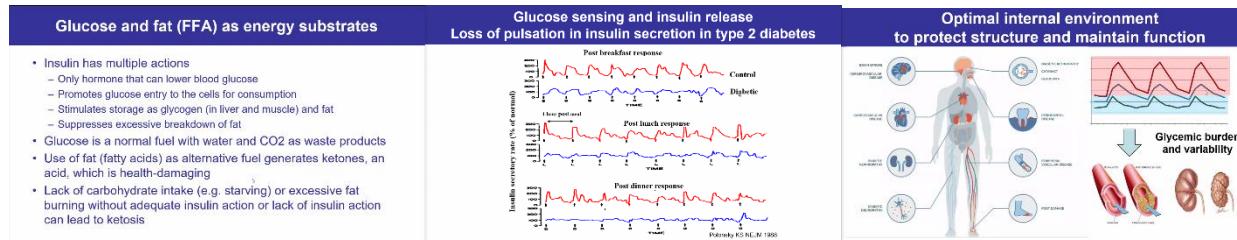
b.

Date: 06/06/2022

Session: Department of Medicine and Therapeutics - Division of Clinical Pharmacology

1. Diabetes

a. Lecturer briefly introduced the definition of diabetes



b.

2. Continuous glucose monitoring and insulin infusion system

a. Lecturer briefly introduced the types of CGM systems and discussed the design challenges, as well as the types of insulin pumps and their advantages and trade-offs

b.

Continuous glucose monitors (CGM)

Non-invasive minute-to-minute measurement of glucose

Insertion device
Sensor
Transmitter/Detector
Reader/Mobile Phone
Share data with health care professional
e.g. Medtronic Pro 2

Real time remote monitoring by care partner

Cloud

1. Professional (blinded CGM)

- Sensor: no user interface
- Glucose profiles uploaded for review by health professional (and patient)
- Treatment adjustment, identifying undetected hypoglycaemia

2. Consumer (blended CGM)

- CGM sensor interface
- Glucose profiles uploaded for review by health professional (and patient)
- Treatment adjustment, identifying undetected hypoglycaemia

Types of CGM

Insulin pumps

- Continuous subcutaneous Insulin Infusion (CSII)
- More physiological replacement insulin
- Basal + Bolus = Total daily dose (TDD)

Basal Bolus Total

Breakfast Lunch Dinner

4:00 8:00 12:00 16:00 20:00 24:00 4:00 8:00

Standalone insulin pump

Insulin reservoir
Cannula
Bolus button (most have built-in bolus wizards)

Bolus Wizard
Bolus 8.8 mmol 1.0
Adjustment 0.0
Bolus 1.0 Deliver Bolus

Choice of pumps

Tethered pumps
Medtronic 640g Sensor augmented
Tandem t:slin
Patch pumps
Eflow
Omnipod
Medtrum
Pod pumps
Dana

Issues and challenges with CGMs

- Sensor life
- Sensor sites and size – the dreaded doorframe
- Skin irritation from adhesives
- \$\$\$Price

SKIN GYM Sensor site

Safety and tolerability

- Adverse event reporting
- Adverse event
- Adverse device event (ADE)
- Severe adverse device event (SADE)
- Device deficiencies

Skin irritation Sensor site

Why CSII vs. MDI

- Improve glucose control
 - Lower HbA1c
 - Less hypoglycaemia
 - Reduce impaired hypoglycaemia awareness
- Better quality of life
 - Less emotional burden
 - Fewer injections: 28 MDI vs 2 CSII insertions / week
- Reduce risk of CVD and premature death (Swedish Diabetes Registry 2003)
 - Pump does not do it
 - MDI has to perform h/t
 - Automode vs retaining control of BG
 - Physicality of having a device attached all the time

Control – Algorithm
Continuous glucose sensor
Request bolus
106 mg/dL
Bolus delivered

Date: 07/06/2022

Session: Electrical and Mechanical Services Department

1. Medical hazards and safety precautions

- a. Lecturer outlined the steps for wearing and removing PPE



2. Electrical safety tester

- a. Lecturer introduced the different classes and categories of protective equipment and to what extent they are rated to protect



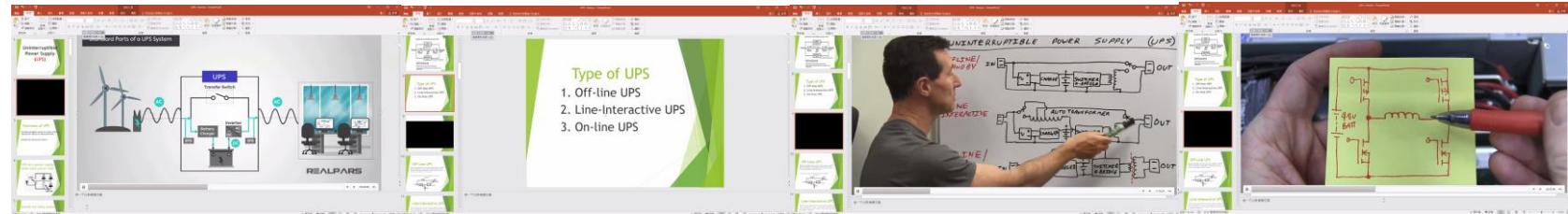
3. Infusion pump and tester

- a. Lecturer outlined the uses of infusions pumps and ways to test and calibrate their functionality



4. Uninterruptible power supply

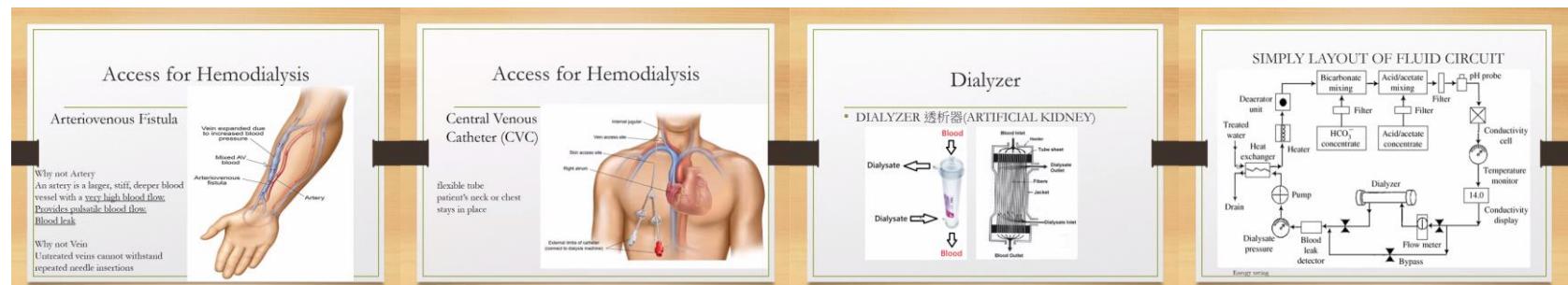
- Lecturer introduced how UPS can help protect sensitive equipment from damage due to irregular supply voltage, as well as the capabilities of different types of UPS



b.

5. Haemodialysis unit

- Lecturer introduced the considerations for blood vessel choice and the rationale for haemodialysis



b.

Date: 08/06/2022

Session: Department of Medicine and Therapeutics – Division of Cardiology

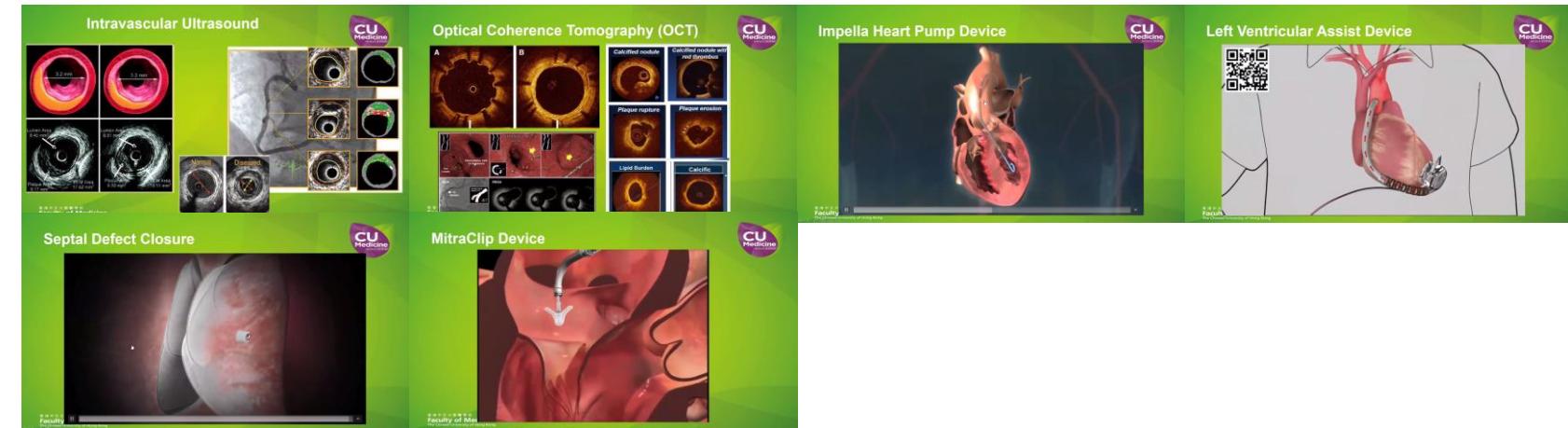
1. Development and advances in percutaneous coronary intervention

a. Lecturer outlined how angioplasties are done and discussed the design challenges for stents



2. Peripheral, venous and structural interventions

a. Lecturer discussed imaging techniques used to assess stent performance as well as introduced numerous operation techniques

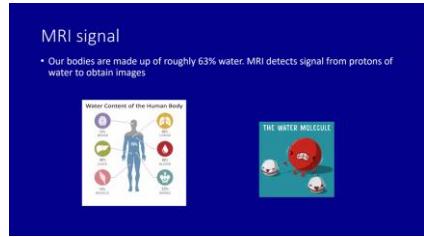


Date: 08/06/2022

Session: Department of Imaging and Interventional Radiology

1. Physics of MR Imaging

- a. Lecturer briefly discussed the rationale for MR imaging



b.

2. Components of an MRI scanner, procedures for performing an MRI scan

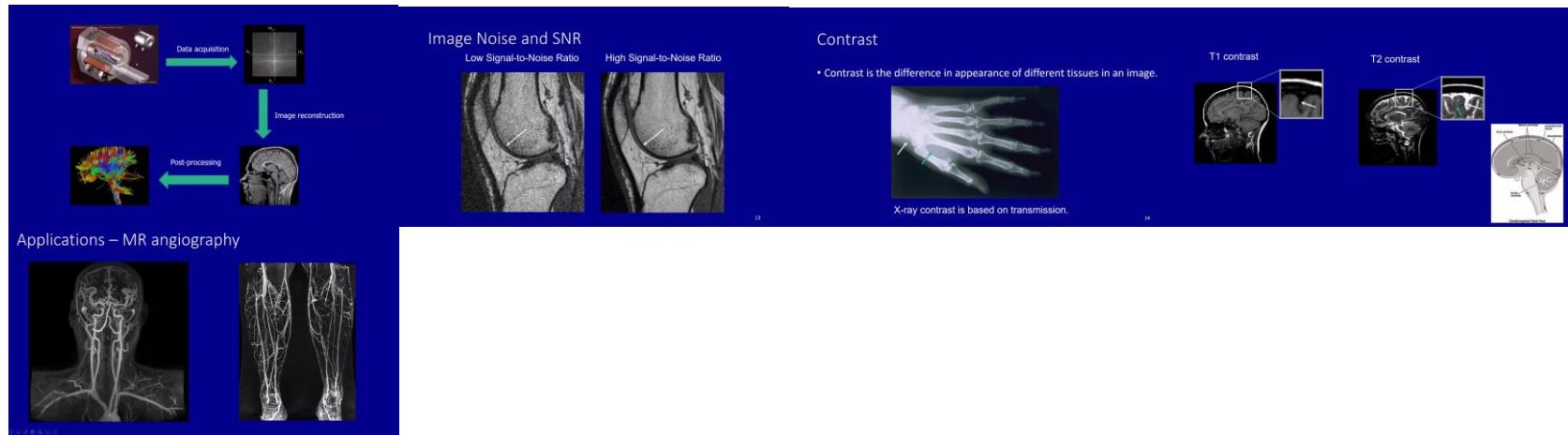
- a. Lecturer went through each component of an MRI scanner



b.

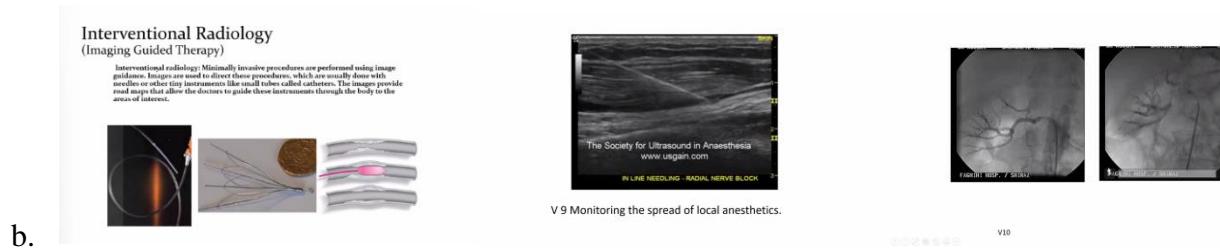
3. Principle of reading MRI images

- a. Lecturer briefly outlined the image acquisition from raw MRI data and discussed how the imaging can be tweaked to highlight different tissues



4. Concept of Interventional radiology

- a. Lecturer discussed the use of real-time imaging to guide catheters



b.

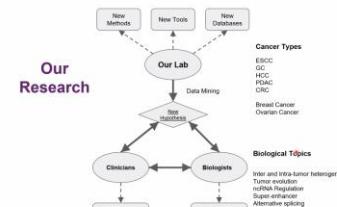
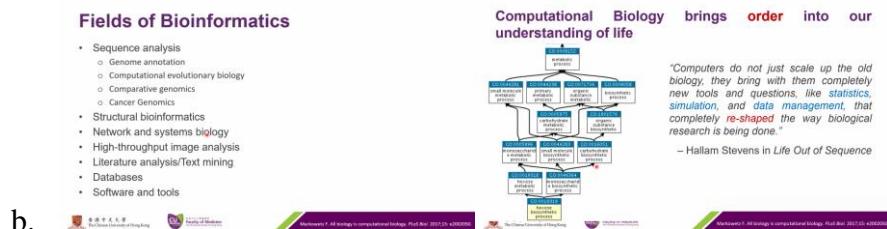
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Date: 08/06/2022

Session: Department of Surgery

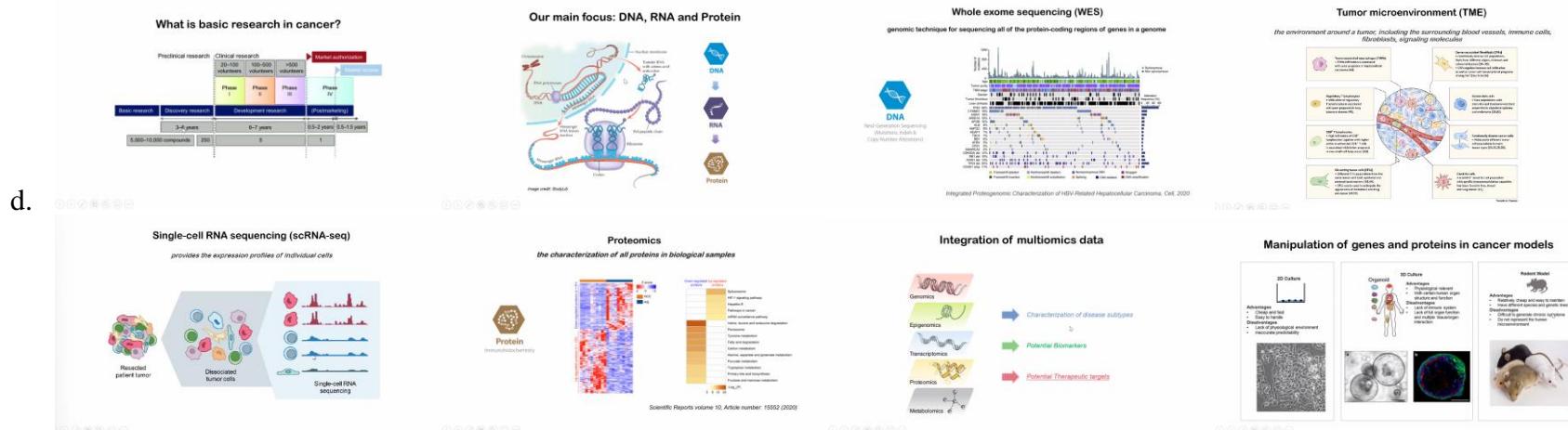
1. Cancer and bioinformatics

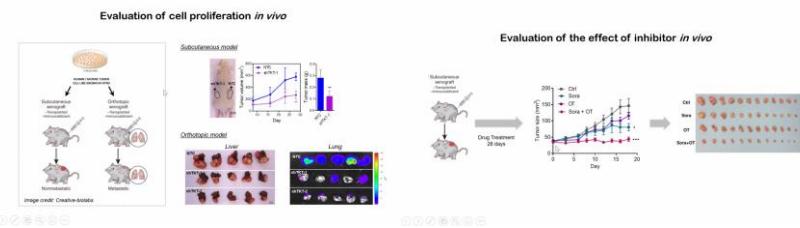
- a. Lecturer introduced what bioinformatics is and its sub-fields, as well as how it aids in new researches and discoveries



b.

- c. Lecturer outlined the efforts and time necessary for drug research, as well as outlined the common procedures taken for cancer gene research





2. Medical robot

- a. Lecturer introduced the challenges of endoscopic robots and the robotic designs and machine learning that can tackle them

Problem statement

Goal: placing the ROI of the instrument at the center of FOV with a customized size following the servo priority.

Requirements:

- Recognize the type and location of the instruments.
- Recognize the priority of the instruments.
- Place the instruments at the center of the camera view according to the surgeon's preference.

First priority Third priority

Real-time surgical image

Kinematic modelling

Background and literature review

OBB-based instruments detection method

$$L = \delta_1 L_{\eta} + \delta_2 L_{\bar{\eta}}$$

$$L_{\eta} = \sum_{i=1}^I \text{smooth}_{L_i}(\eta_i - \bar{\eta}_i)$$

Representation of the instrument based on four gliding vertices list constraint:

b.

- c. Lecturer discussed the current accuracy requirement for colonoscopy and designs that can ease and automate the procedure

Conventional Colonoscopy

- Gold standard for colon inspection and treatment
- Most commonly used in clinical practice
- High accuracy and reliability
- Limitations
- Patient discomfort → social acceptance
- High skill requirement for surgeons → endoscopist source

Proposed solution

- Electromagnetically Actuated Soft-Tethered (EAST) Colonoscope System**
 - Magnetic actuation system
 - Soft-tethered colonoscope
 - Localization unit and control unit
- Objectives**
 - Good patient tolerance
 - Surgeon-friendly manipulation
 - Reliable diagnosis and therapy with high autonomy and efficiency

Small-scale prototype for proof-of-concept

Functionality evaluation

d.

Control evaluation

Automatic trajectory following control

Manual control in a transparent colon mock-up

x2 Speed

Polyp Detection & Diagnosis

11

- e. Lecturer introduced a brain biopsy robotic system and its advantages over traditional brain biopsy, as well as their design iteration process

Clinical background

- Brain and other nervous system cancer: **10th leading cause of death.**
 - In U.S., 23,896 and 18,000 adults are estimated to be diagnosed with and die from brain tumor in 2020.
 - In Hong Kong, there were 257 new cases and 124 deaths in 2018.
- Brain biopsy: **gold standard** to diagnose the type and grade of brain tumors – open and stereotactic.



Management

Procedures in brain biopsy (Fine needle aspiration biopsy):

1. Cannula insertion
2. Vacuum generation
3. Side-cutting
4. Cannula retraction
5. Cannula rotation (clinical requirement)
 - The sampling window might be oriented to another side (e.g., 3 o'clock, 6 o'clock, 9 o'clock, 12 o'clock)



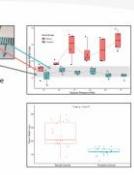
Constrained cannula

A novel brain biopsy cannula with a 0.4-mm ID tissue blocker is proposed.



Constrained cannula

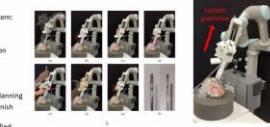
- Proposed cannula:
 - within the range of -20 kPa and -70 kPa, the average yield falls in the adequate range;
 - the average sample weight is **12.34 mg**.



Performance validations

Ex vivo experiment

- Overall workflow with the system:
 - a. navigation
 - b. cannula insertion
 - c. vacuum pressure generation
 - d. side-cutting
 - e. sample acquisition
 - f. re-installation
 - g. side window orientation planning
 - h. repeat step 3 and 4 until finish
- Feasibility of the system is verified.



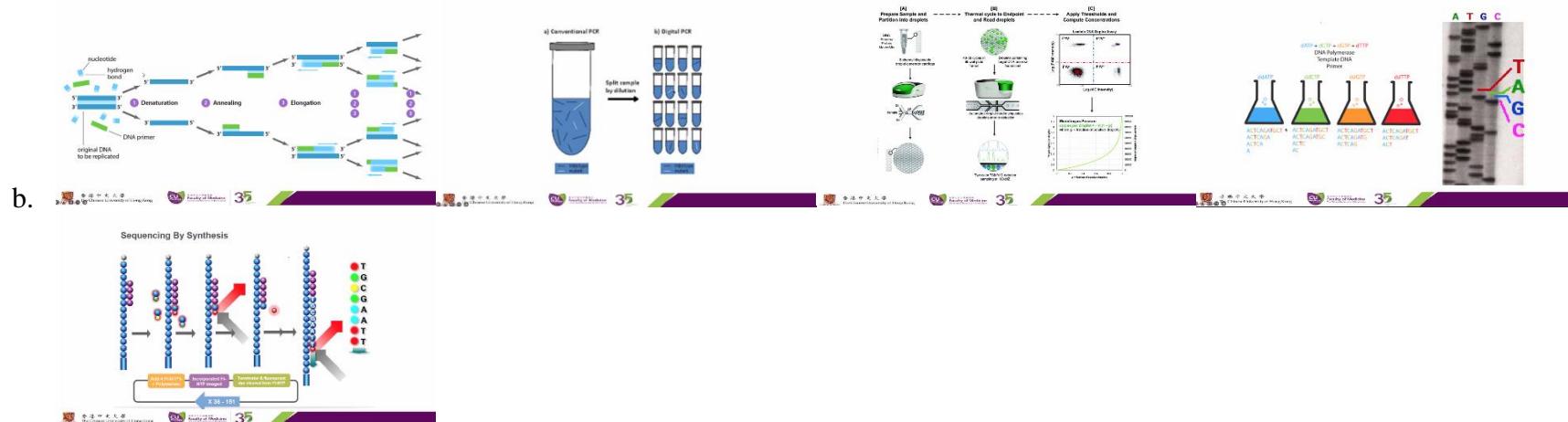
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Date: 10/06/2022

Session: Department of Chemical Pathology

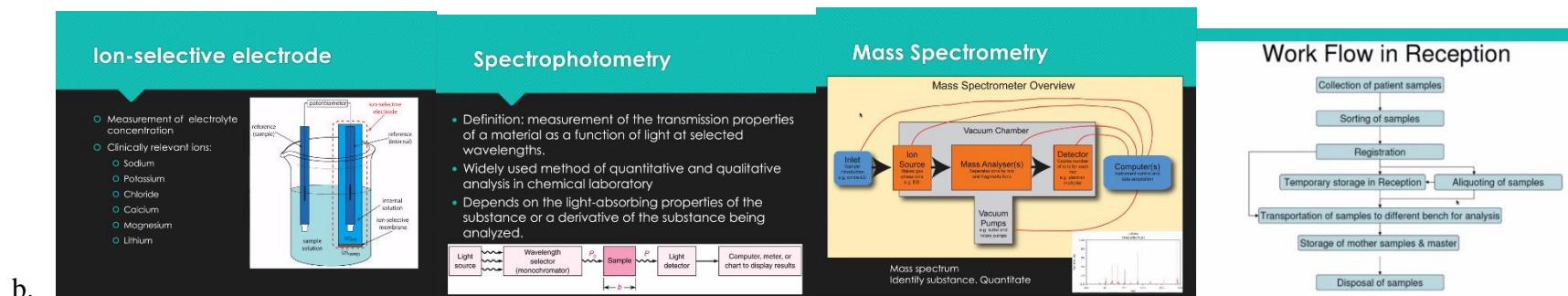
1. Principles of genomic analysis platforms

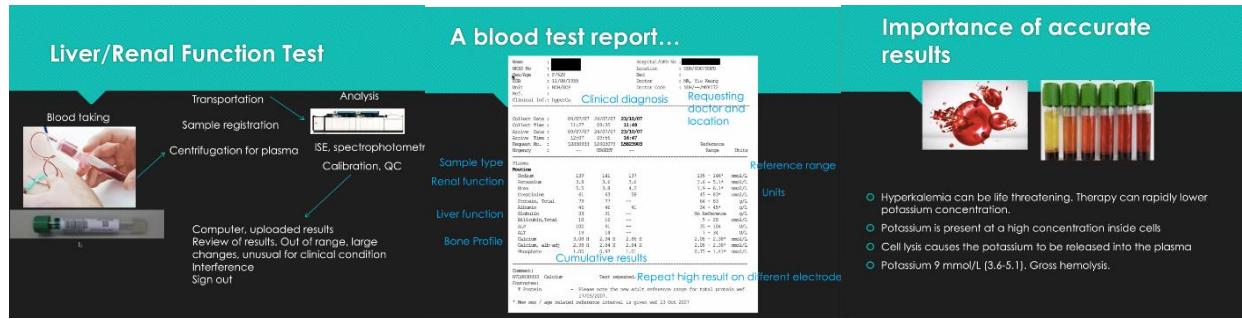
a. Lecturer discussed the rationale for genomic analysis



2. Chemical Pathology

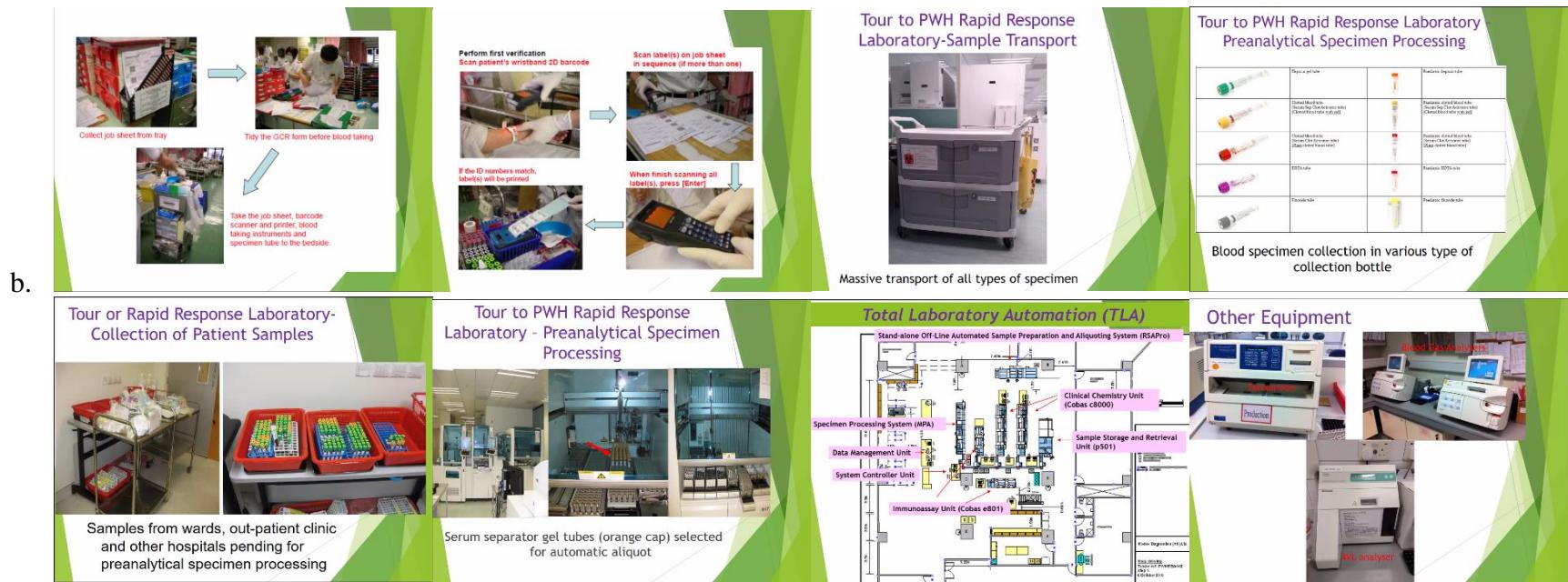
a. Lecturer outlined the common procedures done by chemical pathology department





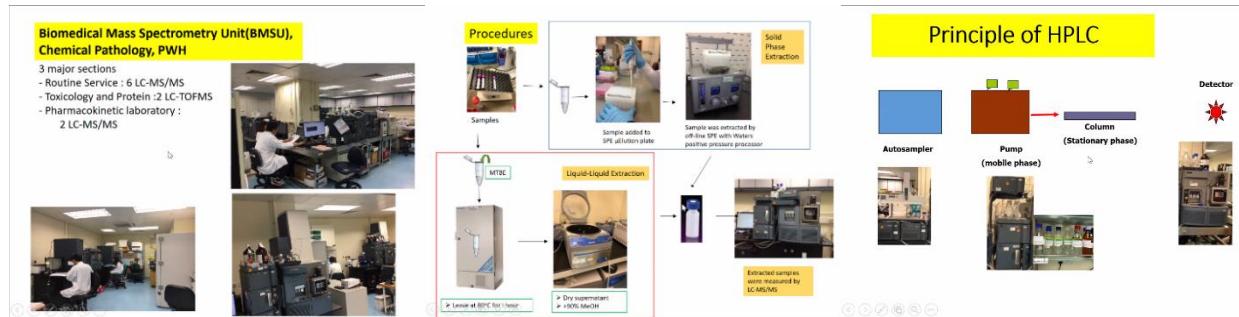
3. Rapid response laboratories

- a. Lecturer described what the stations of a rapid response laboratory do respectively



4. Mass spectrometry

- a. Lecturer outlined how mass spectrometry can be used to identify tissues and chemicals in a sample



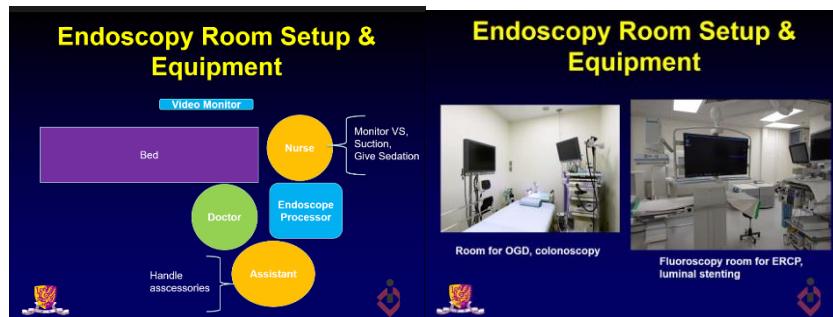
b.

Date: 10/06/2022

Session: Department of Medicine and Therapeutics – Division of Gastroenterology & Hepatology

1. Endoscopy room

- a. Lecturer introduced the layout and facilities of an endoscopy room



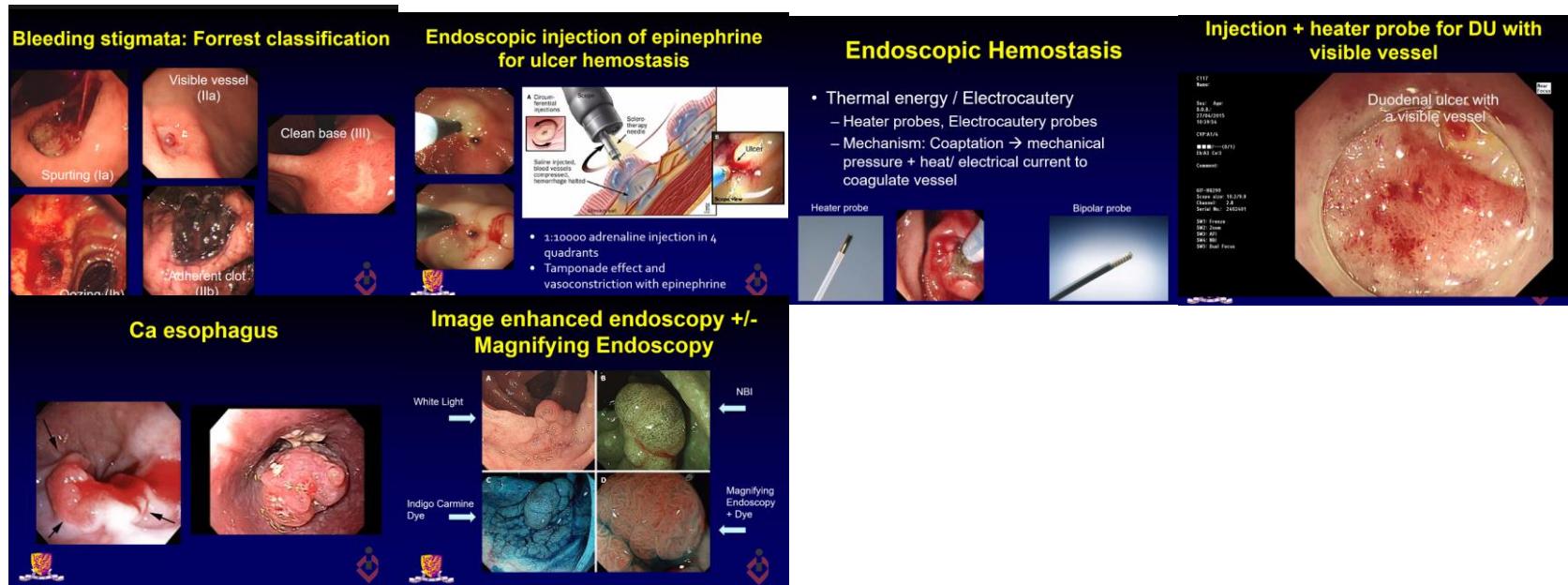
b.

2. Oesophago-gastro-endoscopy

- a. Lecturer introduced the uses of OGE as well as different types of GI bleeding and their treatments



b.



3. Endoscopic Retrograde Cholangiopancreatography

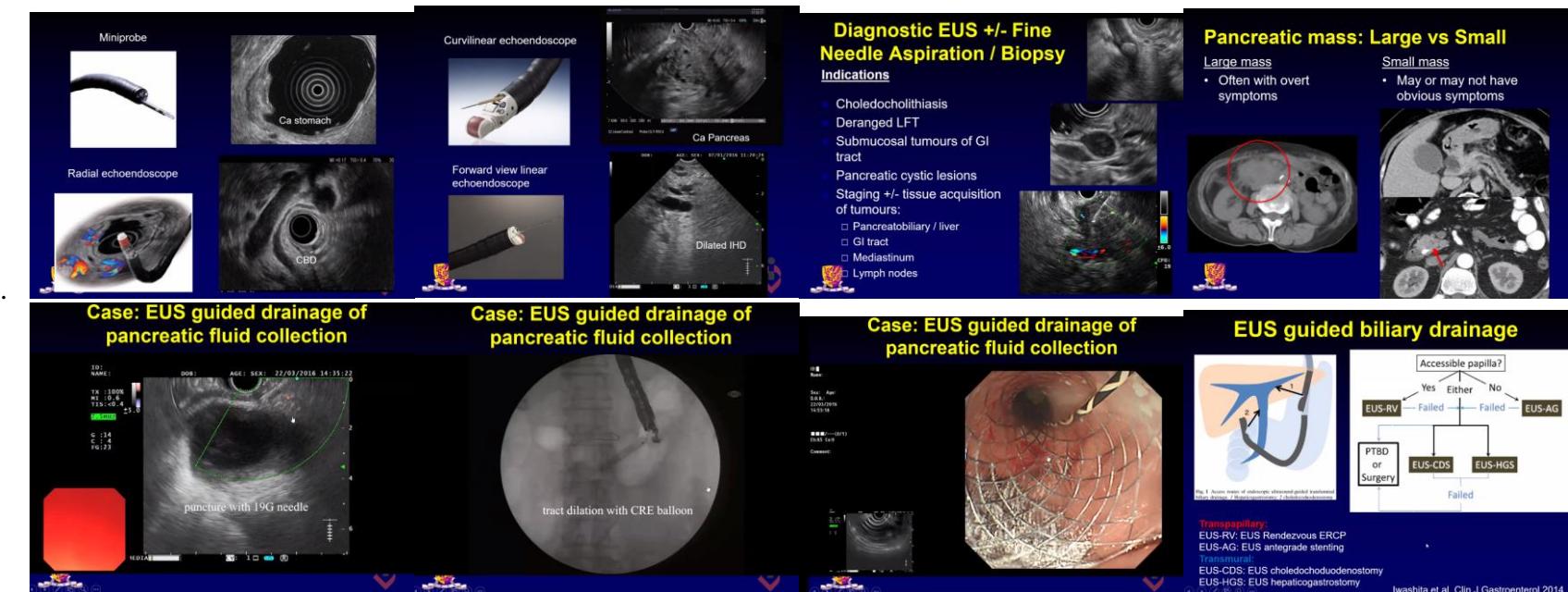
- Lecturer outlined how this technique can be used to stent blocked ducts or remove tumor tissues as well as introduced new robotic systems





4. Endoscopic ultrasound

- a. Lecturer discussed how this technique can be used to provide high-resolution insights into the GI ducts to guide operations

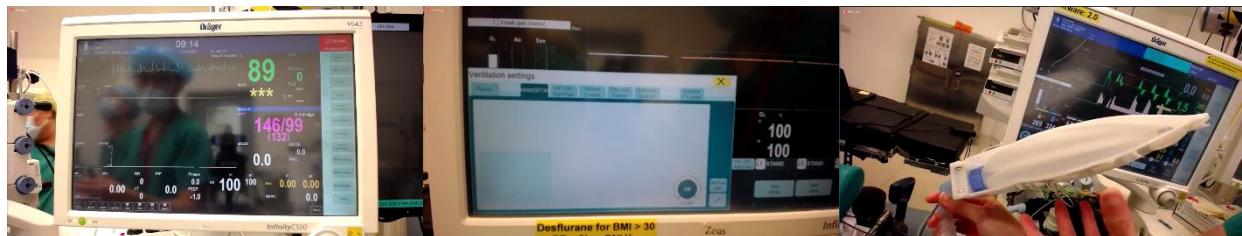


Date: 11/06/2022

Session: Department of Anaesthesia and Intensive Care

1. Anaesthetic machine

- Lecturer introduced the basic functionalities of anaesthetic machines



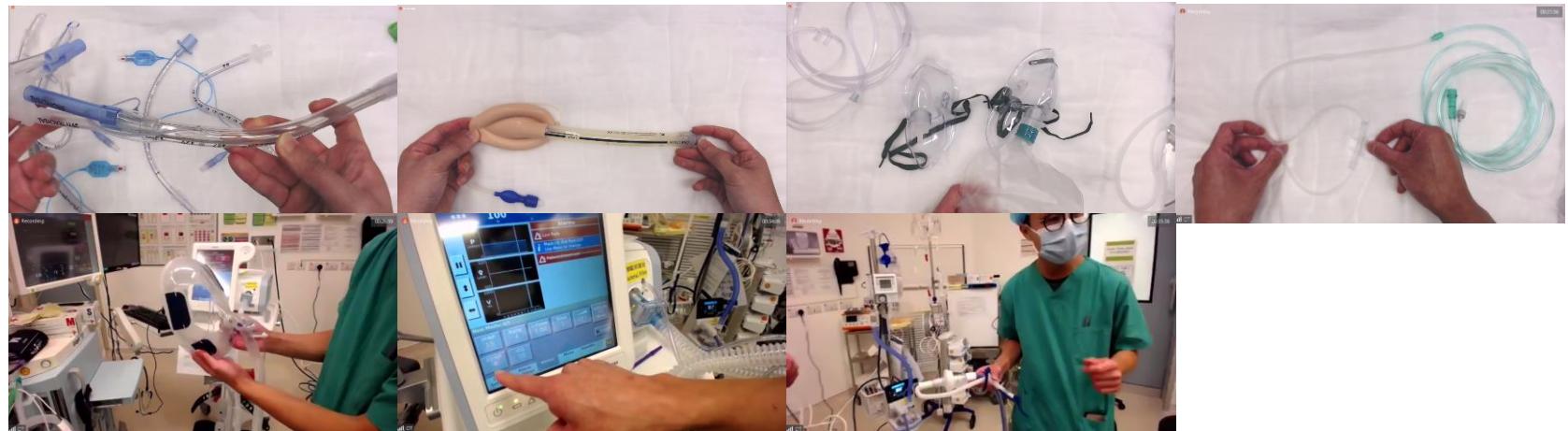
2. Monitors

- Lecturer introduced some vitality monitors as well as some scopes that can show airway obstructions



3. Ventilators

- Lecturer introduced different types of ventilator masks and their capabilities, as well as an air warmer and humidifier



4. Accessories

- a. Lecturer introduced the syringe pump, ultrasound machine, and simulator dummy

