Ministry of Higher Education & Scientific Research
Al-Rasheed University College
Medical Instrumentations Techniques Engineering

وزارة التعليم العالي والبحث العلمي
كلية الرشيد الجامعة
قسم هندسة تقنيات الأجهزة الطبية

حقيبة تعليمية

الأجهزة الطبية 1

Medical Instrumentations 1

إعداد

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2023 - 2022

المقدمة

تهدف المادة لدراسة الاجهزة الطبية كجهاز الاكتروني بحت، ثم اختلافه عن بقية الاجهزة الالكترونية لكونه جهاز طبي ودراسة الدوائر الالكترونية الداخلية ثم التدريب على كافة الاجهزة الالكترونية في الاجهزة الطبية وطرق تشغليها وصيانتها مما يؤهل الطالب في النهاية على استخدام وصيانة الاجهزة الطبية بصورة عامة.

The course aims to study medical devices as a purely electronic device, then differ from the rest of the electronic devices because it is a medical device, study the internal electronic circuits, then train on all electronic devices in medical devices and ways of operating and maintaining them, which ultimately qualifies the student to use and maintain medical devices in general.

فهرس المحتويات

وصف المقرر الدراسي

COURSE SPECIFICATION

This Course Specification provides a concise summary of the main features of the course and the learning outcomes that a typical student might reasonably be expected to achieve and demonstrate if he/she takes full advantage of the learning opportunities that are provided. It should be cross-referenced with the programme specification.

1. Teaching Institution	AL-Rasheed University College
2. University Department/Centre	Medical Instrumentations Techniques Engineering
3. Course title/code	Medical Instrumentations
4. Programme(s) to which it contributes	
5. Modes of Attendance offered	Weekly (theoretical + practical)
6. Semester/Year	2022-2023
7. Number of hours tuition (total)	120(60theoretical + 60practical)
8. Date of production/revision of this specification	2022
9. Aims of the Course	
1-study the medical device as a purely electronic device -	
2- study the device as a medical device and different from electronic	
3-Training in electronic materials in electronic devices and methods of operation and maintenance	
4-trainaing the student for the maintenance of medical devices in general	

10· Learning Outcomes, Teaching ,Learning and Assessment Methode
A- Knowledge and Understanding A1. Understand the basic components of the medical device A2 - Studying laboratory equipment and types A3-Learn the usefulness of each laboratory device A4 - Studying sterilization devices A - Studying old and modern medical devices A6 - Study of radiation and physiotherapy equipment A7 - Studying the infant incubator and its usefulness
B. Subject-specific skills B1. Explains the cause of the malfunction of the medical device B. The computer is used to store the specifications of the medical device B.3. The computer is used as a means of comparing the medical conditions taken from the medical device with data for natural cases stored in the computer B-Diagnoses the results of the medical system
Teaching and Learning Methods
Laboratory experiments on medical devices
Assessment methods
Daily / quarterly tests Practical activities or public activities
C. Thinking Skills C1 - to listen attentively to the student to explain the stadiumStudent. C2- A student should feel the suffering of victims of racial discrimination C3- to recognize the student the impact of science and scientists in life C4- The student should describe the importance of learning medical equipment
Teaching and Learning Methods
Seminars - Educational guidance
Assessment methods
Discuss the stadium with the student - discuss the student with his colleague

D. General and Transferable Skills (other skills relevant to employability and personal development)
D1 - Office skills outside the scientific subject

11. Course Structure

Week	Hours	ILOs	Unit/Module or Topic Title	Teaching Method	Assessment Method
1	2TH+2P	The student understands the lesson	Introduction to medical instruments	Theoretical lecture	Pretest-post test
2-3	4TH+4P	The student understands the lesson	Electronic balance	Theoretical lecture	Pretest-post test
4-5	4TH+4P	The student understands the lesson	Thermal instruments	Theoretical lecture	Pretest-post test
6	2TH+2P	The student understands the lesson	Water baths	Theoretical lecture	Pretest-post test
7-8	4TH+4P	The student understands the lesson	Ovens	Theoretical lecture	Pretest-post test
9-10	4TH+4P	The student understands the lesson	Autoclave	Theoretical lecture	Pretest-post test
11-12	4TH+4P	The student understands the lesson	Incubators (lab.)	Theoretical lecture	Pretest-post test
13-14	4TH+4P	The student understands the lesson	Water distiller	Theoretical lecture	Pretest-post test
15-16	4TH+4P	The student understands the lesson	Cautery	Theoretical lecture	Pretest-post test
17-18	4TH+4P	The student understands the lesson	Other thermal instruments	Theoretical lecture	Pretest-post test
19-20	4TH+4P	The student understands the lesson	Centrifuge	Theoretical lecture	Pretest-post test
21-22-23	6TH+6P	The student understands the lesson	Microscopes(light, dark field, flourcents, polarized, electro)	Theoretical lecture	Pretest-post test

24-25	4TH+4P	The student understands the lesson	X-ray equipment's	Theoretical lecture	Pretest-post test

26-27	4TH+4P	The student understands the lesson	Rehabilitation equipment	Theoretical lecture	Pretest-post test
28-29	4TH+4P	The student understands the lesson	Medical gases system	Theoretical lecture	Pretest-post test
30	2TH+2P	The student understands the lesson	Infant incubators	Theoretical lecture	Pretest-post test

D - the student's ability to scientific research
D3 - the student's ability to participate in extra-curricular activities

12. Infrastructure

Required reading: Biomedical Engineering Handbook - J.D.Bronzino . Medical Instrumentation Application and Design	
Special requirements (include for example workshops, periodicals, IT software, websites)	
Community-based facilities (include for example, guest Lectures , internship , field studies)	

13. Admissions

Pre-requisites	
Minimum number of students	
Maximum number of students	

نموذج وصف المقرر

وصف المقرر

يوفر وصف المقرر هذا إيجازاً مقتضياً لأهم الكلية خصائص تقنيى وهندسية لتعلم المتوقعة من الطالب تحقيقها مبرهناً عما إذا كان قد حقق الاستفادة القصوى من فرص التعلم المتاحة. ولابد من الربط بينها

9. المؤسسة التعليمية	كلية الرشيد الجامعة
. القسم العلمي /	هندسة تقنيات الاجهزة الطبية
11. اسم / رمز المقرر	الاجهزة الطبية
12. أشكال الحضور المتاحة	اسبوعي (نظري+ عملي)
13. الفصل / السنة	2022-2023
14. عدد الساعات الدراسية (الكلي)	120 (60 نظري + 60 عملي)
15.تاريخ إعداد هذا الوصف	2022

16. أهداف المقرر
1-دراسة الجهاز الطبي كجهاز الكتروني بحت
2-دراسة الجهاز كجهاز طبي واختلافه عن الالكترونية
3- التدريب على كافة الدوائر الالكترونية في الاجهزة الطبية وطرق تشغيلها وصيانتها
4-تأهيل الطالب لصيانة الاجهزة الطبية بصورة عامة

12. مخرجات المقرر وطرائق التعليم والتعلم والتقييم

أ- الأهداف المعرفية أ1-يفهم المكونات الاساسية للجهاز الطبي أ2-يدرس الاجهزة المختبرية وانواعها أ3- يتعلم فائدة كل جهاز مختبري أ4-يدرس اجهزة التعقيم أ5- يدرس اجهزة القطع الطبية القديمة والحديثة أ6- يدرس اجهزةالاشعة واجهزة العلاج الطبيعي أ7-يدرس حاضنة الرضع والفائدة منها أ8يتعلم فتح الجهازالطبي وصيانته في حالة وجود اعطال أ9-
ب - الأهداف المهاراتية الخاصة بالمقرر. ب1 –يفسر سبب اعطال الجهاز الطبي ب2 – يستخدم الحاسوب لخزن مواصفات الجهاز الطبي ب3 - يستخدم الحاسوب كوسيلة لمقارنة الحالات المرضية التي تؤخذ من الجهاز الطبي مع بيانات لحالات طبيعية تحفظ في الحاسوب ب4- يشخص نتائج الجهاز الطبي
طرائق التعليم والتعلم
تجارب مختبرية على الاجهزة الطبية
طرائق التقييم
اختبارات يومية /فصلية انشطة عملية او انشطة عامة

ج- الأهداف الوجدانية والقيمية ج1-ان يصغي الطالب بانتباه الى شرح الاستاد ج2-ان يحس الطالب بما يعانيه ضحايا التمييز العرقي ج3-ان يتعرف الطالب على اثر العلم والعلماء في الحياة ج4-ان يصف الطالب اهمية تعلم مادة الاجهزة الطبية
طرائق التعليم والتعلم
ندوات –ارشاد تربوي
طرائق التقييم
مناقشة الاستاد مع الطالب – مناقشة الطالب مع زميله
د - المهارات العامة والتأهيلية المنقولة (المهارات الأخرى المتعلقة بقابلية التوظيف والتطور الشخصي). د1- المهارات المكتبيه خارج الماده العلمية د2-قابلية الطالب على البحث العلمي د3-قابلية الطالب على المشاركة في النشاطات اللاصفية

الأسبوع	الساعات	مخرجات التعلم المطلوبة	اسم الوحدة / أو الموضوع	طريقة التعليم	طريقة التقييم
1	2ن +2ع	الطالب يفهم الدرس	Introduction to medical instruments	محاضرة نظرية	امتحانات اسبوعية اسئلة قبلية وبعدية
3-2	4ن+4ع	الطالب يفهم الدرس	Electronic balance	محاضرة نظرية	امتحانات اسبوعية اسئلة قبلية وبعدية
5-4	4ن+4ع	الطالب يفهم الدرس	Thermal instruments	محاضرة نظرية	امتحانات اسبوعية اسئلة قبلية وبعدية
6	2ن +2ع	الطالب يفهم الدرس	Water baths	محاضرة نظرية	امتحانات اسبوعية اسئلة قبلية وبعدية
8-7	4ن+4ع	الطالب يفهم الدرس	Ovens	محاضرة نظرية	امتحانات اسبوعية اسئلة قبلية وبعدية
10-9	4ن+4ع	الطالب يفهم الدرس	Autoclave	محاضرة نظرية	امتحانات اسبوعية اسئلة قبلية وبعدية
12-11	4ن+4ع	الطالب يفهم الدرس	Incubators (lab.)	محاضرة نظرية	امتحانات اسبوعية اسئلة قبلية وبعدية
14-13	4ن+4ع	الطالب يفهم الدرس	Water distiller	محاضرة نظرية	امتحانات اسبوعية اسئلة قبلية وبعدية
16-15	4ن+4ع	الطالب يفهم الدرس	Cautery	محاضرة نظرية	امتحانات اسبوعية اسئلة قبلية وبعدية
18-17	4ن+4ع	الطالب يفهم الدرس	Other thermal instruments	محاضرة نظرية	امتحانات اسبوعية اسئلة قبلية وبعدية
20-19	4ن+4ع	الطالب يفهم الدرس	Centrifuge	محاضرة نظرية	امتحانات اسبوعية اسئلة قبلية وبعدية
-22-21 23	6ن+6ع	الطالب يفهم الدرس	Microscopes(light, dark field, flourcents, polarized, electro)	محاضرة نظرية	امتحانات اسبوعية اسئلة قبلية وبعدية
25-24	4ن+4ع	الطالب يفهم الدرس	X-ray equipment's	محاضرة نظرية	امتحانات اسبوعية اسئلة قبلية وبعدية
27-26	4ن+4ع	الطالب يفهم الدرس	Rehabilitation equipment	محاضرة نظرية	امتحانات اسبوعية اسئلة قبلية وبعدية

29-28	4ن+4ع	الطالب يفهم الدرس	Medical gases system	محاضرة نظرية	امتحانات اسبوعية اسئلة قبلية وبعدية
30	2ن +2ع	الطالب يفهم الدرس	Infant incubators	محاضرة نظرية	امتحانات اسبوعية اسئلة قبلية وبعدية

10. البنية التحتية	
1- الكتب المقررة المطلوبة	2000-Biomedical Engineering Handbook - J.D.Bronzino-
2- المراجع الرئيسية (المصادر)	Medical Instrumentation Application and Design
ا- الكتب والمراجع التي يوصى بها (المجلات العلمية ، التقارير ،....)	
ب - المراجع الالكترونية، مواقع الانترنيت	www.bme.ncku.edu.com

11. خطة تطوير المقرر الدراسي
اضافة التطوير الحديث للاجهزة في المقرر ومقارنتها مع الانواع القديمة تصميم بوردات للاجهزة الطبية المدكورة

إرشادات للطلبة

- الرغبة والحماس للتعليم
- كن مشاركاً في جميع الأنشطة
- احترم أفكار المدرس والزملاء
- أنقد أفكار المدرس والزملاء بأدب إن كانت هناك حاجة.
- احرص على استثمار الوقت
- تقبل الدور الذي يسند إليك في المجموعة
- حفز أفراد مجموعتك في المشاركة في النشاطات
- احرص على بناء علاقات طيبة مع المدرس والزملاء أثناء المحاضرة
- احرص على ما تعلمته في المحاضرة وطبقه في الميدان .
- ركز ذهنك بالتعليم واحرص على التطبيق المباشر
- تغلق الموبايل قبل الشروع بالمحاضر

المحاضرة الأولى - الزمن: 120 دقيقة

أهداف المحاضرة الاولى:

يتوقع في نهاية الجلسة أن يكون الطالب قادراً على معرفة ما هي الاجهزة الطبية بصورة عامه و مجالات استخدامها.

موضوعات المحاضرة الاولى:

Introduction to medical instruments

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
1	• نشاط التعارف • محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

خطة إجراءات تنفيذ المحاضرة الاولى

الوحدة	المحاضرة	الإجراءات	الزمن بالدقيقة
الأولى	الأولى	الترحيب بالطلبة والتعارف معهم	120 دقيقة
		التعريف بالبرنامج وأهدافه وأهميته	
		والبدء باعطاء المادة العلمية للمحاضرة	

المادة العلمية:

1. Introduction

A medical device may be defined as any appliance, instrument, material, apparatus or other article, either used in a singular form in combination with other equipment/devices, including

the software essential for its intended purpose by the manufacturer to be used for human beings for the following purpose of:

- Diagnosis, prevention, monitoring, treatment or alleviation of disease
- Diagnosis, monitoring, treatment, alleviation of or compensation for an injury or handicap
- Investigation, replacement or modification of the anatomy or of a physiological process control of conception and which does not achieve its principal intended action in or on the human body by pharmacological, immunological or metabolic means, but which may be assisted in its function by such means.

Figure 1: Some of medical instruments and devices

Medical devices form an important component of patient care. From tongue depressors to dialysis machines, medical devices encompass a very broad and complex variety of technologies. The complexities are coupled with the presence of power factors in most medical devices. Thus, in addition to the device performance, the crucial aspect of patient safety and the health provider's safety gets incorporated. In order to comply with all safety requirements, sets

of universal standards and norms have been prescribed, compliance to which ensures delivery of the right technology in the right way. A means to verify the devices against this desired compliance is testing. Thus, product testing brings into existence the first level of assessment of appropriateness and safety of a device.

With developing economies and increasing awareness, people are becoming more conscious about their health. Regardless of the cost factor, people are willing to opt for advanced technologies and solutions to improve their health. Hence medical devices have seen significant growth in the healthcare industry. Further, the medical device industry has its sub-industries like diagnostics, imaging, cardiovascular devices, surgical devices, and orthopaedic devices.

2. Medical Device Types

There are many types of medical equipment such as:

- **Diagnostic Equipment**

Diagnostic medical equipment is any type of equipment or tools used in a hospital setting for the sole purpose of diagnosing a patient's condition. Based on the symptoms described by the patient, a diagnostic test is performed using the appropriate equipment to evaluate the patient internally. The doctor or technician is looking for any abnormalities in the affected organs or parts of the body that are causing the symptoms to be exhibited. Below are some of the most common types of diagnostic equipment used in laboratories and medical clinics:

1. **Medical imaging machines** – Medical imaging is a type of technology that is used to create visual representations of the human body's interior. The visual image produced by the equipment is used for clinical analysis and medical intervention. There are many medical imaging equipment, such as radiography (X-ray machine), computed tomography (CT scan), magnetic resonance imaging (MRI scan), ultrasound, and echocardiography, to name a few.

2. Aside from medical imaging machines, there are other medical devices used for diagnosing patients. Some examples include patient scales, stethoscopes, dopplers, and pulse oximetry.

- **Durable Medical Equipment (DME)**

This type of medical equipment is used mainly for providing therapeutic benefits for certain conditions or illnesses. The use of this equipment must be prescribed by a physician, which is designed to serve a medical purpose. It is a long-term and reusable device that can be used in the hospital or at home for patient care. There are several types of durable medical equipment such as the following:

1. Manual wheelchairs or electric wheelchairs
2. Hospital beds
3. Walkers, crutches, canes (or any similar type of mobility assistive equipment)
4. Pressure mattresses
5. Insulin pumps
6. Breast pumps
7. Patient Lifts
8. Bili lights and blankets
9. Kidney machines

- **Treatment Equipment**

Treatment equipment is any type of medical device or tool that is designed to treat a specific condition. It utilizes modern technology in order to address any abnormalities to restore function in the affected organs or tissues within the body. This can also include the surgical supplies designed to provide treatment for certain conditions that require surgical intervention. Below are common examples of medical treatment equipment that you will find in hospitals and clinics:

1. **Infusion Pumps** – This type of treatment equipment is used in a hospital setting. It is designed to infuse medication, fluids, and other forms of treatment to the patient's circulatory system. This machine is used intravenously but you can also find epidural or arterial infusions. This machine is reliable because it injects controlled amounts of fluids into the patient's system over a given period of time.

2. **LASIK Surgical Machines** – The use of LASIK technology is used primarily for the treatment of eye conditions. It is designed for use on patients suffering from myopia, hyperopia, or astigmatism.

3. **Medical Lasers** – The laser is a revolutionary technology introduced in the medical field for the treatment of various medical conditions. It is a device that emits a wavelength of electromagnetic radiation for clinical applications. These wavelengths vary when it comes to energy level and pulse duration. These settings are to be determined by the attending physician during treatment.

- **Medical Laboratory Equipment**

The use of medical laboratory equipment is often seen in medical clinics or diagnostic laboratories. These types of equipment are intended for the analysis of blood, urine, genes, and other biological material. Below are the most common examples of medical laboratory equipment used in the medical field:

1. Blood gas analyzers
2. Chemistry analyzers
3. Blood collection supplies
4. Electrolyte analyzers
5. Differential counters
6. Drug testing analyzers
7. Coagulation analyzers
8. Hematology analyzers
9. Urinalysis analyzers
10. Microbiological systems

As medical technology continues to develop, you can expect that there will be more types of medical equipment emerging. This is good news to patients who can expect quality medical care and diagnosis utilizing the latest in medical technology.

3 . Medical Device Classification

The FDA categorizes medical devices into one of three classes – Class I, II, or III – based on their risks and the regulatory controls necessary to provide a reasonable assurance of safety and effectiveness. Class I devices generally pose the lowest risk to the patient and/or user and Class III devices pose the highest risk.

Class	Characterization / Device type	Example
Class I	Low risk level	Thermometers, Tongue depressors
Class IIA	Low to Moderate risk level	Hypodermic needles
Class IIB	Moderate to High risk level	Lung ventilators and bone fixation plates
Class III	High risk level	Heart valves and implantable defibrillators

الوحدة الثانية - المحاضرة الثانية - الزمن: 120دقيقة

أهداف المحاضرة الثانية:

يتوقع في نهاية الجلسة أن يكون الطالب قادراً على معرفة ماهو Electronic balance واستخداماته وطرق تشغيله.

موضوعات المحاضرة الثانية:

Electronic balance – part 1

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
2	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

1. Introduction

Electronic balance is an instrument used in the accurate measurement of weight of materials. Electronic balance is a significant instrument for the laboratories for precise measurement of chemicals which are used in various experiments. Laboratory electronic balance provides digital result of measurement. Some of the application areas for laboratory electronic balance are pharmaceutical research, scientific research, industrial, food research, educational research and others. On the basis of types of products electronic balance instrument can be classified into top loading balance and analytical balance. Electronic balance helps to produce repetitive result with great accuracy in research. Small and low cost of electronic balance instrument prefer for measuring food and more expensive version of electronic balance instruments are used in the labs and government agencies.

Figure 1: The electronic balance

The history of balances and scales dates back to Ancient Egypt. A simplistic equal-arm balance on a fulcrum that compared two masses was the standard. Today, scales are much more complicated and have a multitude of uses. Applications range from laboratories weighing of chemicals to weighing of packages for shipping purposes. To fully understand how types of balances and scales operate, there must be an understanding of the difference between **mass and weight. Although mass and weight are two different entities, the process of determining both weight and mass is called weighing.**

Mass is a constant unit of the amount of matter an object possesses. It stays the same no matter where the measurement is taken. The most common units for mass are the kilogram and gram.

Weight is the heaviness of an item. It is dependent on the gravity on the item multiplied by the mass, which is constant. The weight of an object on the top of a mountain will be less than the weight of the same object at the bottom due to gravity variations. A unit of measurement for weight is the newton. A newton considers the mass of an object and the relative gravity and gives the total force, which is weight.

الوحدة الثالثة - المحاضرة الثالثة - الزمن: 120دقيقة

أهداف المحاضرة الثالثة:

يتوقع في نهاية الجلسة أن يكون الطالب قادراً على معرفة ماهو Electronic balance واستخداماته وطرق تشغيله.

موضوعات المحاضرة الثالثة:

Electronic balance – part 2

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
3	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

1. Electronic Balances Work

The quickest way to understand the principle of how electronic balances work, is to first understand how they are constructed. There are two basic types of electronic balance designs.

A. Electromagnetic balancing type.

B. Electrical resistance wire type (load cell type)

These are based on completely different principles, but what they both have in common is that neither directly measures mass. They measure the force that acts downward on the pan. This force is converted to an electrical signal and displayed on a digital display. As a means of measuring force, the electromagnetic balance method utilizes the electromagnetic force generated from a magnet and coil, whereas the electrical resistance wire method utilizes the

change in resistance value of a strain gauge attached to a piece of metal that bends in response to a force.

So why do electronic balances display mass values when that is not what they measure? It is because the reference standards for mass are weights, which are placed on a pan to inform the electronic balance that a given force is equivalent to a given number of grams, which is used for conversion. Consequently, electronic balances that do not perform this conversion accurately cannot display accurate mass values.

Various principles are used for measuring the weight of objects. The following briefly describes the operating principles and features of the two most popular methods, **"electromagnetic type" and "load cell type."**

A. Electromagnetic Type

This is also called the "electromagnetic balance method." With mechanical balances, the sample is placed at one end of the beam and the weight is placed at the other end, and the value of the weight when both are perfectly balanced becomes the mass of the sample. With electromagnetic type balances, an electrical force (electromagnetic force) is applied instead of a placed weight to balance the beam. The amount of electricity required for balancing the beam changes according to the weight of the sample that is placed. The amount of current when the beam is perfectly balanced is detected, and the mass is obtained from that detected value.

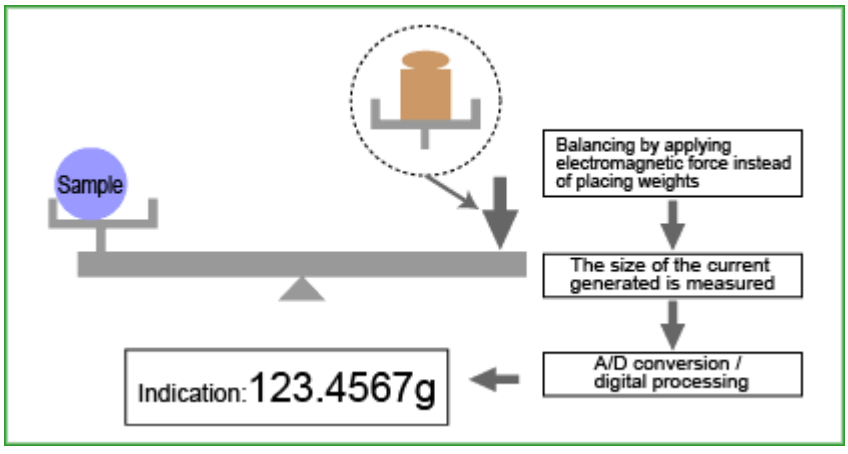

Figure 2: The electromagnetic balance

B. Load Cell Type (electrical resistance wire method)

One end of an object (elastic body) made of aluminium and shaped as shown in the figure is fixed in place, and the sample is placed on the other end. The weight of the sample causes the elastic body to flex. The amount of flex causes the strain gauges attached to the elastic body to expand and contract, changing the amount of electricity that is output (strictly speaking, the resistance value). The mass is then obtained from that amount of electricity.

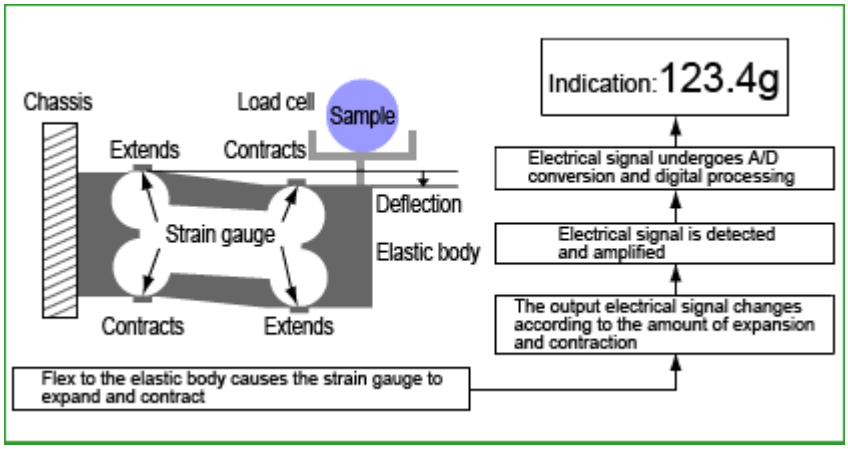

Figure 3: The electrical balance

The table below explains the comparison between Electromagnetic Type and Load Cell Type

	Electromagnetic Type	**Load Cell Type**
Advantages	High accuracy	• Simple structure • Even large models are easy to make
Disadvantages	• Complex structure • Difficult to downsize	Accuracy is limited
Applications	Ultra-precision balances such as analytical balances	• Small, cheap balances that require only moderate accuracy • Large balances

3. Balance and Scale Terms

There are many Balance and Scale Terms have to understand as explain :

- **Accuracy**: the ability of a scale to provide a result that is as close as possible to the actual value. The best modern balances have an accuracy of better than one part in 100 million when one-kilogram masses are compared.

- **Calibration**: the comparison between the output of a scale or balance against a standard value. Usually done with a standard known weight and adjusted so the instrument gives a reading in agreement.

- **Capacity**: the heaviest load that can be measured on the instrument.

- **Precision**: amount of agreement between repeated measurements of the same quantity; also known as repeatability. Note: A scale can be extremely precise but not necessarily be accurate.

- **Readability**: this is the smallest division at which the scale or balance can be read. It can vary as much as 0.1g to 0.0000001g. Readability designates the number of places after the decimal point that the scale can be read.

Numerical Decimal	Number of Decimal	Fraction
0.1g	1 place	1/10 gram
.01	2 places	1/100 gram
.001	3 places	1/1000 gram
.0001	4 places	1/10,000 gram (1/10)
.0001	5 places	1/100,000 gram (1/100)

- **Tare**: the act of removing a known weight of an object, usually the weighing container, to zero a scale. This means that the final reading will be of the material to be weighed and will not reflect the weight of the container. Most balances allow taring to 100% of capacity.

الوحدة الرابعة - المحاضرة الرابعة - الزمن: 120دقيقة

أهداف المحاضرة الرابعة:

يتوقع في نهاية الجلسة أن يكون الطالب قادراً على معرفة ماهو Water Baths واستخداماته وطرق تشغيله.

موضوعات المحاضرة الرابعة:

Water Baths – part 1

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
4	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

1. Introduction

A laboratory water bath is used to heat samples in the lab. Some applications include maintaining cell lines or heating flammable chemicals that might combust if exposed to open flame. A water bath generally consists of a heating unit, a stainless steel chamber that holds the water and samples, and a control interface. Different types of water baths offer additional functionality such as a circulating water bath that keep a more even temperature or a shaking water bath that keeps the samples in motion while they are heated. A water bath is a lab constant temperature equipment, providing heat source for varieties of devices that need.

A laboratory water bath is used to heat samples. Some applications include maintaining cell lines or heating flammable chemicals that might combust if exposed to open flame. A water bath generally consists of a heating unit, a stainless-steel chamber that holds the water and samples, and a control interface. Different types of water baths offer additional functionality such as a circulating water bath that keep a more even temperature or a shaking water bath that keeps the samples in motion while they are heated.

Figure 1: The laboratory water bath

2. The working principle of the water bath

The water bath works in the presence of a Cu50 temperature sensor which transfers the water temperature in the device up to a resistance value which is amplified and compared with an integrated amplifier, which then puts into the output control signals and maintains the optimum heating power of electric heating tube and thus keeps the bath at a constant temperature. Since the water, the bath is a heating device, and in this device, water is used as a medium to transfer heat into the component of the sample solution, and since water reaches the boiling temperature of 100 degrees Celsius, thus, temperature-sensitive glassware or sample should not be treated using this method.

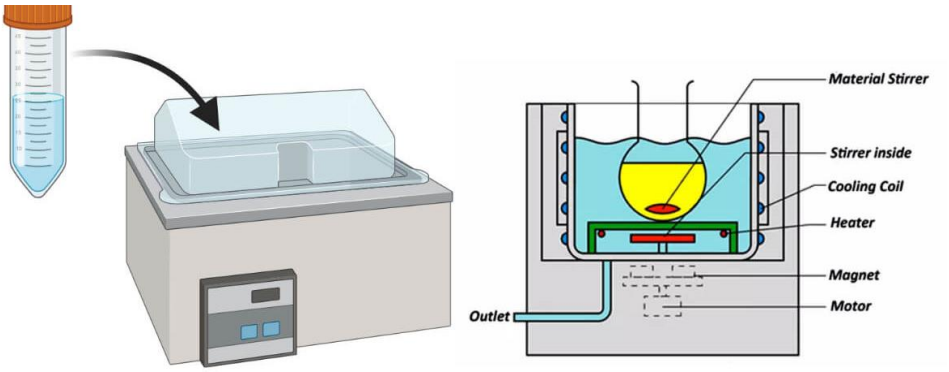

Figure 2: The working principle of the water bath

The temperature range in the water bath between 30-100 degrees Celsius. To keep the temperature constant, the water bath uses the circulated heat to generate motion while heating inside the sample. But if the sample requires a temperature above 100 degrees Celsius, then an oil, sand, and silicone bath is preferred.

الوحدة الخامسة - المحاضرة الخامسة - الزمن: 120دقيقة

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موضوعات المحاضرة الخامسة:

Water Baths – part 2

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
5	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

3. Components of the hot water bath

The hot water bath consists of the following:

- **Container or Tank Bath:** In the container, the test samples are kept in hot water for a long period of time. The container of a Laboratory Water Bath is made up of insulated metal such as stainless steel.

- **Container Led:** The lid helps to keep covering the container, so that water does not evaporate out of it. It's mainly made up of heat resistant glass or insulated metal.
- **Heater:** A laboratory water bath contains a Cu50 temperature sensor, which helps to generate heat.

- **Thermometer:** This helps to check the temperature of the water bath. It can be inbuilt or placed individually.

- **Thermostat or regulator:** A thermostat helps to maintain the temperature of a water bath at a constant level.

- **Propeller or stirrer device:** It helps to circulate the water inside the water bath (Found in Circulating water baths).

- **Outlet**: It helps to get the water out of the container.

- **Indicator light:** All water bath should contain an indicator light. When the light is on the water bath is heating. If the water bath reaches the required temperature the light will be turn off to maintain the constant temperature.

4. Types of Water Hot Bath

There are many types of water hot bath as following:

A. Shaking water bath: This type of water bath has an extra control for shaking, which help in the movement of hot water and liquid test sample. This shaking features of a shaking water bath can be turned on or off. In microbiological laboratories, a shaking water bath helps in the incubation of a growing culture with proper air circulation.

B. Circulating water bath: Stirrers or circulating water bath is used for enzymatic and serologic experiments. In the circulating water bath, the hot water is thoroughly circulated throughout the bath, which is resulting in a more uniform temperature.

C. Non-circulating water bath: non-circulating water baths rely primarily on convection instead of water being uniformly heated, which results in a less accurate in terms of temperature control.

5. Limitation of Water Bath

The water bath has limitation, and it is to Changing water daily and keep clean from the inside to prevent the encrustation of important components in a water bath. When using the water bath, keep the lid closed so that the water does not evaporate. Measure the inside and outside temperature of the water bath once a week. Make sure, the thermometer does not stick to the wall of the water bath.

6. Water bath maintenance

Proper maintenance is essential for prolonged life, no matter the type of water bath you are using. **Firstly,** the type of water you are going to be using should be considered carefully. Distilled water works best in water baths because tap water can contain minerals that build up over time. **Secondly,** make sure to drain the water bath every time to keep it in good condition. This kind of equipment needs to be cleaned regularly. It must be made sure whether it is switched off and remove the container before cleaning. Wipe the seals to clear any debris and be careful not to spill water into the unit as it can damage electrical components. Do not use corrosive cleaning agents on a water bath, and only use a damp cloth and mild detergent for cleaning.

الوحدة السادسة - المحاضرة السادسة - الزمن: 120دقيقة

أهداف المحاضرة السادسة:

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موضوعات المحاضرة السادسة:

Ovens – part 1

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
6	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

1. Introduction

Hot air ovens are laboratory and scientific equipment which uses dry heat (hot air mixture) for sterilization of laboratory equipment. The dry heat sterilization process is developed by Louis Pasteur to sterilize the equipment using the hot air ovens. Dry heat sterilization is the heating process in which the material which is placed inside the oven has the characteristics which will not melt, catch fire or changes its form while heating at high temperature. A hot air oven is a laboratory instrument that uses dry heat to sterilize laboratory equipment and other materials. That equipment cannot be wet or material that will not melt, catch fire, or change form when exposed to high temperatures are sterilized by using the dry heat sterilization method. Hot air oven also known as forced air circulating oven. Some examples of material which can not be sterilized by employing a hot air oven such as surgical dressings, rubber items, or plastic material.

Figure 1: Hot air ovens

To destroy microorganisms and bacterial spores, a hot air oven provides extremely high temperatures over several hours. The widely used temperature-time relationship in hot air ovens to destroy microorganisms are 170 degrees Celsius for 30 minutes, 160 degrees Celsius for 60 minutes, and 150 degrees Celsius for 150 minutes. Most of the medical industries use hot air ovens to sterilize laboratory instruments and material due to its simple standard operating procedure and low price. It also provides quick-drying processes. The process of dry heat sterilization using a hot air oven Originally developed by Louis Pasteur. The temperature range of a hot air oven is 50 to 300 ° C. It can be controlled by using a temperature regulator. The forced air circulation provided by the oven ensures the temperature uniformity throughout the oven. In a hot air oven first, the surface of the material is sterilized then the temperature slowly enters the center of the item.

2. Working Principle of Hot air oven/Hot air oven principle

The hot air oven is based on the principle method of dry heat sterilization. Since conduction is the basis of dry heat sterilizations, thus the temperature first reaches the surface of the material to be sterilized, and then it gradually moves towards the core of the material. Thus, dry heat sterilization makes sure to sterilize every part of the material. Then, the whole material gets a uniform supply of heat, and if this heat is employed for a certain amount of time, then it helps in the sterilization of all different kinds of microorganisms, such as bacteria, viruses, fungi, and even the resistant Endospores, which escape most of the sterilization procedures.

Dry heat sterilizes the material by inducing oxidizing the particles inside it and damaging their primary component, which results in the ultimate death of the organism. Usually, the temperature that is set for efficient sterilization is about an hour. Since hot air is lighter than cold air, thus increasing the temperature inside the chamber results in the flow of hot air up to the roof of the chamber while cold air comes down. Thus, it facilitates the circulation of hot air inside the chamber.

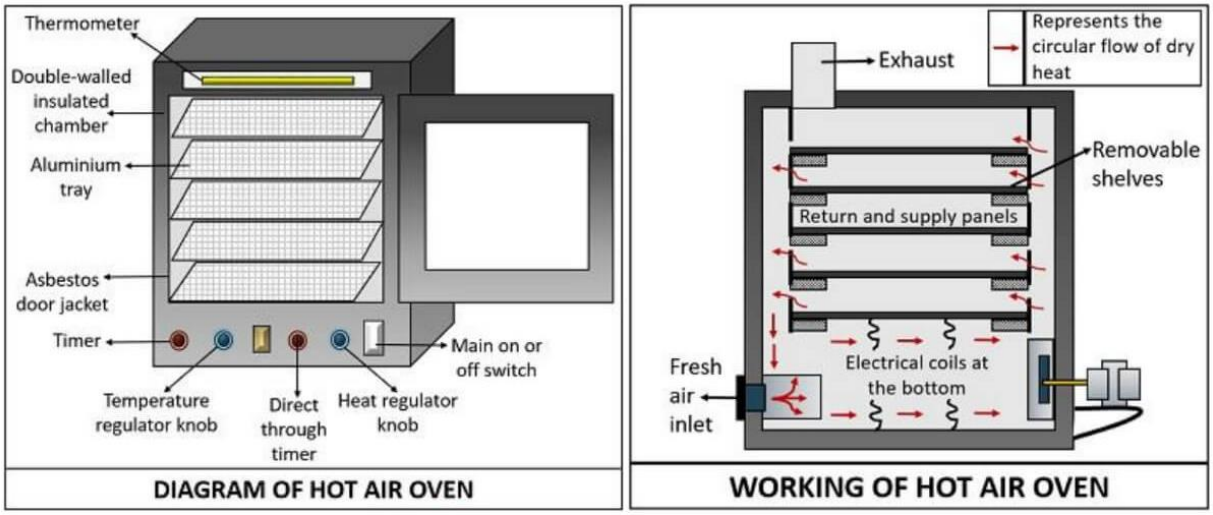

Figure 2: Working principle of hot air oven

الوحدة السابعة - المحاضرة السابعة - الزمن: 120دقيقة

أهداف المحاضرة السابعة:

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موضوعات المحاضرة السابعة:

Ovens – part 2

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
7	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

3. Parts/ Components of Hot Air Oven

There are many components of hot air oven as follow:

- **External cabinet:** It is made up of stainless steel, and it also covers the inner chamber.
- **Glass wool insulation:** Glass wool is fitted between the inner and external chamber, which provides insulation to the system.
- **Inner cabinet:** This is also made up of stainless steel, and the material to be sterilized is kept inside it.
- **Tubular air heaters:** Heat inside the inner chamber is created using tubular air heaters, and they usually present in a pair of two on each side of the inner chamber.
- **Motor-driven blower:** It helps in the uniform circulation of the hot air within the chamber.
- **Temperature sensor:** It is a temperature display present on the screen which measures the inside temperature of the chamber.
- **Tray slots:** They are used to hold multiple trays.

- **PID temperature controller:** during the entire cycle of circulation of hot air, this temperature controller helps in maintaining the accurate temperature. It also helps in controlling the temperature and displays it on screen.
- **Load indicator:** Indicates the overload of material inside the chamber.
- **On/off switch:** helps turn the hot air oven on/off.
- **Safety thermostat:** aka over-temperature protection device, which helps keep the oven and specimen inside it safe in case of any malfunctioning, thus avoiding damage.

4. Types of hot air oven

There are present different types of hot air oven such as;

a) Gravity Convection: Gravity Convection Air is distributed by spontaneous convection. As hot air flows up, a gentle flow holds temperatures moderately uniform inside a container and wholly uniform in any distinct position.

b) Forced Convection Ovens: These ovens carry a fan that gives limited air circulation within the heating container. This method provides very fast heat up and restoration times, mixed with especially low-temperature differences inside the working chamber. Flexible vents and semi-forced exhaust deliver it a conventional sample-drying oven.

c) Mechanical Convection: Mechanical Convection is a gravitation convection oven served with a re-circulating fan in a working container.

d) Forced Exhaust Ovens: In these ovens, air is pushed into the working container by a fan and scattered through an adaptable vent. This variety of oven is especially helpful in purposes where the heating process provides vapors or fumes that require to be immediately and continuously discharged from the working container. All of the forced air ovens consume at a higher percentage than a convection oven. Though, much larger forced exhaust velocities can be accomplished by adding an air channel and a flexible outlet. This adjustment takes an extra $100 and is totally achievable with forced convection ovens.

e) Side Draught Ovens: Certain ovens produce airflow from one side to the other i.e. left to right. Speedy heat up and restoration time make this type of oven prototype for preheating plastic cloths(hospitals, etc.) or any profession where smooth sheets or plates are used.

5. The uses of hot air oven

There are many application and uses of hot air oven such as:

- **Annealing:** The process of annealing involves heating and then cooling material, such as glass or steel, in order to reduce hardness and increase ductility. High-temperature ovens are used in this process, often in the application of metallurgy, medical device manufacturing and material science industries. These annealed materials can be cut and shaped more readily to be used in the production of things such as syringes and catheters.

- **Die-bond curing:** Through a combination of drying and baking, lab ovens cure substances in order to harden their chemical composition. This is a means of creating epoxies, glues, plastics and rubbers used in polymer research, nanotechnology and semiconductor industries. The increased bond strength is also exceptionally useful in adhering components directly onto circuitry, many of which are used in military, space and medical systems.

- **Drying:** A necessity for many environmental, biological and clinical labs; gravity convection, forced air and vacuum ovens are used in the drying of samples to remove moisture from them. Forced air and vacuum ovens are best suited to samples that are easily broken down, as these remove moisture and lower the boiling point of water, letting the sample to be dried at a lower temperature. Gravity convection ovens, meanwhile, are often used to dry fine particles as these are liable to scatter with high air flow and need a more natural airflow in order to protect these delicate samples.

- **Polyimide baking:** Added to the oven in liquid form, the polyimide is then thermally baked to create a thin film or a layer for various uses, including stress buffer coating for redistribution layers, adhesion, chip bonding and much more.

- **Sterilising:** At their most basic, laboratory ovens can also be used to sterilise lab equipment and glassware. Carried out in a hot air oven, the ideal temperature needs to be at least 160°C, with contents monitored at this heat for 45 to 60 minutes. A slow cooling period is needed, as removing items from the oven straight away can cause them to crack, while the gradual cooling prevents potentially harmful air, containing contaminating organisms, from entering the oven. Additionally, all items that need to be sterilised also have to dry – using a temperature of 60°C is thought to be acceptable when routinely using glassware.

- **Other uses:** Additionally, lab ovens are employed to perform material testing, analysing attributes such as determine tensile strength, deformation and resiliency of manufactured products, solder strength in circuit boards and more. Lab ovens are also used in biological, forensic and environmental labs where their uses are more specialised. In forensic labs, specially configured vacuum ovens are used to develop fingerprints, while biological labs use gravity convection ovens to remove microbiological contaminants in lab equipment, along with vacuum ovens in order to adhere substrates to the surface of filters. Elsewhere, environmental laboratories weigh specimens before and after drying to determine their moisture content.

6. Advantage and disadvantage of hot air oven

There are many Advantage and disadvantage of hot air oven as follow:

- **The advantages:**
  - No need to water to sterilize the material.
  - Not much pressure is created like autoclave which creates it easy to manage and also makes it safer to work with.
  - In a laboratory environment, it is more fitting to use as compared to other sterilizers.
  - Hot air oven is much smaller in size as compared to autoclaves and also more effective.
  - A hot air oven can be more speedy than an autoclave and higher temperature can be achieved as compared to other means.
  - The operating procedure is simple as compared to other sterilization methods
  - Its price is low as compared to autoclave.

- **The disadvantages**
  - It is unable to sterilize some living organisms, such as prions, because it uses dry heat rather than using wet heat because it uses the principle of thermal inactivation by oxidation.
  - Surgical dressings, rubber items, or plastic materials are some of the materials that do not fit with a hot air oven because they can melt down even at lower temperatures.

الوحدة الثامنة - المحاضرة الثامنة - الزمن: 120 دقيقة

أهداف المحاضرة الثامنة:

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موضوعات المحاضرة الثامنة:

Autoclave – part 1

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
8	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

1. Introduction

It is always a danger to health working in a microbiology or pathology lab. In such laboratories where lots of work goes on with bacteria and virus, or possibly infected materials, the need for sterilization is paramount. The slightest chance of contamination from a 'dirty' apparatus can shut down a whole lab, and – let's hope not – get someone deadly sick. This is where an autoclave comes in very handy. Bacteria and viruses and living or semi-living things and as such, they can live within very specific boundaries only in specific environments. Unlike the glass beaker that held some bacteria culture, they won't survive at high temperatures and pressure. And that is the environment you can create within an Autoclave – very unfriendly to any kind of microorganism. Autoclaves are also known as steam sterilizers, and are typically used for healthcare or industrial applications. An autoclave is a machine that uses steam under pressure to kill harmful bacteria, viruses, fungi, and spores on items that are placed inside a pressure vessel. The items are heated to an appropriate sterilization temperature for a given

amount of time. The moisture in the steam efficiently transfers heat to the items to destroy the protein structure of the bacteria and spores.

Figure 1: Autoclaves

The steam digester, a prototype of the autoclave that is better known now as a pressure cooker, was invented by French-born physicist Denis Papin in 1679.1 It wasn't until 1879 that the French microbiologist Charles Chamberland created a new version called the autoclave to be used in medical applications. The science of disinfection and sterilization began in 1881 with the research of Robert Koch on the disinfecting properties of steam and hot air. He demonstrated the greater power of penetration exhibited by moist heat (steam) compared to dry heat. Finally, in 1933 modern autoclave technology was introduced with the first pressure steam sterilizer that controlled performance by measuring the temperature in the chamber drain line (thermostatic trap). Prior to this date, pressure was the sole indication of control with no means to verify temperature or air elimination. Over time, new autoclave technology has been developed including pre-vacuum cycles in 1958, and steam-flush pressure-pulse in 1987 allowing the science to evolve into the autoclaves, or steam sterilizers, used in hospitals today.

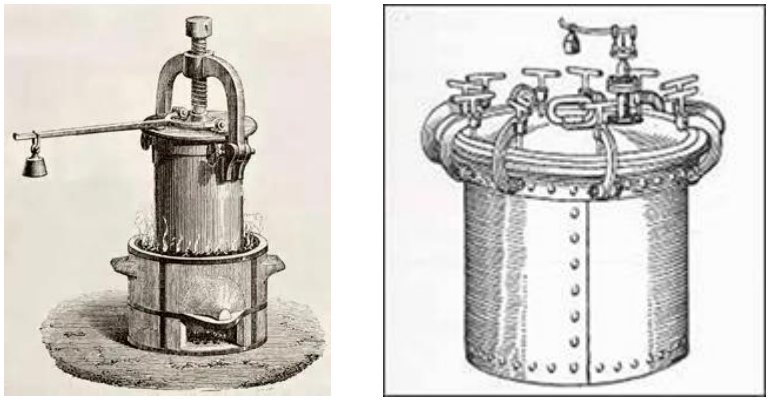

Figure 2: The first steam sterilizer built in 1880 by Charles Chamberland

2. The principle of an autoclave

The autoclave works on the principle of moist heat sterilization where steam under pressure is used to sterilize the material present inside the chamber. The high pressure increases the boiling point of water and thus helps achieve a higher temperature for sterilization. Water usually boils at 100°C under normal atmospheric pressure (760 mm of Hg); however, the boiling point of water increases if the pressure is to be increased. Similarly, the high pressure also facilitates the rapid penetration of heat into deeper parts of the material, and moisture present in the steam causes the coagulation of proteins causing an irreversible loss of function and activity of microbes.

This principle is employed in an autoclave where the water boils at 121°C at the pressure of 15 psi or 775 mm of Hg. When this steam comes in contact with the surface, it kills the microbes by giving off latent heat. The condensed liquid ensures the moist killing of the microbes. Once the sterilization phase is completed (which depends on the level of contamination of material inside), the pressure is released from the inside of the chamber through the whistle. The pressure inside the chamber is then restored back to the ambient pressure while the components inside remain hot for some time.

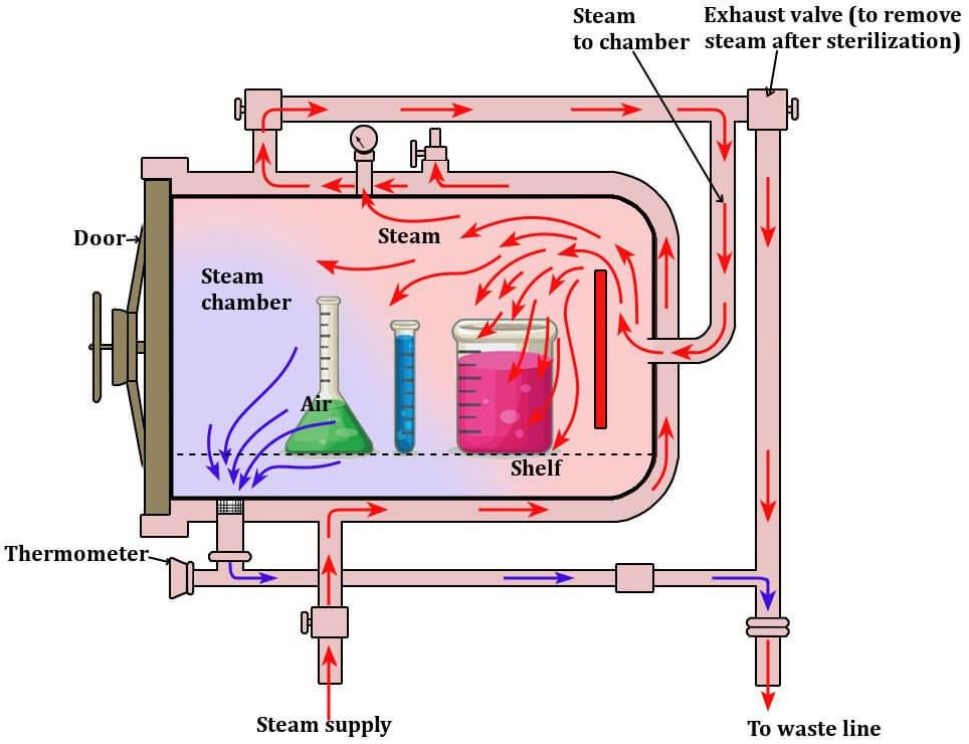

Figure 3: The principle of an autoclave

الوحدة التاسعة - المحاضرة التاسعة - الزمن: 120 دقيقة

أهداف المحاضرة التاسعة:

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موضوعات المحاضرة التاسعة:

Autoclave – part 2

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
9	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

Procedure for running an autoclave

In general, an autoclave is run at a temperature of 121°C for at least 30 minutes by using saturated steam under at least 15 psi of pressure. The following are the steps to be followed while running an autoclave:

- Before beginning to use the autoclave, it should be checked for any items left from the previous cycle.
- A sufficient amount of water is then put inside the chamber.
- The materials to be sterilized are placed inside the chamber.
- The lid is then closed, and the screws are tightened to ensure an airtight condition, and the electric heater is switched on.
- The safety valves are adjusted to maintain the required pressure in the chamber.
- Once the water inside the chamber boils, the air-water mixture is allowed to escape through the discharge tube to let all the air inside to be displaced. The complete displacement can be ensured once the water bubbles cease to come out from the pipe.

- The drainage pipe is then closed, and the steam inside is allowed to reach the desired levels (15 lbs in most cases).
- Once the pressure is reached, the whistle blows to remove excess pressure from the chamber.
- After the whistle, the autoclave is run for a holding period, which is 15 minutes in most cases.
- The electric heater is switched off, and the autoclave is allowed to cool until the pressure gauge indicates the pressure inside has lowered down to that of the atmospheric pressure.
- The discharge pipe is then opened to allow the entry of air from the outside into the autoclave.
- Finally, the lid is opened, and the sterilized materials are taken out of the chamber.

4. Types of Autoclave

There are different types of autoclaves present in the market, some of which are:

- **Pressure cooker type/ Laboratory bench autoclaves (N-type):** These, as domestic pressure cookers, are still in use in many parts of the world. more modern type has a metal chamber with a secure metal lid that can be fastened and sealed with a rubber gasket It has an air and steam discharge tap, pressure gauge, and safety valve. There is an electric immersion heate at the bottom of the chamber.

- **Gravity displacement type autoclave:** This is the common type of autoclave used in laboratories. In this type of autoclave, the steam is created inside the chamber via the heating unit, which then moves around the chamber for sterilization. This type of autoclave is comparatively cheaper than other types.

- **Positive pressure displacement type (B-type):** In this type of autoclave, the steam is generated in a separate steam generator which is then passed into the autoclave. This autoclave is faster as the steam can be generated within seconds. This type of autoclave is an improvement over the gravity displacement type.

- **Negative pressure displacement type (S-type)**: This is another type of autoclave that contains both the steam generator as well as a vacuum generator. Here, the vacuum generator pulls out all the air from inside the autoclave while the steam generator creates steam. The steam is then passed into the autoclave. This is the most recommended type of autoclave as it is very accurate and achieves a high sterility assurance level. This is also the most expensive type of autoclave.

Figure 4: Types of Autoclaves

5. Construction/Parts of Autoclaves

The autoclave is made of following components/parts:

- **Vessel/pressure chamber:** The vessel is made from stainless steel. The inner chamber is protected by outer jacket. The inner chamber is the place where we keep the autoclavable material for sterilization. The size of the chamber varies and selected based on the motive of use.

- **Heater:** The electric heater is placed beneath the chamber. The electric heater working principle is similar to geezer. The electric heater start heating it causes boiling of water. The

user need to maintained the water level as per the marking. Less water may cause burning and more water may lead to enter water in the experimental material.

- **Lid/Door:** The Vessel mouth is covered by lid or door. It is also made from stainless steel. The lid allows trapping and retaining the heat and pressure inside the chamber and producing favorable environment for sterilization. The lid is tightly closed with the help of airtight screw.

- **Pressure gauge:** It is present on the upper surface of lid. Its function is to indicate the level of pressure that is produced during autoclaving. It is vital part because it allows us to visually see the rise of pressure and alert for any forthcoming mishap hence it ensures the safety.

- **Pressure releasing unit/whistle:** The whistle is placed on top of the surface of the lid, just like pressure cooker. The whistle allows us to release the pressure whenever required.

- **Safety Valve:** It is present on the surface of the lid. Their function is to avoid catastrophic accident especially when pressure inside the chamber is uncontrollable.

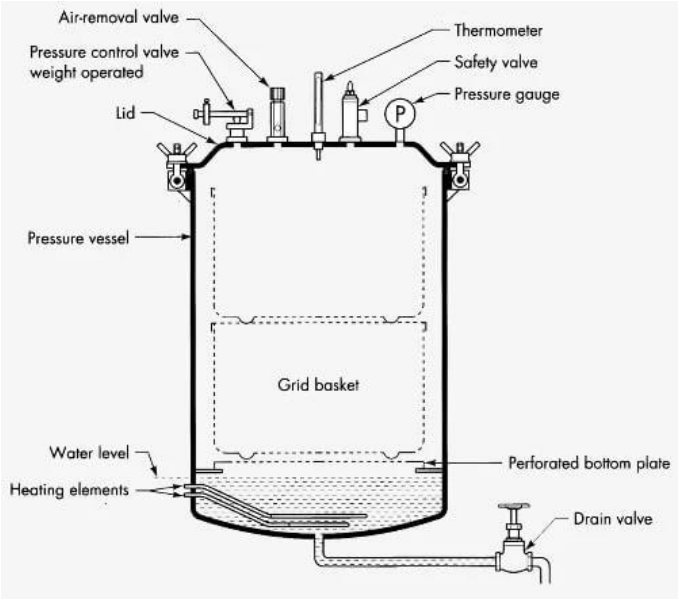

Figure 5: Construction/Parts of Autoclaves

6. Materials Are and Aren't Autoclavable

An autoclave is an effective way to sterilize equipment, tools, and certain chemicals. However, not all materials can be autoclaved. Therefore, before autoclaving, ensure the material or items can withstand high temperatures and pressure.

- **Autoclavable materials:**
  - **Glass:** Only autoclave pyrex or pyrex type glass materials. Therefore, before purchasing, ask the vendor about the glass material.
  - **Metals:** Most metals available in labs can withstand an autoclave environment.
  - **Polypropylene-made items:** It's an autoclavable inexpensive resin used to make different bags, trays, and pans.
  - **Plastic items:** Not all plastics are autoclave safe. Other than products made from polypropylene (PP) and polypropylene copolymer (PPCO), items made from fluoropolymers, such as Teflon PFA, FEP, or ETFE, can be autoclaved
  - Autoclave polycarbonate items with caution. Do not expose them to steam additives and alkaline detergents. Also, they can only withstand 30-50 autoclaving cycles. However, you should note that sterilizing these materials reduces their mechanical strength.
  - Media solutions, paper and latex gloves placed in biohazardous autoclave waste bags, surgical tools, contaminated solid items, water, hospital linens, and animal food and bedding are autoclavable.

- **Non-autoclavable materials:**
  - Do not autoclave the plastic materials made from HDPE, LDPE, PET, and PETG resins. They can melt and damage your autoclave – instead, sterilize these materials with gas (ethylene oxide formaldehyde).

- Paper is a combustible substance, so it should not be directly autoclaved. It might catch fire.
- Do not sterilize water-proof or water-resistant materials like powders and oil with an autoclave.

- Never autoclave materials that are flammable, toxic, and corrosive (such as phenol, ether, trichloroacetic acid, and chloroform).

- Do not sterilize household bleach or chlorine-based (or chlorine-containing) products, radioactive materials, acids, low-density (LDPE) and high-density polyethylene (HDPE), materials contaminated with chemotherapeutic agents, or paraffin-embedded tissue using the autoclave.

7. Industrial Autoclaves VS. Medical Autoclaves

Autoclaves may be used in a variety of industrial and medical applications. Industrial autoclaves are used in manufacturing environments to process parts and materials using heated steam and pressure: for example, in the manufacturing of pressure treated woods and specialized rubbers used in the tires of your car. Autoclaves are also used in the scientific research and pharmaceutical industries – beyond sterilizing equipment used in laboratory research most autoclaves come equipped with a liquid cycle to sterilize liquids used in laboratory environments.

Medical steam sterilizers are used in healthcare environments for the sterilization of heat and moisture-stable items such as surgical instruments, implanted medical devices and surgical drapes and linens. The cycles used in medical steam sterilizers are developed and validated according to recognized industry standards. In the United States, steam sterilizers used in healthcare must be cleared for use by the Food and Drug Administration for the sterilizer manufacturer's stated intended use.

الوحدة العاشرة - المحاضرة العاشرة - الزمن: 120 دقيقة

أهداف المحاضرة العاشرة:

يتوقع في نهاية الجلسة أن يكون الطالب قادراً على معرفة ماهو Diathermy Therapeutic واستخداماته وطرق تشغيله.

موضوعات المحاضرة العاشرة:

Therapeutic Diathermy – part 1

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
10	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

Introduction:

While it was recognized several thousand years ago that hot baths were therapeutic, it was not until the mid 1980's that the pain relieving properties of heat were somewhat understood. Two primary therapeutic effects take place in the heated area; there is an increase in metabolism resulting in relaxation of the capillary system (vasodilatation), and there is an increase of blood flow, which moves in to cool the heated area. The relaxation and increased blood flow are beneficial to damaged tissue. The physical methods of producing heat in the body are:

1. Conductive heating
2. Infrared (IR) radiation heating
3. Radio wave heating (Diathermy) and
4. The ultrasonic wave heating

The conductive method is based on the physical fact that if two objects of different temperatures are placed in contact, heat will transfer by conduction from the warmer object to the cooler one. The total heat transferred will depend upon the area of contact, the temperature difference, the time of contact and the thermal conductivity of the materials. Hot baths, hot packs, electric heating pads, and occasionally hot paraffin applied to the skin heat the body by conduction. Conductive heat transfer lead to local surface heating since the circulating blood effectively removes the heat that penetrates deep into the tissue.

Applications

Conductive heating is used in treating conditions such arthritis, neuritis, sprains and strain, contusions, sinusitis and back pain.

Radiant heat is (IR) is also used for surface heating of the body. This is the same form of heat we feel from the sun or from an open flame. The IR wave lengths are between 800 nm and 40000 nm (1 nm = 10^{-9} m). The waves penetrate the skin about 3mm and increase the surface temperature. Excessive exposure cause reddening (erythema) and sometime swelling (edema). Very prolonged exposure causes browning or hardening of the skin. Radiative heating is generally used for the same conditions of the conductive heating, but it is considered to be more effective because the heat penetrates a bit deeper.

When alternating electric current passes through the body, various effects such as heating and electric shock take place. The amount of heat that can be transferred to the body by electrical diathermy increases as the frequency of the current increases.

Method of generation Infrared:

1. By putting tungsten wire inside a steel tube insulated internally to prevent the touch wire with the tube.
2. By putting tungsten wire inside glass tube, like electric heaters used in buildings.

Heater power= P= IV

$= I^2R = V^2/r$

Where:

I= current in Ampere (A)

V= voltage across the heater in volt (V)

R= heater resistance in ohm (Ω)

Example: Calculate the power and current in glass tube IR heater having r=20Ω, used on line voltage = 220v, 50 Hz.

Solution:

$P=V^2/R$

$= (220)^2/ 20 = 2420$ watt

I= V/R

=220/20 = 11 Amp.

Diathermy:

The use of frequencies near 30 MHz for heating is called short-wave diathermy. Long wave diathermy, at frequencies near 10 KHz was used, but this has become obsolete. In 1951, a mode of diathermy that uses microwaves of a frequency of 2450 MHz was introduced. Microwaves are used in radar and in microwave ovens.

Heat from diathermy penetrates deeper into the body than radiant and conductive heat. It is thus useful for internal heating and has been used in the treatment of inflammation of the skeleton, bursitis, and neuralgia.

الوحدة الحادية عشر – الحادية عشر - الزمن: 120 دقيقة

أهداف المحاضرة الحادية عشر:

يتوقع في نهاية الجلسة أن يكون الطالب قادراً على معرفة ماهو Diathermy Therapeutic واستخداماته وطرق تشغيله.

موضوعات المحاضرة الحادية عشر:

Therapeutic Diathermy – part 1

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
11	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

Short Wave Diathermy:

Short wave diathermy heats the deep tissues of the body. It has been used in relieving muscle spasms; pain from protruded inter vertebral discs, degenerative joint disease, and bursitis, and as a deep heating agent for joints with minimal soft tissue coverage such as knee, elbow, and ankle.

In short-wave diathermy, two methods are used to get the electromagnetic energy into the body; **the capacitance coupling method** and **inductance coupling method.**

Capacitance Coupling Method In both methods, the body part to be heated becomes a part of a resonant electrical circuit.

- A simple resonant circuit consists of a capacitor and an inductor.
- Electrical energy from a power supply flows back and forth between the capacitor and the inductor, thus providing an alternating electric field (or current).

- In the capacitance coupling method of short wave diathermy, the tissue to be heated is placed between two capacitor plates that have an oscillating electric field across them (Fig. 1).
- The changing electric field forces the ions in the tissue to move back and forth; they thus acquire kinetic energy, part of which is dissipated when the ions collide with molecules in the tissue.
- The heat produced when the energy is dissipated depends approximately on the square of the current times a constant determined by the tissue properties. This type of energy loss is called joule (resistive) heating.

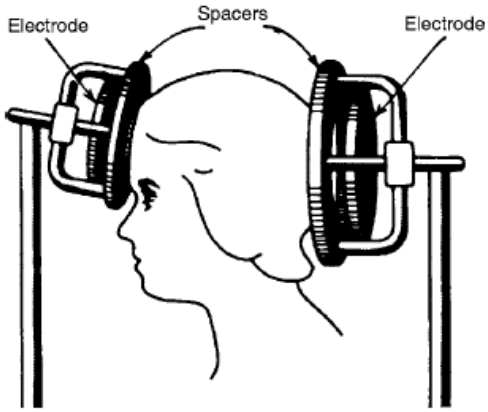

Fig.1. Location of capacitive coupling electrodes for short wave diathermy of the head.

Inductance coupling Method

In inductive diathermy, the portion of the body to be heated is placed within or near the inductor (Fig. 2). A 30 MHz current in the coil produces an alternating magnetic field in the tissue that produces eddy current in it. The energy lost by eddy currents appears as heat in the tissue.

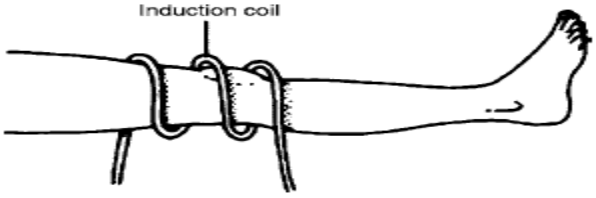

Fig. 2. Location of inductive coupling coil for short wave diathermy of the leg.

** Eddy current: are electric currents induced within conductors by a changing magnetic field in the conductor. These circulating eddies of current have inductance and thus induce magnetic fields. These fields can cause repulsion, attraction, propulsion, drag, and heating effects.

Applications of Short wave Diathermy

Short -wave diathermy is used in the treatment of bursitis, arthritis, traumatic injuries, strains, and sprains. However, it does have a limitation, when short-wave diathermy is used on muscle tissue surrounded by a fatty layer; a disproportionate amount of energy is lost in the fat.

While short- wave diathermy is a much better heater of deep tissue than the hot baths, or infrared lights, it is far from ideal because of the large amount of energy deposited in surface fatty layers. For this reason microwave diathermy is frequently employed.

Pad Electrodes have great current density in the superficial tissues with spread of current in the deeper tissues. So this type of electrodes must be put on the body and the distance between two electrodes must be more than 7 cm.

Cuff Electrodes cause deeper heating but they are applicable only for limbs and not for body region.

Electrodes separated from tissue by an insulting ring are to transfer the radio frequency (RF) energy through the air-gap. The air - gap acts as a coupling capacitance.

Cable Wrap A few turns wrapped causes inductive heating.

Pancake coil is used for flat body parts.

Fig. 3 shows various types of electrodes used in diathermy Units.

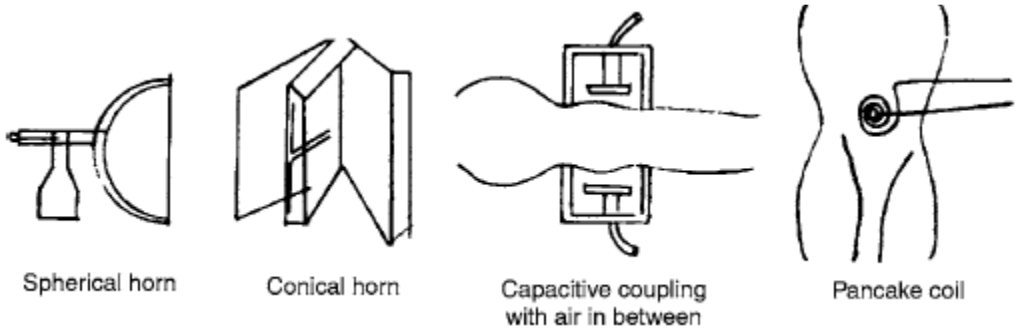

Fig. 3. Various methods of application of physiotherapy in diathermy**.**

Microwave diathermy:

- Microwave diathermy, is another form of electromagnetic energy, is usually easier to apply than short wave diathermy.
- We are all aware of the tissue heating ability of microwave home ovens; microwave diathermy developed out of radar research in 1940s.
- The microwaves are **produced** in a special tube called **magnetron** and are then emitted from the applicator (antenna).
- The antenna is usually designed so that it can be placed several inches from the region to be treated.
- The microwaves from the antenna penetrate deep into the tissues, causing a temperature rise and deep heating.
- Microwave diathermy is used in the treatment of fractures, sprains, bursitis, injuries to tendons, and arthritis.
- The frequency used in microwave is 2450 MHz because this frequency was the one available after World War II. This is unfortunate since later research has shown that a frequency closer to 900 MHz would be more effective in therapy, causing more uniform heating around bony regions.
- Like light waves, microwaves can be transmitted, reflected or refracted at a surface, and absorbed by a medium.

الوحدة الثانية عشر – الثانية عشر - الزمن: 120 دقيقة

أهداف المحاضرة الثانية:

يتوقع في نهاية الجلسة أن يكون الطالب قادراً على معرفة ماهو Wax Bath واستخداماته وطرق تشغيله.

موضوعات المحاضرة الثانية عشر:

Wax Bath

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
12	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

Introduction:

Its medical instrument used water as a media of heat transmission. Is one of the devices the task used in physical therapy wide spread and includes the joints of the body and uses the principle of latent heat through the wax of the type which is a special wax (paraffin), which is a special kind of prefer to use because it is gaining heat slowly and lose it slowly and to keep the parties and parts warm to allow for the place.

The parts of wax bath:

1. Mechanical part.
2. Electric part.

1. Mechanical Dirt:

1. The Coat.
2. Fiber glass:
3. The external form (wax container) .

4. The chamber.
5. The shelves (mesh).
6. Drain.

1. **The coat** : The coat is made of aluminum or stainless steel because resisting the mechanical shocks, resisting the oxidation & rectangle solid shape to be easily placed anywhere. The coat consists of several surfaces an isolator material prevents heat from getting outside.

2. **Fiber glass**

There are two type of it first:

a) Brown fiber glass: be somewhat cheap, but it is a dangerous substance because it causes inflammation' in the chest should be wary of dealing with.

b) Yellow fiber glass:

Available by many and is also a serious but less dangerous than brown, because the sensitivity and cause him to be careful to wear gloves. The advantage of fiberglass good insulator of heat and use it in your wax bath due to lack of access of heat from inside the device to the outside and maintain the internal temperature, [very bad conduction heat so it is suitable for heat insulation purpose].

3. **Wax container** : It is a container containing wax[paraffin wax] used in the treatment process and is made of stainless steel and be mobile in order to ease switch to different parts of the body.

4. **The chamber**: The chamber is completely made of aluminum or stainless steel, rectangular solid shape to suit dealing with various objects, it has thermally insulated from all other part It also contains a container of water must be distilled water because it contains salt which is responsible for melting the wax and keep it in a liquid state by heating the water by heater.

5. **The shelves (mesh)**: The mesh is made of aluminum or steel it contains of group of holes to increase thermal conductivity.

6. **Drain:** It is water regulator (tube), used to vacuum the water from the chamber, it is used as manually maintenance or calibration to remove the waste water or uncomforted table water.

2. **Electric part**:

1. The power supply.
2. The heater.

3. Thermostat.

4. Temperature indicator (thermometer).

5. Timer.

6. Fuses.

7. Control panel.

1. **Power supply**: The used supply in dry sterilized wax bath is 220v — 50Hz the step down transformer and rectifying circuit (AC to DC convert) To run the control panel if the parameters, numeric or other departments in the modern fashion .

2. **The heater**: The electric heating system is the system in which heating produce by rising of temperature caused by the passing of electric current through a conductor having a high resistor to current flow, it is only placed in base of the instrument.

3. **Thermostat**: Is a sensor of heat connecting directly with heater and the separation of heater in certain degrees so as to obtain the temperature we need as needed and also used to protect the device.

4. **Temperature indicator**. Tows way are used in temperature indicator there are thermometer and thermocouple & Identified for the internal temperature.

5. **Timer:** There are two type of timer electrical or mechanical at range 5-60 min given period of time required for sterilization.

6. **Fuse:** To protect the circuit from high current, high loads ,short circuts..

7. **Control panel**:

Contains several elements and the most important about indicator power lamp usually green & indicator heater lamp usually red & contain switch on-off and timer & knob.

• **There are three reasons to select paraffin wax**:

1. The wax vaporizes in very high temperature.

2. The wax considers low electric connectivity material.

3. The waxes miss the heat slowly& the wax keeps the heat to possible long time (20-30 minute).

Method of treatment:

1. Remove watch and rings, in the treatment area, if rings can not be removed, cover them with several thicknesses of gauze and hold the gauze in place with masking tape.

2. Protect the patient clothing from the paraffin because it causes skin scrape (sensitivity),

3. Explain to the patient that the paraffin will feel hot, but it not burn.

4. Inspect the part to be treated:

a) The skin must be clean into the contaminate the tank. If it is not clean, the patint must be wash it with soap and water.

b) The skin must be dry and free from perspiration because it may cause burn.

c) The skin must be freefrom draining lesions, rashes and scrathes which must be covered by gauze.

Advantage of wax bath:

1. Fast, acting, drug, free heat therapy.

2. Proven effective to smooth pain and stiffness.

3. Effective on arthritis, joint stiffness, muscle spasms, dry cracked skin and more.

4. Versatile, safe, and easy to use.

Disadvantage of wax bath:

1. Sedimentation occurs at the bottom of the bath, the bath must be cleaned regularly at least twice a year.

2. Contamination of the wax by atmospheric dust may occurs unless the lid covers it when not use.

Faults & repair:

Which is a few faults due to the lack of electrical parts in the device because it does not contain many electronic parts and faults in this device is (heater -thermostat - sensitive — switch on/off - fuse) and the repair is to replace damaged parts .

About wax bath:

The principle of operation of the device is heating water and the way you are melting wax is used in physical therapy and treatment is a natural by immersion may not be possible in some places access to the immersion are used way Spilling the places to be treated or using the brush to get to difficult places and prefer to use paraffin wax so as to acquisition of the heat slowly and the loss of slowly making it a good treatment of the joints to keep them warm for a long time that the treatment of the wax up (approximately 54 C) .

الوحدة الثالثة عشر - المحاضرة الثالثة عشر - الزمن: 120دقيقة

أهداف المحاضرة الثالثة عشر:

يتوقع في نهاية الجلسة أن يكون الطالب قادراً على معرفة ماهو WATER DISTILLATION واستخداماته وطرق تشغيله.

موضوعات المحاضرة الثالثة عشر:

WATER DISTILLATION – part 1

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
13	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

Distillation: is a separation process that involves heating a liquid to its boiling point, transferring the vapour to a different portion of the apparatus, then condensing the vapour and collecting the condensate in another container. This technique is one of the most useful for separating a mixture of liquids when the components have different boiling points. Industrially, distillation is the basis for the separation of crude oil into the various, more useful hydrocarbon fractions. Chemically, distillation is the principal method for purifying liquids (e.g. samples, or solvents for performing reactions). Successful distillation depends on several factors, including the difference in boiling points of the materials in the mixture, and therefore the difference in their vapour pressures, the type of apparatus used, and the care exercised by the experimentalist

Distillation of a Pure Liquid

A pure liquid has a constant boiling point as long as liquid and vapour are in equilibrium. In a simple distillation of a pure substance, as the temperature rises, the vapour pressure increases.

As the vapour expands, it passes out of the heated portion of the apparatus until it comes into contact with the cold surface of the water-cooled condenser. When the vapour is cooled, it condenses and passes down the condenser into the receiver

How Does Distillation Work?

Distillation works by exploiting the different boiling temperatures of liquids. To separate two or more liquids by distillation, you first heat them in a flask. The more volatile liquid (the liquid with the lower boiling point) will typically evaporate first and the vapor will pass into a condensing column, where it can revert into a liquid (condense) on the cool glass where it trickles into a collection flask. Heating further will cause the less volatile liquids to evaporate and distill at higher temperatures. The two main kinds of distillation are simple distillation and fractional distillation, and both are used widely.

الوحدة الرابعة عشر - المحاضرة الرابعة عشر - الزمن: 120دقيقة

أهداف المحاضرة الرابعة عشر :

يتوقع في نهاية الجلسة أن يكون الطالب قادراً على معرفة ماهو WATER DISTILLATION واستخداماته وطرق تشغيله.

موضوعات المحاضرة الرابعة عشر:

WATER DISTILLATION – part 2

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
14	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

Simple Distillation

The setup for a simple distillation is shown in Figure 1. A simple distillation apparatus consists of a boiling flask (round-bottom flask) attached to an adapter holding a thermometer (to determine the boiling temperature of the liquid). The adapter connects to a condenser into which cold water is constantly passed through. The condenser leads into a collection flask for the purified liquid.

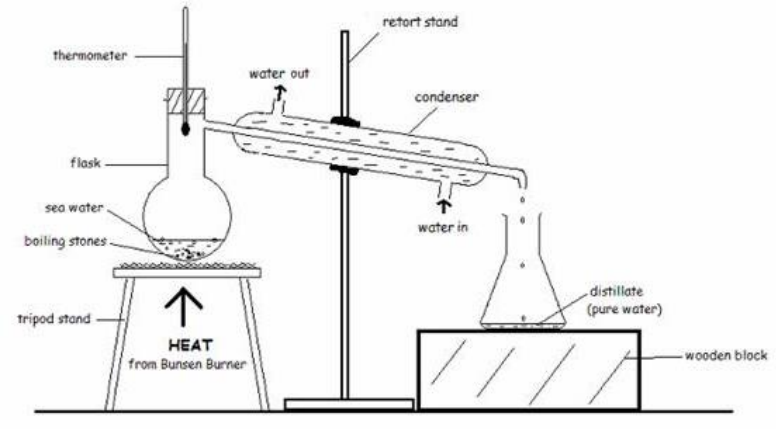

Figure 1: Simple distillation Apparatus

Fractional Distillation

Fractional distillation is essentially the same as simple distillation except that a fractionating column is placed between the boiling flask and the condenser. The fractionating column is usually filled with glass or plastic beads. These beads improve the separation between the liquids being distilled. The reason that fractional distillation gives better separation between the liquids is because the glass beads in the fractionating column provide "theoretical plates" on which the refluxing liquid can condense, re-evaporate, and condense again, essentially distilling the compound over and over. The more volatile liquids will tend to push towards the top of the fractionating column, while lower boiling liquids will stay towards the bottom, giving a better separation between the liquids. Of course, the more theoretical plates that you add to a column (the more surfaces or beads), the longer the distillation will take (typically), and the more energy required to keep reevaporating liquid in the fractionating column (this is more of a concern in industrial distillations than in an academic lab where energy cost is not a major cause for worry).

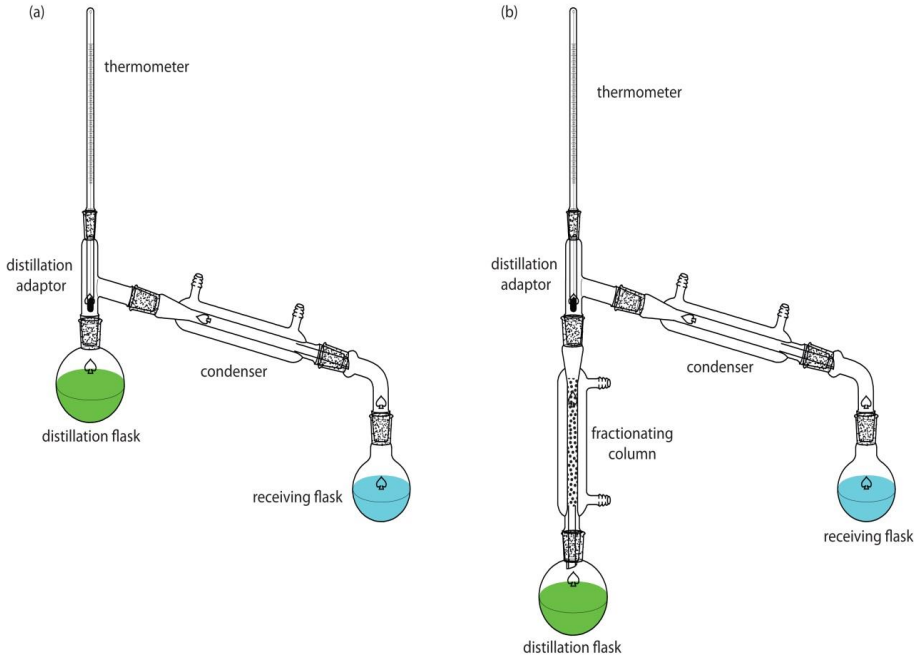

Figure 2: (2) Simple Apparatus (b) Fractional Apparatus

The choice of whether to use fractional distillation or simple distillation depends on the two liquids being separated. Typically, using simple distillation is preferrable because the apparatus is, well, simpler, and a simple distillation typically goes faster than a fractional distillation (and requires less energy). On the other hand, fractional distillation gives better separation between the liquids. The choice of whether to use simple or fractional distillation, then, depends usually on the difference in boiling temperatures between the two liquids. If there is a large difference in the boiling points (>70^{o}C) between the two liquids then simple distillation is probably the best option. On the other hand, if there is only a small temperature difference between the two liquids a fractional distillation is the preferable option.

	Simple distillation	Fractional distillation
Advantages	• simpler setup than fractional • faster distillation times • consumes less energy than fractional distillation	• much better separation between liquids than simple distillation • can more readily purify complex mixtures than simple distillation
Disadvantages	• requires the liquids to have large boiling point differences (>70^{o}C) • gives poorer separation than fractional distillation • only works well with relatively pure liquids	• more complicated setup than simple distillation • takes longer for liquids to distill • consumes more energy than simple distillation
Best used for:	separating relatively pure liquids with large boiling differences or liquids with solid impurities	separating complex mixtures of liquids with smaller boiling point separations.

Assembling the Fractional Distillation Apparatus:

The apparatus should be assembled starting with the appropriate sized round bottomed flask fitting into the heating mantle and working outwards toward the receiving flask. In order to select your flask size, remember that the flask should only be about 2/3 full of the liquid to be distilled. It is useful to support the heating mantle on a wooden block or an iron ring so that heating may be discontinued immediately. Note that clamping of the round bottomed flask, which is advisable, becomes essential if the heating mantle is to be removed.

Check that the joints remain tightly sealed periodically throughout the distillation; a gap, particularly in the still-head, would lead to a serious loss of material. You may wish to use elastic bands to prevent joints from opening. However, do not rely on these as your principal

means of holding the apparatus together; the bands often break if the distillation temperature is relatively high.

Remember that the distilling flask should only be 2/3 full of the liquid to be distilled. A boiling stone must be added to the cold liquid to ensure smooth distillation and prevent "bumping". Without a boiling stone, bubbles of vapour do not escape easily from the body of the liquid, with the result that the liquid becomes superheated and the vapour is expelled periodically in a sudden uncontrollable burst that causes the apparatus to bump. Never add a boiling stone to the heated liquid as you will run the risk of releasing large amounts of vapour at once. Since the pores of the boiling stone fill with liquid as soon as boiling ceases the stone cannot be reused. The fractionating column is assembled using the wider of your two condensers. This has three indentations at the bottom of the inner glass tube, and introducing 2-3 small pieces of glass tubing into the bottom of the column to plug the end prevents the smaller beads from passing through the column. Fill the column with glass beads. The glass beads provide the large surface area necessary for the multiple condensation-revapourisation process of fractionation. It is important that the distilling flask is NEVER distilled to dryness, as this creates a potential risk of explosion.

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أهداف المحاضرة الخامسة عشر:

يتوقع في نهاية الجلسة أن يكون الطالب قادراً على معرفة ماهو ELECTROSURGICAL UNIT واستخداماته وطرق تشغيله.

موضوعات المحاضرة الخامسة عشر:

ELECTROSURGICAL UNIT – part 1

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
15	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

An electrosurgical unit (ESU) passes high-frequency electric currents through biologic tissues to achieve specific surgical effects such as cutting, coagulation, or desiccation. It has been used since the 1920s to cut tissue effectively while at the same time controlling the amount of bleeding. Cutting is achieved primarily with a continuous sinusoidal waveform, whereas coagulation is achieved primarily with a series of sinusoidal wave packets. An electrosurgical unit can be operated in two modes, the monopolar mode and the bipolar mode. The most difference between these two modes is the method in which the electric current enters and leaves the tissue.

Theory of Operation

In principle, electrosurgery is based on the rapid heating of tissue. To better understand the thermodynamic events during electrosurgery, it helps to know the general effects of heat on

biologic tissue. Consider a tissue volume that experiences a temperature increase from normal body temperature to 45°C within a few seconds.

The cytochemical changes do in fact occur. However, these changes are reversible, and the cells return to their normal function when the temperature returns to normal values. Above 45°C, irreversible changes take place that inhibit normal cell functions and lead to cell death. First, between 45°C and 60°C, the proteins in the cell lose their quaternary configuration and solidify into a glutinous substance, this process, termed coagulation, are accompanied by tissue blanching. Further increasing the temperature up to 100°C leads to tissue drying, this process is called desiccation. If the temperature is increased beyond 100°C, the solid contents of the tissue reduce to carbon, a process referred to as carbonization. Tissue damage depends not only on temperature, however, but also on the length of exposure to heat.

In the monopolar mode, the active electrode either touches the tissue directly or is held a few millimeters above the tissue. When the electrode is held above the tissue, the electric current bridges the air gap by creating an electric discharge arc. A visible arc forms when the electric field strength exceeds 1 kV/mm in the gap and disappears when the field strength drops below a certain threshold level.

Monopolar Electrosurgery

In monopolar electrosurgery, tissue is cut and coagulated by completing an electrical circuit that includes a high-frequency oscillator and amplifiers within the ESU, the patient plate, the connecting cables, and the electrodes. In most applications, electric current from the ESU is conducted through the surgical site with an active cable and electrode. The electrosurgical current is then dispersed through the patient to a return electrode returning the energy to the generator to complete the path. Monopolar electrosurgery has the means of delivering energy to the tissue through several modalities (modes of operation): pure cut, blended cut, desiccation (or pinpoint), and spray (or fulguration). The delivery system of the monopolar electrosurgical generator can be a hand controlled pencil (reusable or disposable) or a foot controlled pencil.

A number of accessories can be adapted to the foot control output jack to deliver energy through a number of instruments.

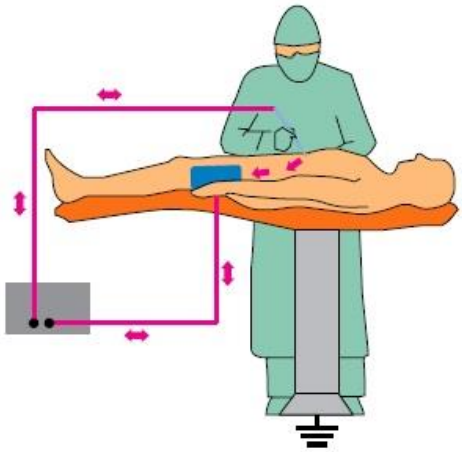

Figure 1: Monopolar ESU

Bipolar Electrosurgery

In bipolar electrosurgery, two electrodes (generally the tips of a pair forceps or scissors) serve as the equivalent of the active and dispersive leads in the monopolar mode. Bipolar electrosurgery does not require a patient plate. Electrosurgical current in the patient is restricted to a small volume of tissue in the immediate region of application of the forceps. This affords greater control over the area to be coagulated. Damage to sensitive tissues in close proximity to the instrument can be avoided. There is less chance of current capacitively or directly arcing to surrounding structures such as the bowel. Patient burns are virtually eliminated.

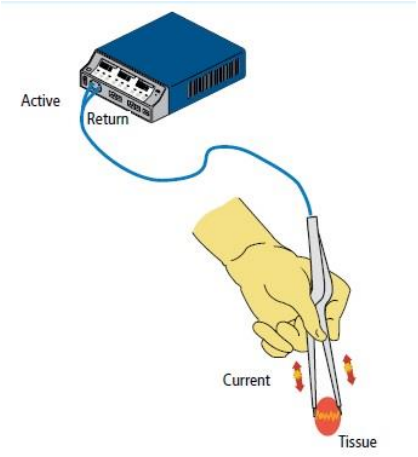

Figure 2: Bipolar ESU

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المادة العلمية:

Dispersive Electrodes

A dispersive electrode is an electrode with a relatively large surface area which is positioned on the patient in order to allow the high frequency current to flow back with a low current intensity in order to prevent any physical effects, such as undesired burns. Over the years electrosurgery has advanced, so too have the types and styles of dispersive electrodes. Early on in electrosurgery the only choice was a solid pad (at first a stainless steel plate) that was placed on the patient to disperse the heat of the RF energy. If the solid plate was not applied correctly or began to move off the patient during the case, the ESU would continue to deliver
energy to the tissue, causing a potentially dangerous situation.

Current Density

Electrosurgery makes use of an intensely concentrated current to induce a heat energy that is capable of a range of effects: from the drying out of cells with consequent coagulation of

blood, to the vaporization of cells permitting an electrode to physically separate a path through living tissue. The degree of current concentration is called “current density.”

Current density is one of the most important concepts in electrosurgery. Simply stated, current density is the amount of current concentration at a given point. In electrosurgery all of the RF current is forced to flow through the tiny area where the active electrode makes contact with the skin. At this point, the current flow is concentrated intensely. The heat at the site is great enough to achieve cutting and coagulation. Current leaves the body via a dispersive electrode (grounding pad). The pad has a large surface area thus the current density is quite low. As long as this large, so-called “dispersive” electrode makes good contact with the skin it should offer a passage of least resistance for safe exit of the RF current from the patient. The large surface area generates little heat. A generator supplies RF to the active electrode. Current passes through the patient, exiting by way of the return electrode. It returns to the generator to complete the circuit. Without complete circular path, from generator to patient, back to the generator, the current should not flow.

ESU waveform:

ESU generators are able to produce a variety of electrical waveforms. As a waveform change, so will the corresponding tissue effect. Using a constant waveform, like "cut", the surgeon is able to vaporize or cut tissue. This waveform produces heat very rapidly. Using an intermittent waveform like "coagulation", cause the generator to modify the waveform so that the duty cycle "ON time" is reduced. This interrupted waveform will produce less heat, instead of tissue vaporization, a coagulum produced.

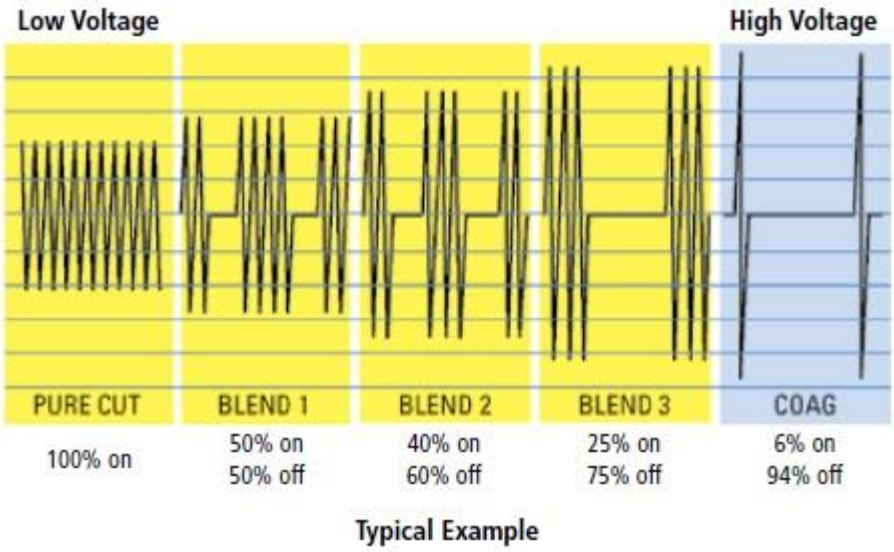

Figure 3: ESU waveform

ESU circuits:

Spark gap circuits: the first electrosurgical instrument used spark gap technique and figure 4 shows the principle of work of spark gap instrument. Consist of high voltage transformer and electric spark gap and C1/L1 circuit. The transformer will increase the voltage from 220 v to 3000-4000v which is able to ionize the air in the gap between the two points of tungsten. When the gapstart to spark during production of electric arc by alternating pattern, it will produce currents which radio frequencies which start to oscillate in the circuit (C1/L1). This circuit is coupled "connect" with output circuit (L1/L2) by induction. The output energy which gone to the patient can be control its intensity through taken different level of energy from L2 through switch S2 which is connect with the active electrode. Depending on the type and design of the instrument the power is between 25 watt and few hundred watts. The coils RF1 and RF2 are used for protection and prevent the effect or return back of radio frequencies to the input power. In some instrument the capacitor is used parallel with the secondary coil of the transformer T1. These generators are used in cauterization and coagulation to stop the bleeding from blood vessels. Most of these instruments exist in two mode cut and coagulate. The rough foot selector switch. The wave for cutting is pure sinusoidal wave while the coagulation wave is damped oscillation wave according to the type and technique of the instrument.

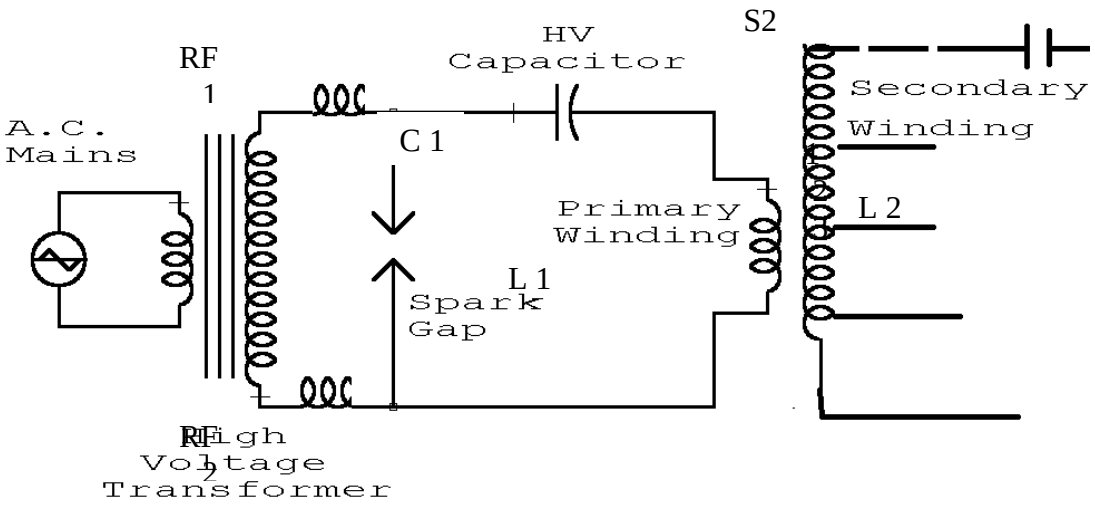

Figure 4: Spark Gap circuit

2) Electronics circuits for electro surgery "solid-state circuit":

The electronics circuits are used now in electrosurgical instruments so its small in size and weight, the circuit in (figure 8) is one of the types of amplifier of the power of radio frequency. The circuit is push-pull/parallel circuit. There are two raw or sides of 3 transistors from Q1 -Q3 "the first", and from Q4____Q6 "the second". Each three transistors are connected parallel, and the two raw are connected by push-pull circuit. The transformers used in the circuit in a form of "toroid-shaped" to determine the magnetic field in the circuit.

The radio frequency signal can be produced by Oscillator as shown in figure (9). When the transistor (QI) in forward deviation state, the circuit will be oscillate with radio frequency according the value of circuit's element. The transistor (Q2) works as control switch to control (Q1). When the (Q2) works, it caused to (Q1) works also "forward deviation". In the cutting mode the (Q2) continue working and the output signal is continuous sinusoid / wave (figure 9), but during coagulation mode rectangular wave is given to the base of transistor (Q2) which is going to cut it to produce chopped sinusoid wave (figure 9). There are another circuits used another technique according to the manufacture company.

3. thyratron coagulation current generator

Adamped coagulation wavefrom is generated in the circuit shown V1 is vacuum tube power thyratron acts triggered switch (Thyratron is ages filled triode tube). A node and cathode both

having high impedance until the voltage between gride and cathode exceeds acertain thre shold voltage at that point the gas inside tube ionized cansing low impedance between cathod and anode. Thyratron behaves as a switch turn on. The circuit operating as follows:

1- When power is applied V1 is off the capacitor (c3) charges through (RF) chocks L3
2- A pulse generator circuit applied pulses to grid of (V1) at (25 KHz) rate.
3- When the amplitude of the pulses is exceed the threshold point of V1, then V1 ionized and become on (C3) rapidly discharge through (L1).
4- The energy from L1/C3 is compled to the O/P Diode (D1) acts to damped the wave from.
5- The thryratron the deionized allowing (C3) charged again and soon.

Testing Electrosurgery machine:-

The methods of testing electrosurgery machine for checking the O/P RF Power are:

1- Toroid transformer oscilloscope output:

   This act as shown in figure (2) uses a dummy load resistor (R1) to simulate the patient and an (RF) ammeter to measure the current through (R1) the resistor should have a resistance between 200-500 the ammeter should have a (0˷ 2A) full scale range and must be thermocouple RF meter.

The thermocouple (RF) ammeter is inherently an (rms) reading device so it provides a true picture of the actual O/P level Peak reading devices are also sometimes used.

There are two disadvantages with the RF meter they are more expensive than other types of movement meter the other problem is the matter of linearity. The thermocouple (RF) meter does not have a liner scale it is more crowded on the low end of the range than the top so it is difficult to read low power levels.

Transformer (T1) in circuit used to sample the (RF) wave from for display on the oscilloscope.

2.**Voltage divider circuits:**

This circuit uses resistor voltage divider (R2/R3) and diode rectifier (D1) to develop a (D.C) level to drive a (o˷ 1 A) d.c. meter movment. The circuit here is essentially apeak reading deviser so it can be calibrated in watt only.

3-Toroid current transformer:

This circuit is another peak reading test it used a toroidal current transformer but with two windings one winding is connected to J2 for display of the wave form on an oscilloscope while the other devices a d.c. meter through arectifierdiode (D1).

This circuit useful when testing electronsurgery machine of low power rating.

Note :- the heating of tissue is due to the RF power disspated in the tissue:

$P=PVI_d^2$

P= resistivity of tissue

V= cubic volume (m^3)

I_d = current density (A/m^2)

Ex: calculate the R.F power $0.2m^3$ of tissne with p= $1.6*10^3$ r.m, Id 0.36 A/m^2

Solution

$P=PVI_d^2$

P= (1.6*103)(0.2)(0.36)2 = 41.6

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المادة العلمية:

1.1 Fundamentals and Definitions

A centrifuge comprises....

• Electric motor

• Drive shaft

• Rotor to hold tubes

SEDIMENTATION of suspended and some dissolved particles occurs due to centrifugal force. -

Two principal uses

1. Separate out solid matter as a PELLET from dissolved solutes as SUPERNATANT
2. Separate soluble macromolecules of different mass or density

Also sometimes used to provide centrifugal force to drive other processes, eg ultrafiltration.

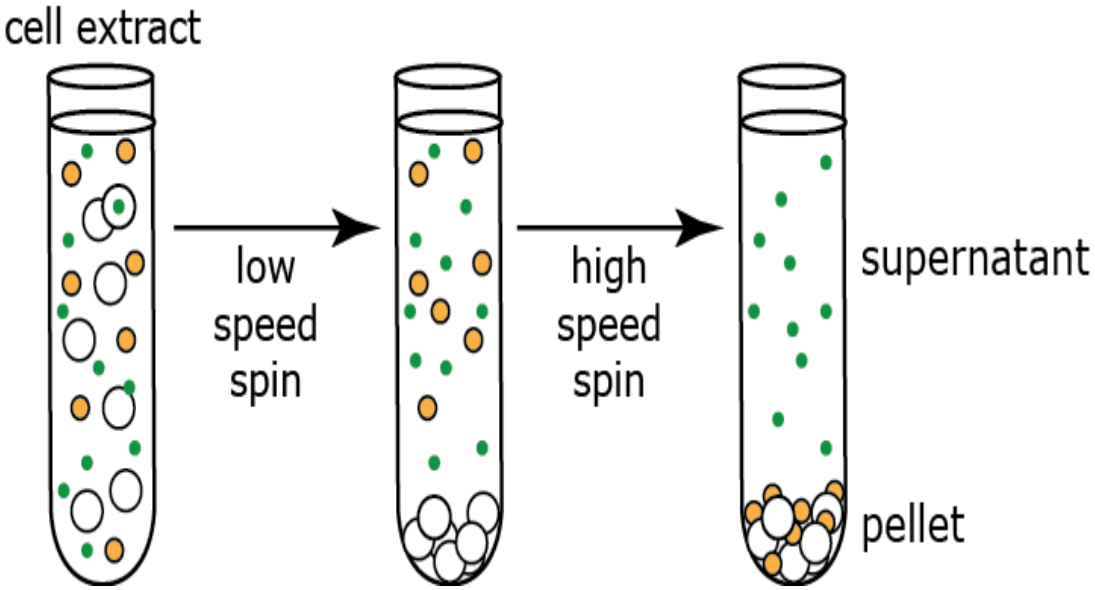

Fig 1.: show the relationship between the speed and the separation.

1.2 Centrifuge Rotors

A. Fixed Angle Rotor

B. Swinging Bucket Rotor

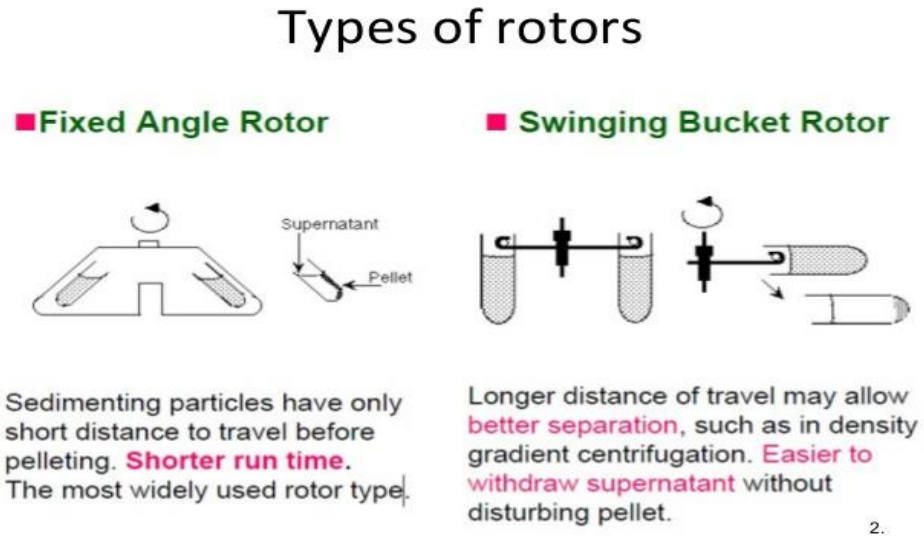

Fig.2: Show the types of rotor in centrifuge.

1.3 Principles of Centrifugation

Sediment ing force on particle

= Mass x centrifugal field

= $M\omega^2 r$

where ω = angular velocity of rotor (radians/sec)

r = radius (ie distance of particle from axis of rotation)

Relative Centrifugal Force (RCF)

RCF = $1.119 \times 10^{-5} \times (rpm)^2 \times r$

RCF value reported as "No. x g" (ie multiples of earth's gravitational (force). Equation used to calculate NOMOGRAMS (see eg Hohne & Peck p 147) for quickly finding RCF at given speed and rotor type (radius).

1.3.1 Interacting Forces in Centrifugation

Sedimenting force, $m\omega^2 r$, is opposed by...

1- **Flotation Force** (Archimedes) = $m\omega 2rvp$

Where: v = partial specific volume

(volume displaced by lg of sedimenting particles)

ρ = density of solution

NET SEDIMENTING FORCE on particle, after allowing for flotation

= $m\omega^2 r(1- vp)$

2- **Frictional Resistance**

against particle moving through fluid.

= f.v

where: f = frictional coefficient v = particle velocity

3- **Diffusion** - acting to counter uneven concentration distributions set up when dissolved molecules sediment.

BALANCE between the

SEDIMENTING FORCE and

COUNTERACTING FORCES

leads to various formulae and equations used in

• PREPARATIVE CENTRIFUGATION eg to calculate the time required to sediment a particle to the bottom of the tube and in

• ANALYTICAL ULTRACENTRIFUGATION techniques used to determine SEDIMENTATION COEFFICIENTS and MOLECULAR MASSES of dissolved macromolecules.

1.4 Density Gradient Centrifugation

In absence of a density gradient, separated bands of solute in the centrifuge are gravitationally unstable.

CAN'T OCCUR because layer of concentrated, dense solution overlaying less dense solvent would lead to mixing by convection and nullify the separation.

In absence of stabilising density gradient, can form boundaries (cf electrophoresis 9.3) but not zones. In analytical ultracentrifuge, moving boundaries and concentration distributions observed by optical device.

Create DENSITY GRADIENT in tube

Use a non-interacting, low M. Wt solute in continuously increasing concentration from meniscus to bottom of tube.

Important technique for purifying proteins and particularly nucleic acids.

Two different types of density gradient centrifugation, for two different purposes are:

• Zonal (or Rate Zonal) Centrifugation

(Sucrose density gradient centrifugation)

• Isopycnic Centrifugation

(Caesium chloride density gradient centrifugation)

1.4.1 Zonal Centrifugation

Mixture to be separated is layered on top of a SUCROSE, or FICOLL, GRADIENT (increasing concentration down the tube)

- provides gravitational stability as different species move down tube at different rates forming separate bands.

Species are separated by differences in SEDIMENTATION COEFFICIENT (S)

= Rate of movement down tube

Centrifugal force S

S is increased for particle of LARGER MASS

(because sedimenting force α M(1-vρ)

S is also increased for MORE COMPACT STRUCTURES of equal particle mass

(frictional coefficient is less)

Mild non-denaturing procedure, useful for protein purification, and for intact cells and organelles.

1.4.2 Isopyncic Centrifugation

Molecules separated on EQUILIBRIUM POSITION, NOT by RATES of sedimentation. Each molecule floats or sinks to position where density equals density of CsC1 solution. Then no net sedimenting force on molecules.

Isopycnic = Equal density

and separation is on basis of DIFFERENT DENSITIES of the particles.

Very useful for purifying nucleic acid species of different density; also in separating proteoglycans extracted from cartilage.

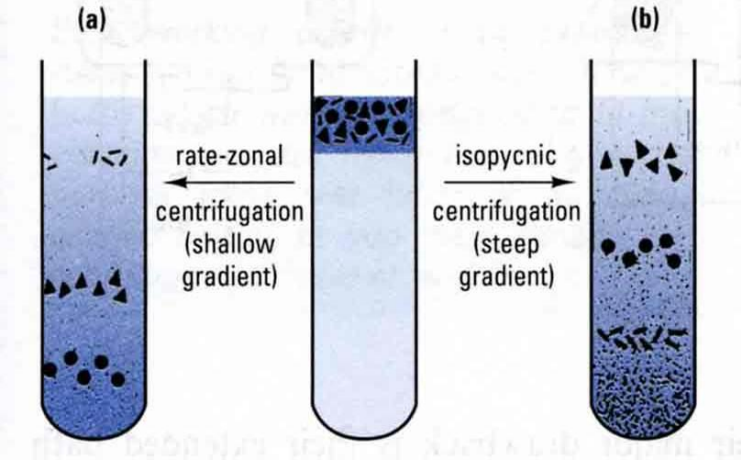

Fig3: show the zonal and isopycnic density gradient.

Density gradients are used in many different operations:

- To separate particles of different densities (isopycnography, which is short for "equilibrium density gradient centrifuation)
- To separate particles of different sizes (sedimentation centrifugation)
- Column elutions that must smoothly go from one concentration to another
- Isolation of diamond dust (isopycnography)
- Isolation of bovine X-sperm from Y-sperm (dairy industry) (sedimentation without centrifugation)

There are several ways for making density gradients including those that use syringes, twin linked containers, and other devices. Here are two very simple additional ways to make linear density gradients:

1. This might be simple but it is one that takes many hours: fill a plastic centrifuge tube with - say - a 10% sucrose solution. Put it in the freezer. The first part that freezes will be almost pure water at the top, with only a little sucrose trapped in it, but as the overlying ice layer gets thicker, more and more sucrose is trapped within it. Thus when it is completely frozen, the top has little sucrose and the bottom has much. Upon subsequent thawing, the bottom melts first, and the melting proceeds upwards reinforcing the preparation of the gradient.
2. Here is one that takes about 60 seconds of time from start to finish!The beauty of this procedure, which was invented by this author with the help of a remarkable undergraduate, is that it is not limited to centrifuge tubes. Cylinders of any size will work.

A. **Isopycnography** (Equilibrium Density Gradient Centrifugation), which is used for separating things on the basis of differing intrinsic densities. This is a "static" system as the experimental objects come to rest at points in the tube at which they are in density equilibrium with the surrounding solvent at that point.

B. **Sedimentation Centrifugation**, which is used to separate things on the basis of their differing "effective" sizes, or, roughly, on the basis of molecular weights. This is a "dynamic"

situation because the experimental objects have started at the top and are settling through the gradient at rates roughly proportionate to the square roots of their molecular weights.

The centrifuge works if a structure is denser or has a greater mass than its surroundings, because that causes it to move downward in the tube. If it has a lesser mass or is less dense, the structure separates to the top of the test tube. There are several speeds of centrifugation, and each have a specific purpose:

• Low-speed: large, dense bodies or leftover debris from the preparation of a substance
• Higher speed: intermediate sized objects such as chloroplasts and mitochondria
• Very high speed: microtubules, microfilaments, ribosomes, etc.

For extremely precise centrifugation, two different methods are used:

• Density gradient centrifugation
• Buoyant density centrifugation

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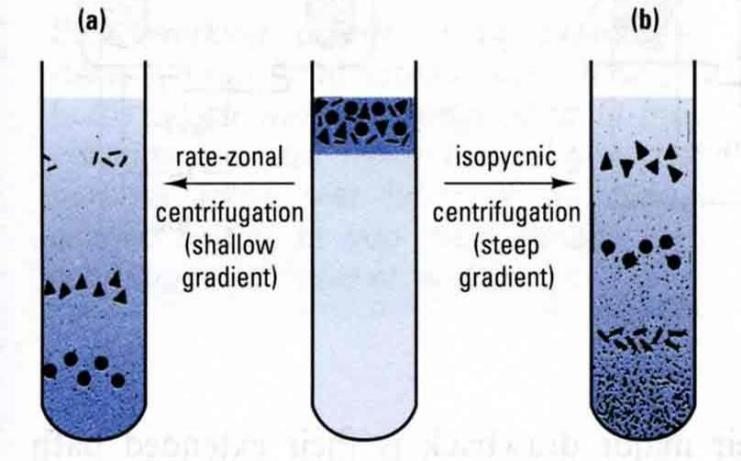

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A. **Isopycnography** (Equilibrium Density Gradient Centrifugation), which is used for separating things on the basis of differing intrinsic densities. This is a "static" system as the experimental objects come to rest at points in the tube at which they are in density equilibrium with the surrounding solvent at that point.

B. **Sedimentation Centrifugation**, which is used to separate things on the basis of their differing "effective" sizes, or, roughly, on the basis of molecular weights. This is a "dynamic" situation because the experimental objects have started at the top and are settling through the gradient at rates roughly proportionate to the square roots of their molecular weights.

The centrifuge works if a structure is denser or has a greater mass than its surroundings, because that causes it to move downward in the tube. If it has a lesser mass or is less dense, the structure separates to the top of the test tube. There are several speeds of centrifugation, and each have a specific purpose:

• Low-speed: large, dense bodies or leftover debris from the preparation of a substance
• Higher speed: intermediate sized objects such as chloroplasts and mitochondria
• Very high speed: microtubules, microfilaments, ribosomes, etc.

For extremely precise centrifugation, two different methods are used:

• Density gradient centrifugation
• Buoyant density centrifugation

الوحدة التاسعة عشر - المحاضرة التاسعة عشر- الزمن: 120دقيقة

أهداف المحاضرة التاسعة عشر:

يتوقع في نهاية الجلسة أن يكون الطالب قادراً على معرفة ماهو MICROSCOPE واستخداماته وطرق تشغيله.

موضوعات المحاضرة التاسعة عشر:

MICROSCOPE – part 1

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
19	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

A microscope is a high precision optical instrument that uses a lens or a combination of lenses to produce highly magnified images of small specimens or objects especially when they are too small to be seen by the naked (unaided) eye. A light source is used (either by mirrors or lamps) to make it easier to see the subject matter.

Microscopy is the use of a microscope or investigation by a microscope

Types of Microscopes: Most microscopes are called light (bright field) microscopes since they rely on light to observe the magnified image of a specimen or object. Within this category are two main categories:

(**1**) Compound (high power microscopes

(**2**) Stereo or dissecting (low power microscopes).

Compound Microscope: This is the most common type of microscope. It can also be referred to as a biological or research microscope. The compound microscope is what many refer to as a high power microscope. The magnification (power) can have a range from about 40x to 1000x

and some can go up to 1500x or 2000x. Much serious work of a compound microscope is done at 400x to 500x. Compound refers to the fact that in order to enlarge an image

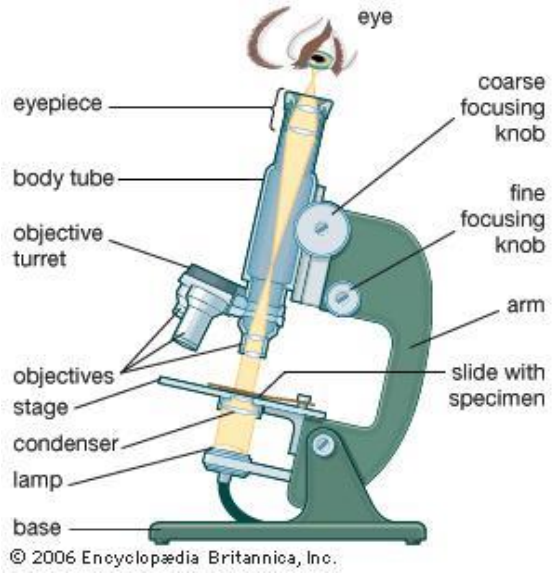

Figure (1) compound microscope

Principle: a single light path passes through a series of lenses in a line where each lens magnifies the image over the previous one. In other words, one light path with multiple lenses equals a compound microscope. The image is seen by the observer as if it were only 10" (250mm) from your eye. In the standard form the lenses consist of an objective lens (closest to the object or specimen) and an eyepiece lens (closest to the observers' eye) and a means of adjusting the focus and position of the specimen or object. In addition, a compound microscope uses light (reflected from a mirror, from indirect sunlight, from desk lamps or other interior light sources, or from built-in lamps) to illuminate the specimen or object so that you can see it with your eye. The objective lens usually consists of three or four lenses (sometimes even five) on a rotating nosepiece (turret) so that the power can be changed. The image produced at the eye is two dimensional (2-D) and usually reversed and upside down. The most used light method is trans-illumination (light projected from below to pass through the specimen). At 400x much detail can be seen at the cellular level of biological specimens.

Stereo Microscope:

Stereo microscopes are the second most common type of microscope. They can also be referred to as dissection, or inspection microscopes. The stereo microscope is what many refer to as a low power microscope. Magnification (power) can have a range from about 10x to 80x with magnification in the 10x to 40x the most popular. Also, zoom models from about 10x to 60x or so are very convenient. Low power is used for examining larger sized items like insect parts, flower parts, rocks and fossils, stamps, coins, PC boards, material surfaces, hair, etc.

Principle: There are two separate light paths (as opposed to a single light path in a compound microscope) which produce a true stereo, three dimensional (3-D) image of the specimen or object. Within the objective lens you will find two lenses (one for each path of light) side-by-side. The optical design parameters of a stereo microscope limit its 3-D effects to low powers only. Also in the category of low power microscopes is the single light path (like a compound microscope) type usually referred to as a dissecting microscope. This type is more economical than the stereo type but is very useful for examining large sized specimens and objects.

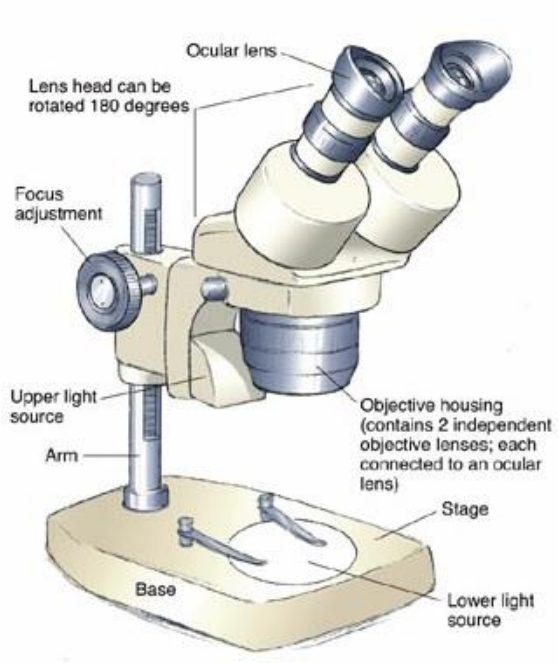

Figure (2) stereo microscope

In the standard form the lenses consist of objective lenses (closest to the object or specimen) and eyepiece lenses (closest to the observers' eyes) and a means of adjusting the focus and

position of the object or specimen. In addition, a stereo microscope uses light (from desk or table lamps, indirect sunlight, other interior light sources, or from built-in or attached lamps) to illuminate the specimen or object so that you can see it with your eyes. The images you see are correct (upright and normal which is the opposite of compound microscopes). Most stereo microscopes have both top and bottom built-in or attached illumination to handle various objects and specimens of all varieties, shapes, and colors.

الوحدة العشرون - المحاضرة العشرون- الزمن: 120دقيقة

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موضوعات المحاضرة العشرون:

MICROSCOPE – part 2

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
20	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

Other Types of Microscopes These are usually advanced and expensive type microscopes made for specific usages mainly in advanced medical and research. There are many, many types but some of the more popular types are listed below.

- **Phase Contrast** This is a microscope that uses the differences in the phase of light transmitted or reflected by a specimen to form distinct, contrasting images of different parts of the specimen.
- **Polarizing** A microscope in which the object viewed is illuminated by polarized light for typically analyzing the content and make-up of organic or inorganic material like crystals, chemical microscopy, and optical mineralogy
- **Fluorescence** These microscopes use an illumination method that is used to locate fluorescently tagged material (protein, enzyme, genes) by exciting the specimen with one wavelength of light in hopes that the fluorescence will appear by emitting a light at a different wavelength.

❖ **Metallurgical** A microscope that is used for identification, inspection, and analysis of different metals and alloys.

❖ **Electron Beams** These microscopes very expensive and use a beam of highly energetic electrons instead of light to examine objects on a very fine scale. This allows the microscope to surpass the resolution limits of optical microscopes and can magnify specimens up to 250,000x or more. Users can examine the topography of a specimen, its morphology, composition, etc.

❖ **Digital** These are a combination of a microscope and a digital camera. The camera can be integrated (built-in) with the microscope or specialized cameras (imagers) can be purchased separately and adapted to virtually any microscope at economical prices. With basic software provided (with the camera (or using your own photo editing software) the user can display, save, and edit images. Some more expensive software packages allows for a variety of image analysis useful for medical, educational, and sophisticated research usage. Handheld Digital Microscopes use new technology for a miniature camera and illuminator in one unit. You use a PC or laptop computer to view and image.

Part of microscope:

Objective Lenses: The objective lenses are the most important components of microscopes. Their basic function is to gather the light passing through the specimen and then to project the image up into the body of the microscope.

Then, the **eyepiece lens** system further magnifies the image for your eye to see. Most quality microscopes use glass for the objectives and even for beginner microscopes, stay away from plastic objectives lenses as the quality level is quite inferior. The objectives are the lens system closest to the specimen. There is *one* objective for each eyepiece in a compound microscope.

For stereo microscopes, there are objective *pairs* (one objective lens for each eyepiece lens) which give the 3-D effect.

On compound microscope objectives, there is printed the following information on each one such as power, tube length. Tube length of the objectives usually have a DIN

(interchangeable) of 185mm or 195mm. Objectives vary in power from 1x to 160x in compound microscopes but the most common power range is from 4x to 100x.

Most compound microscopes have three or four (occasionally five) objectives usually of 4x, 10x, 40x, and 100x (oil immersion) which revolve on a nosepiece (turret) to give different magnifying powers. The 4x, 10x, and 40x are called "dry" objectives which means they operate with air between the objective and the specimen. The 100x is called a "wet" objective which means it operates with immersion oil between the lens and the specimen.

For stereo microscopes, they usually have one or two objectives lenses which normally are 1x, 2x, 3x, or 4x. In addition, there are zoom models which operate from about 0.5x up to 5x. The extent of corrections for lens errors (aberrations) and flatness of the image field determines the usefulness and cost of the objectives for compound microscopes.

N.A. (numerical aperture) is a number that expresses the ability of a lens to resolve fine details in an object being observed especially those close together. As the N.A. number increases, the resolution becomes better. The N.A. may vary from 0.04 (low power) to 1.4 (high power Plan wet objective). The N.A. will be marked on the objective and the typical N.A. for the following are; 4x=0.10, 10x=0.25, 40x=0.65, and 100x=1.25. Resolution (actual not theoretical) is the separation distance of two details (points or lines) lying close together still seen as separate. Resolution comes from the objective and not the eyepieces as the eyepieces only magnify the resolution. Sometimes objectives have a color ring (universally used) to aid in identifying the magnification: black (1x), brown (2x), red (4x), yellow (10x), green (20x), turquoise (25x), light blue (40x), dark blue (60x), white (100x). Another number on the objective (like 0.17).Oil Immersion concentrates the light path and increases the resolution. Immersion oil is the only suitable oil for this purpose and will allow high magnifications and avoid damage to the objectives. There are two basic types of oil immersion – Type A is for low viscosity and Type B is for high viscosity.

The eyepiece consists of a series of lenses mounted in a tube (barrel) at the upper end of the microscope. Its basic function is to look at the focused, magnified image projected by the objective lens and magnify that image a second time before your eye looks at the image of the specimen. For special applications, eyepieces can have scales, pointers, crosshairs, markers, etc. on them.

The eyepoint is the location (or position) of the eye from the eyepiece which allows for the best possible viewing of the image. Some eyepieces use a pointer to point at a section of the specimen. You can rotate the pointer by turning the eyepiece

Condenser Lens (Sub-stage Condenser) is a glass lens or lens system located within or below the stage on compound microscopes. Its basic function is to gather the light coming in from the light source and to concentrate that light into a light cone onto the specimen.

High power objective lenses have very tiny diameters and require concentrated light to work properly. A basic condenser is fixed in place. A moveable and more precise and more expensive condenser is the Abbe condenser. It usually can be moved up and down vertically, regulating the amount of light from the illuminator. It mounts under the stage and usually has an adjustable iris type aperture to control the diameter of the beam of light entering the lens system. By changing the size of the iris and moving the lens up or down from the stage, the diameter and focal point of the cone of light that goes through the specimen can be controlled. Some condensers can be designed to have special accessories for phase contrast, polarized light, differential interference, and dark field microscopy.

The diaphragm is also called the sub-stage diaphragm or aperture diaphragm. The diaphragm is normally located under the stage of a microscope and it adjusts the amount of light passing into the slide or specimen. It is most useful at high powers. Most compound microscopes have one of two types of diaphragm:

1. **Disc Diaphragm** – is the simplest and least expensive of the two types. It is located between the light source and the slide or specimen. It contains a rotating disk (usually fixed) with five to ten openings of differing diameters which limit the amount of light passing through to the specimen.

2. **Iris Diaphragm** – is the better and more expensive of the two types. It has a continuously variable diameter (like the iris of an eye or a camera shutter) which has a function to limit the size of the opening through which light passes from the light source to optimize resolution, contrast, and sharpness. It is usually controlled by a lever.

Illumination Systems (Light Source): Since specimens rarely generate their own light, illumination is necessary. Illumination is the application of light onto an object or specimen in a microscope. The illuminator is the source of light which illuminates the object or specimen

to be observed. Illumination of the object or specimen should be bright, free of glare, and evenly dispersed in the field of view. The simplest means of illumination can be provided by overhead lights, desk or table lamps, or indirect sunlight. Many compound microscopes are provided with adjustable plano/concave mirrors which reflect an external light source into the microscope. The flat slide (plano) of the mirror usually provides the sharper image but if stronger and brighter illumination is needed then use the concave side.

These methods are the least expensive illumination methods but it can be difficult to direct the light source for proper illumination. The more expensive and common illumination is by using built-in or attached light sources using bulbs or lamps that provide direct and intense illumination. These light sources can be from above the specimen or object which is used mainly with low power stereo microscopes and is called incident (reflected) light or from below a specimen (typically a slide specimen) which is light passing up through the specimen from inside the base and called transillumination (transmitted light).

Illumination lamps or bulbs come in various types:

- Tungsten – is an incandescent bulb filament which is the most common and least expensive. They give off a yellowish hue and give off moderate heat. They are typically 15-watt or 20-watt.
- Halogen – is a lamp which generally is the hottest light source for a microscope. The light is very bright, very white, and concentrated. The halogen type is more expensive than the tungsten. They are typically 15-watt or 20-watt.
- Fluorescent – is a lamp that is cool in temperature. The light is bright and white and very sharp while being comfortable to the eye. The fluorescent is great for observing live specimens. They are typically 5-watt to 10-watt and generate the same brightness as the tungsten or halogens do. They can be built in the base of a microscope or they can be attached (called a ring light) to observe from above.
- LED – these are light emitting diodes which provide a bright light source with virtually no heat. The white beam is brighter and cooler than the other illumination systems. They are typically battery operated and thus are cordless and great for outdoor use also.

Focus Systems A focus control allows you to adjust the focus of the microscope. Every microscope includes a focusing control (knob) for quick (coarse) focusing of the image.

More expensive compound microscope models include a coarse (quick) and fine focusing control. The fine focus is particularly advantageous in high power applications and required for 400x and higher but is not available on stereo microscopes since they are only low power.

Coaxial controls (focus) are where both the coarse and fine focus knobs are on one large control (on top of each other). The larger knob is typically for the coarse focusing and the smaller knob for the fine focusing. The smaller knob is usually centered on the inside of the larger one.

Head (Body) The head is the upper part of the microscope that connects the eyepiece to the nosepiece or turret. Some heads are fixed in place and allow you to tilt them from angles of 0° up to 60°. There are several types of heads:

- Monocular – this is a microscope with a single eyepiece. A monocular head with a second vertical viewing port is called a teaching head (dual view head) which can be used by a second person (or teacher) to observe the same image as the first person. Or, the second port can be used with various cameras.
- Binocular – this is a microscope with two eyepieces, one for each eye. They are generally used on high power compound microscopes and all low power stereo microscopes and are generally more comfortable to use than a monocular type.
- Trinocular – this is a microscope with a binocular head for viewing and an additional port that can be used for a third eyepiece for a second person (or teacher) to use or it would be used for various photo applications.

Nosepiece (Turret or Revolving Nosepiece): The nosepiece is a rotating turret located above the stage on compound microscopes that can hold multiple objective lenses of various magnifications. By rotating the objectives into the light path and over the specimen you can observe various magnifications of the specimen during your examination. As any of the objectives are rotated they will click when the precise location is reached.

Arm: The arm (also called the stand or limb) is the component of a microscope which contains the focus mechanism and supports the stage, as well as the body or head which contains the eyepieces. It provides the rigidity of a microscope as it rises from the base. A few types of arms are:

- ❖Fixed – a type of arm where the arm and the body are integral parts of the microscope and connected solidly to the base.
- ❖Pillar (Post) – a type of arm which consists of a single post rising vertically from the base. The microscope body can rotate about the post and also be moved up and down on it.
- ❖Boom (Universal) – a long boom type stand used to support a microscope body. It has many adjustments allowing the microscope to be aligned in a wide variety of configurations. This is the least common type of arm.

Base: The base is the bottom support part of the microscope. It provides balance and rigidity. It houses electrical components for illumination.

Eyepiece Tubes The eyepiece tubes are also called observation tubes or drawtubes. They are attached to the arm above the nosepiece. They are usually set at angles of 45° or 30° for comfortable viewing. The bottom of the eyepiece tubes hold a special lens called the eyepiece (tube) lens. The tube length is a fixed measurement in millimeters of the distance from the objective shoulder to the seat of the eyepiece.

Tube Lens At the bottom of the eyepiece tubes is a tube lens. Its function is to gather the parallel rays of light projected by the objective lens and bring those rays to focus at the plane of the fixed diaphragm of the eyepiece. On some microscopes, the tube lens is built into the body of the microscope itself.

Stage: The platform beneath the objectives on which the slide or object to be observed is placed is called a stage. It has a smooth, flat surface and can be rectangular or circular. The simple type of stage is called a plain stage and the more sophisticated stage is called a mechanical stage.

A stage plate is used with stereo microscopes and this plate fits in over the lower illumination in a circular hole. It normally is a frosted glass plate or a dual sided (white and black) plastic plate which can be used for improving contrast on various specimens to be viewed with top illumination.

الوحدة الحادي والعشرون – المحاضرة الحادي و العشرون- الزمن: 120دقيقة

أهداف المحاضرة الحادي والعشرون:

يتوقع في نهاية الجلسة أن يكون الطالب قادراً على معرفة ماهو X-RAY واستخداماته وطرق تشغيله.

موضوعات المحاضرة الحادي و العشرون:

X-RAY – part 1

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
21	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

X-ray: is a part of electromagnetic spectrum with short wave length, high frequences, high energy radiation, not all projected x-ray arrive at the film some are absorbed or deflected, the resistance to x-ray penetration is called radio density. In human body are increasicly in bone and lower in air.

The Feature of X-ray:

1. It has the ability to penetrate material with different degrees of energies except lead.
2. Unvisual spectrum wave.
3. The ionic effect: that it can be ionic atom of air:
4. The physiological effect: it can penetrate living tissues, such killing the red blood cell.
5. The photographic effect: it can be effective in photosensitive film.
6. The fluorescent effect: that it can be effect in crystal.
7. The useful range of wave length of x-ray

- For diagnostic(0.1-1A°) use

  A-still picture (radiography): used to examine bones+ internal organs.

B-Continuous picture (fluoroscopy): used to examine organ system such as function.

C- Motor picture (angiography): used to examine circulator systems.

D- Still picture x-ray scans (tomography): used to examine bones + organs + tissues from many different angles.

- For theraptic purpose (0.1-100A°): using for killing and remove the cancer cell,

Principle of work:

Work of x-ray device depends on:

• X-ray absorbed or deflected such as pass through the body.

• Project x-ray arrive at the film, in the human body ,air has lowest radiodence,fat, liver ,blood ,muscle and bone are increasicly radiodence,the result an image in which radiodence tissues are in shade of gray to black.

• If the organ that examiner not containing bone then x-rays technique done by giving the patient barium solution that is causes the contours of organ such as gastric and intestinal lining to appear white.

Components of x-ray machines

1- **High tungsten transformer (lmf)**: using for raise voltage-250 kV. It's connected directly with tube by cable transmitted in it a large amount of power.

• Property of transformer:

a- High voltage

b- High frequency

c- Low current

2- **X-ray tube**:

X-ray produced whenever high—speed electrons are suddenly brought to rest. This is done by accelerating electrons in an electric field between two electrodes. The kinetic energy of the accelerated electrons is converted to three principle ways:-

a- Less than 1% into x-ray.

b- 98% into heat.

c- Some electrons producing heat, x-radiation.

The requirements of the x-ray tube:

1. Source of electrons (cathode), consisting of:

   A-focusing cap of nickel to focus the electron to the target.

   B-filament of fine tungsten wire coiled to form spiral, mounted within the focusing cup.

   - Big filament (24v) (for giving electron).

   - Small filament (12v) (for spiral).

2- Energy to accelerate the electrons (potential different across the tube by high —tension transformer).

3- Free electron path (vacuum).

4- Device to stop the electron beam (anode) &there are two types of anode:

-Fixed type: made of cylindrical block copper. Its face inclined at angle (20°).when power target in it with high voltage in one face cause to corrode.

- Rotating type: it solve the corrode problem, it's a disc of tungsten with beveled edge.

5- Envelope glass: made of heat resisting glass.

6- shield: is made of steel sheet or aluminum, lined with a thin sheet of lead.

7- oil: put in the space between the tube and the shield, the function of oil:

1- Has good insulating

2- Cooling properties

3- Cool off the spiral.

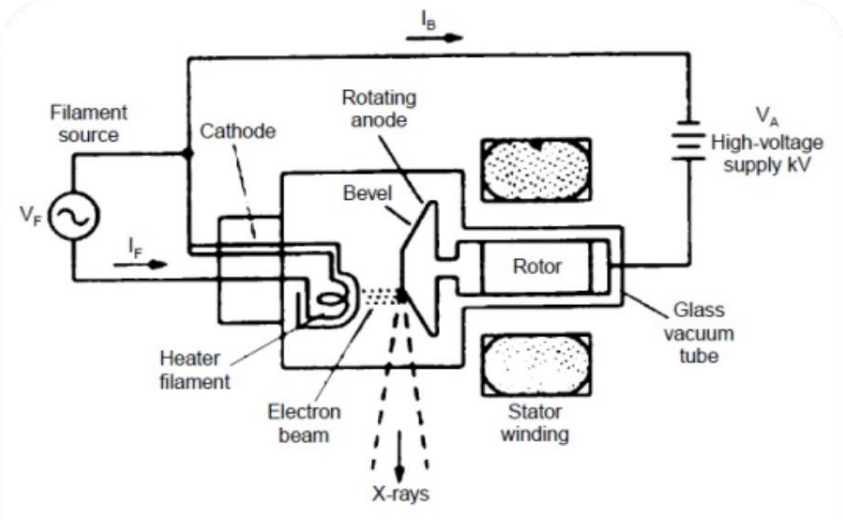

Figure1: showing x-ray tube using rotating anode

3-**Hand switch**: used for switching and determining the contours of image in photosensitive film, using in two cases:

A- Ready at once.

B- Exposure timing switching.

The range of voltage that is using, for teeth (7-10v), for palm of hand (10-15v), for arm (15-20v), head (20-30v), chest (30-40v), so 1000 for total body.

4- **Control switch**: consist of three gages, every one connecting to fuse and light lamp for indication to work.

- Kilo voltage control.
- Milliamp gage control.
- Timer.

5- **Filters**: for absorbed the increasing x- ray wave.

6- **Bedstead**: used for setting the patient on it, its made of material absorbed x-ray wave containing:

a) Cassette: it's found under the body of patient containing the photosensitive film .its made of three types of materials plastic, aluminum, fiberglass.

b) Photosensitive film: to show the image giving by x-ray scan, its more than one type and size (8x12cm, 12x18, 24x18, 14x14, 17x14, 30x40 cm), the film should not be displayed to light. There are two types of bed (fixed in earth, movement bed).

7- **Low tension transformer**: it's connecting directly with control switch (low voltage, high current, low power.

8- **Electrical parts**:

-Two types of fuse (a-glass, b-pottery) the value of fuse (5A, 10A).

-switch on/off, changeable resistance (using for change between ms, kV, t), & relay.

-heating resistance: using for carrier high temperature that is resulting from electrons movement and for reduce heat use heat sing.

9- **Acid**: for showing the image and display in film after washing and using silver bromide for fixed the image in film.

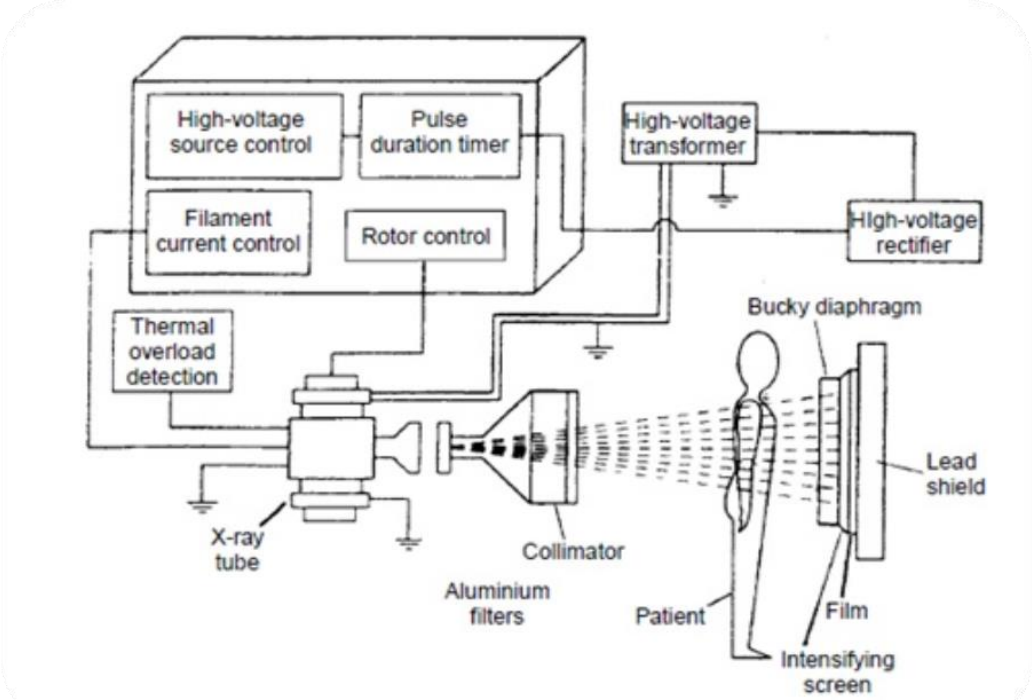

Figure 2: below shows a block diagram of an x-ray machine

❖ The collimeter: used for focus &controlled the image.

❖ Pulse duration: control the time of current.

❖ Current control: determine the density of image.

❖ Voltage control: determine the contruse of image.

❖ Intensity screen; using for clear & contrast of image, consist of material with high atomic weight using for reflected &deflected the x-ray wave in phosphore layer.

❖ Using phosphore in layer of film because the film sensitive for light not x-ray radiation because the phosphor layer converted x-ray radiation in to photons.

❖ After 50,000-60,000 image then filment is dameged.

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موضوعات المحاضرة الثاني وعشرون:

X-RAY – part 2

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
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المادة العلمية:

Daily maintenance

1-check up the connection cable_between the source of voltage and device.

2-check up the fuse.

3-check up of fitment.

4-make sure that the acid used for showing image is not bad and used right procedure.

Faults and maintenance

- contrast of image is bad because

1. Not give enough voltage for exposure of x-ray.
2. The cables connection of high tension does not examine.
3. Damage in filament.
4. Defect in cassette of film.
5. The film doesn't focus exactly under the patient.
6. Bad acid using for showing image.

- **Maintenance**

-examine every connection.

-repair any part that is damage or defect.

-give effective voltage for wave.

-focus film under patient.

- using good acid for showing image.

The image dose not display:

1. Damage in filament (24V).
2. Damage in hand switch.
3. The given voltage for exposure of x-ray is not enough.
4. The cable of high tension is not connecting.
5. Fuse is damaged.
6. Wire of hand switch has been cutting.
7. The gage of kV, ms, T are damaged

--The display is black image because:

1. High voltage is given (result from second filament).
2. The small filament (12v) has been damaged.
3. Damage in gage of kV, ms, T, or fuse.

X-ray machine accessories

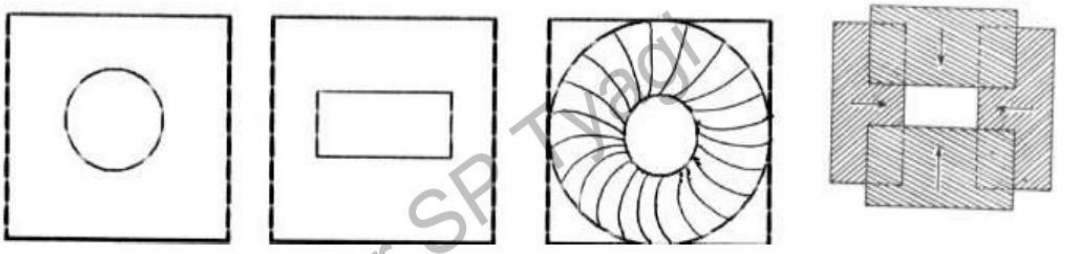
X-ray beam collimator: theses are the devices made of lead and are used to restrict x-ray beam up to a desired area. In diagnostic radiology their use offer advantages of minimizing x-ray dose to the patient. The following two types of collimators are used:

- 1. aperture diaphragm
- 2. cones and cylinders

Aperture diaphragm

— This may be fixed aperture size type or adjustable variable aperture size. The aperture shape may be square or rectangular.

—



Fixed circular aperture diaphragm	Fixed rectangular aperture diaphragm	Adjustable circular aperture diaphragm	**Adjustable rectangular aperture diaphragm**

Cones and cylinders

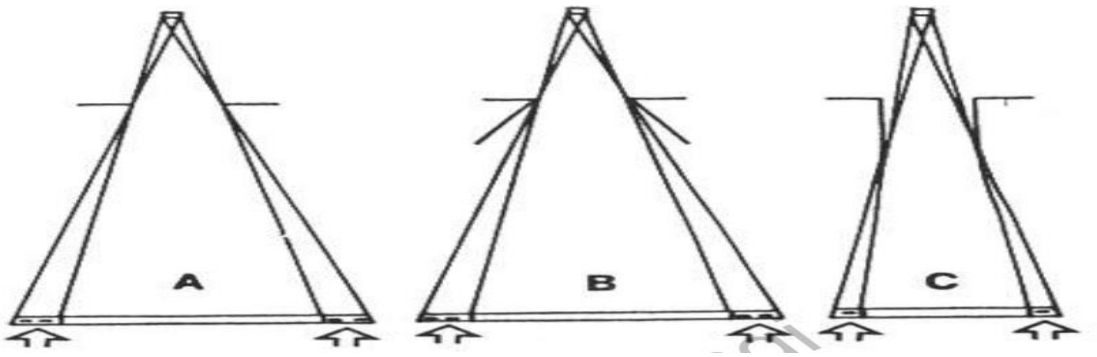
— As the name indicates these devices are either conical or cylindrical shaped.

— All the collimators are fixed at the exit point of x-ray beam from the window of x-ray tube. There is disadvantage in use of fixed aperture or cone and cylinder type collimators as they have to be changed every time a different area has to be exposed.

Non adjustable cylinder	Adjustable cylinder	Cone

Penumbra formation

— Penumbra is the lighter shadow formed towards the edges of a dark shadow. It is formed by overlapping of light or x-ray originating in one direction from the different source. The penumbra is less with cylinder type collimator and more with aperture diaphragm.



X-ray beam filter

These filters have thin layer of aluminium (0.5-1 mm) inside them and are used to absorb lower energy photons of x-ray beam.

As we know that diagnostic x-ray beam is consisting of a spectrum of different energies in which the lower energy photons do not contribute towards diagnostic quality of radiograph (and rather increase the radiation dose of patient unnecessarily).

Therefore, these aluminum filters are placed between x-ray beam and the patient so that primary beam comprises only useful photons.

Grid

This is a flat plate containing a series of alternating strips of radiographic (lead) and radiolucent material (plastic or thin aluminum) enclosed in aluminum protective covering of thin aluminum. The grid is placed between the part to be radiographed and cassette so as to absorb scatter radiation falling on the film. Use of grid, however results in removal of large quantity of x-rays required to produce desired radiographic density and thus radiographic exposure factors have to be increased to compensate for the losses.

الوحدة الثالثة وعشرون - المحاضرة الثالثة وعشرون- الزمن: 120دقيقة

أهداف المحاضرة الثالثة وعشرون:

يتوقع في نهاية الجلسة أن يكون الطالب قادراً على معرفة ماهو INFANT INCUBATOR واستخداماته وطرق تشغيله.

موضوعات المحاضرة الثالثة وعشرون:

INFANT INCUBATOR – part 1

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
23	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

A neonatal incubator is a rigid box-like enclosure in which an infant can be kept in a controlled environment for observation and care. The device may include a heater, a fan, a container for water to add humidity, a control valve through which oxygen may be added, and access ports for nursing care.

Principles of Operation:-

- The neonate lies on a mattress in the infant compartment, which is enclosed by a clear plastic hood. Most incubators have hand access ports with doors that permit the infant to be handled while limiting the introduction of cool room air.
- The clinician can raise or remove the plastic hood or open a panel to gain greater access to the infant. Some units feature an air curtain that causes warm air to sweep past the opening.
- Most incubators warm the infant by a forced or natural flow of heated air. At least one unit supplements air convection by actively warming the incubator walls to reduce radiant heat loss.

- Another unit uses a mattress of warm water, rather than a convective airflow, to warm the infant.
- Heating and humidification systems are located beneath the infant compartment.
- A fan or natural flow circulates air past the heater and the temperature measuring device, over a water reservoir used to humidify the air (if desired), and up into the infant compartment.
- Most incubators are equipped with proportional heating controls that provide electrical power to the heating coil in response to the difference between the actual temperature and the desired temperature.

Most units have two modes of operation:

- a) Air-temperature control: With the air-temperature (manual) control, the operator sets the temperature of the air in the incubator; changes in infant body temperature are usually measured periodically with a thermometer, and adjustments in air temperature are made accordingly.
- b) Skin-temperature control: In the skin temperature control mode, also called the servo (automatic) mode, a sensor is taped to the infant's skin, and the heater responds to changes in the sensor to keep the skin temperature at the preset level.

Many incubators have one or two oxygen inlet ports and can be equipped with optional oxygen controllers. These incubators can also provide support and protection for oxygen cylinders when oxygen must be delivered to the infant in the incubator. Because the room temperature of the nursery is nearly always lower than the temperature inside the incubator, radiant heat loss through the incubator walls accounts for as much as half the infant's total heat loss. In some nurseries, a plastic heat shield is placed over the infant inside the incubator to minimize radiant heat loss. In addition, some incubators have double walls separated by an air space to prevent excessive heat loss. However, in a study comparing heat loss from servo-regulated single- and double walled.

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موضوعات المحاضرة الرابعة وعشرون:

INFANT INCUBATOR – part 2

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
24	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

The main system of infant incubator:-

1- Air circulation system:- contain:

a- Fans used to distribute the air inside the glass and also distribute the temperature that the heater made it through the operation.

b- Micro filter:- it is made of special fibers composed of three layer to pure the air.the micro filter must be replace each three month.

c- Filter cap

d- Air convection tube:- it convect air from behind filter directly to air champer.

2- Humidification system:- contain

a. water tank:- it is contain distilled water down infant champer,water must be replaced every 24 hours at least.

b. sawtooth plate:- is used to hot air passage distance increase on water tank to obtain on proper humidification.

c. mechanical switch to control on dry and moist air

3- Heating system

a. heater

b. thermostat used to control the temperature inside the incubator so it will disconnected when the temperature reached the wanted level, when temperature decrease or increase from 37 °c or according to the situation of the baby.

c. safety thermostate used to prevent temperature from increasing above 38 °c that connect with electronic circuit shots a sound or light alarm in case increasing of temperature.

4- control system:-the control system uses thermistor in bridge circuit,with the set point resistance, the bridge out put is amplified, giving the voltage V1, which is proportional to the diffrence in temperature between the thermistor and the set point resister.A 1 HZ-low freqeuncy saw tooth generator produces voltage V2, having an amplitude aqual to the maximam value of V1, then V1 and V2 are compared in a comparator circuit that produces on out put voltage V3 when V1 is graeter than V2. V3 voltage controls agate pulse generator that produces pulses for the silicon-controlled switch. While V3 is high,the silicon controlled switch allows the power line voltage to be applied to the heater of the incubator. Figure (1) shows the block diagram of control system.

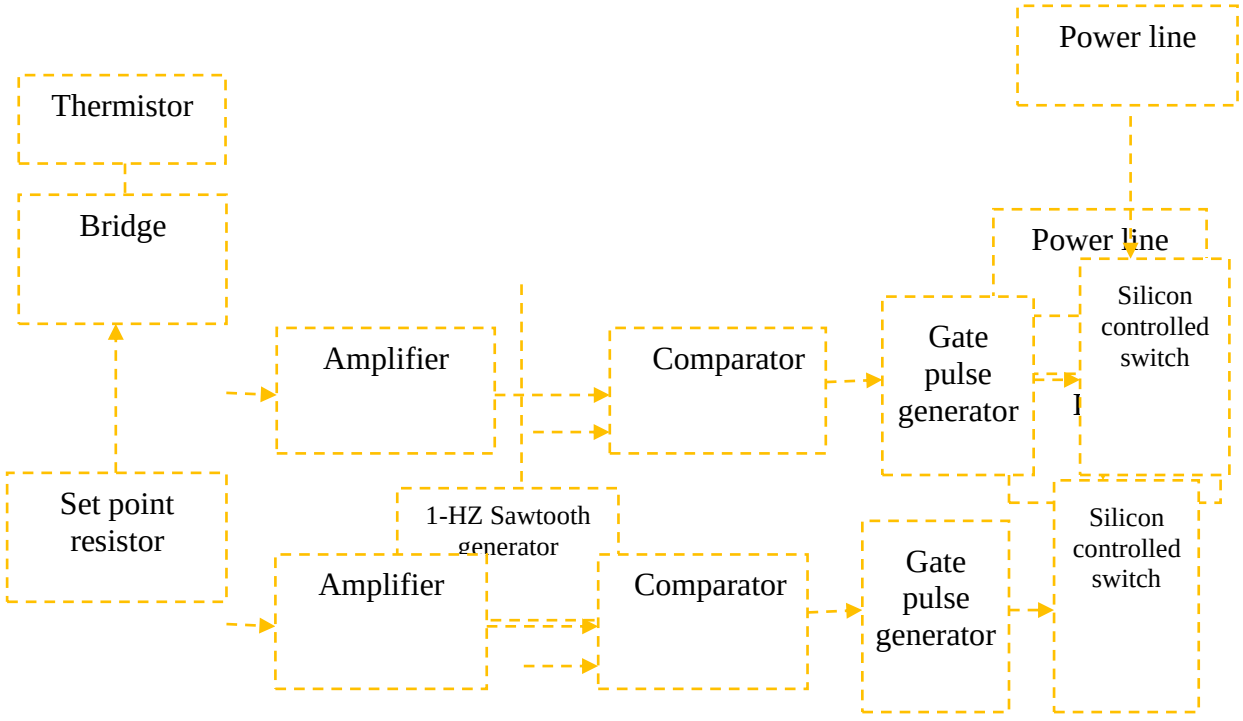

Figure (1): block diagram of control system

4- infant champer: - it is made of resist glass or plastic. It is contained group of holes to control and regulate infant position and temperature

5- Alarm system:- incubator have simple alarm system to alert the clinical staff if there is any dangerous of the device. The system contain a temp controller switch that carriers power to alarm when the temperature exceeds the safe limit, there is a buzzer connected in series with that is activated by a bimetallic strip.

Faults and maintenance:

1. The temperature high inside the glass, in order to solve this problem we should check the motor of fan, where the fan not work because of burning of motor or problem in switch of working. And then check the thermostat that control the temperature inside the glass, in this case the heater work with all its nature because there will be no control on thermostat, so it is should be change, in order to prevent burning of the child.
2. If there is no reading to the temperature its either fault in the thermostat or fault in the sensor which is responsible for reading.
3. There is a leak inside the glass of incubator, so make sure that all the holes or opening found in the hot glass closed and there is no leak.
4. The incubator has no problem and do not work so check the power supply.
5. Fault in the increasing temperature alarm lamp.

الوحدة الخامسة وعشرون - المحاضرة الخامسة وعشرون- الزمن: 120دقيقة

أهداف المحاضرة الخامسة وعشرون:

يتوقع في نهاية الجلسة أن يكون الطالب قادراً على معرفة Medical gases system **واستخداماته وطرق تشغيله.**

موضوعات المحاضرة الخامسة وعشرون:

Medical gases system– part 1

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
25	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

1- Introduction

Most people think of the medical gas system as oxygen that is pumped to patients in surgery or in their hospital room. In fact, there are several gases that make up the average medical gas system including the anesthesia gases that are part of the cart in the operating room. Medical gas systems sustain life and are regulated as a drug. This means multiple layers of restrictions and instruction on the proper, safe and legal way to do things. According to CBC News, the first recorded medical gas cross connection deaths were at a former Sudbury General Hospital in Canada back in 1973. The outcome of this tragic event was the evolution of a code requiring 3rd party verification and later installer certifications.

The concern for patients and the efficiency of hospitals has led to several layers of oversight of medical gas systems from the government (CMS and OSHA) their agents (TJC and NPV) and the industry in the NFPA 99-2012 code. While all these organizations have oversight and regulatory power over medical sites using gases, their regulations do not always seem to completely agree.

Since there is so much scrutiny over the use of these medicinal gases, most hospitals hire third party inspectors annually to check every element of their system to confirm they are working correctly to keep patients and staff safe and meet the standards set by the organizations above. Not passing a medical gas inspection (or receiving citations) can affect a hospital's reimbursement and or accreditation status . This guide is to provide an overview of medical gas systems including :

Medical Gas Source Equipment
Manifold Rooms and Equipment
Medical Gas Alarm Systems
Patient Room Gas Connections
Hoses, Pigtails and Connectors
Additional Resources

Piped medical gas comes from somewhere and like running water, you don't think about it until you open the faucet and nothing comes out. Source equipment are the pumps, compressors, manifolds and bulk containers that provide or create medical gases in the hospital piping system. Source equipment may have multiple pieces of hardware to filter, pressurize, clean, dry or regulate the gas to provide a clean and safe pressurized medical gas that meets the NFPA required pressure and volume rates at each medical gas terminal. Let's first consider the most popular medical gas, Oxygen.

Oxygen

Oxygen can come from a high pressure cylinder and in some cases like dentist offices, may in fact be connected directly to the equipment that touches the patient. Most hospitals and even medical buildings though have an oxygen supply that comes from a tank of liquid oxygen stored in a special room or most often outside the building. Commonly, in the back of the hospital you will see a very tall white tank connected to pipes at the bottom and surrounded by a fence. This tank contains hundreds of gallons of liquid oxygen. A hospital is required to have a minimum of one day's supply on hand as well as a one normal day's back up supply should the main system fail to sustain their patients giving them time to fix or replace the primary oxygen supply .

The liquid oxygen boils at normal temperatures and the gaseous phase is piped at a regulated pressure into the hospital building where it is measured and the pressure regulated before being piped throughout the building. At the entry point, there must be a shut off valve and a pressure sensing alarm. In fact, the main and back up oxygen sources are monitored so that the alarms can tell not only that the gas is present and at the right pressure, but how much is in the primary and back up supply as well. This information is presented to the facility manager on a Master Alarm panel as well as the duplicate master alarm panel usually in the security office that is monitored 24/7 . Cylinders of oxygen are defined by their color, green, their label and their unique gas specific connection fittin.

Once the oxygen is in the piped gas system it follows through a special kind of copper pipe that has to be brazed together in a nitrogen atmosphere. These oxygen pipes in the walls and ceilings of the hospital deliver the pure oxygen to the outlets on the wall we are used to seeing. Before the oxygen gets to those outlets it is valved, gauged and alarmed one or two more times. The system is set up to be able to isolate a section of the hospital piping for repair, maintenance and inspection purposes. Zone valves are accessibly located on the patient floors to isolate a group of patient rooms in the event of an emergency or maintenance. Some zone valves will have a zone alarm panel located on the same floor to monitor the pressure that is delivered to each terminal. These valves must have visual gauges attached downstream of the valve to give a visual reading of the pressure so that hospital personnel will know the pressure in the line. Zone valves and gauges are most often built into a box set into the wall so that only authorized people can touch them . The oxygen flows from the zone valve to outlets in patient areas or to another local alarm and valve setup near, but not in, the operating or procedure rooms. The oxygen flow may then be connected to anesthesia equipment or a breathing mask.

The oxygen is distributed through the outlet on the wall with a gas specific “quick connect” type fitting that comes in 7 different mechanical configurations. Oxygen outlets, fittings and flexible hoses are colored green and will only connect with oxygen components. Patients connected to house oxygen will have a volume regulator usually connected to the wall outlet to control the amount of oxygen coming to their mask or canella.

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موضوعات المحاضرة السادسة وعشرون:

Medical gases system– part 2

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
26	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

Medical Vacuum

Vacuum is the second most popular medical gas in use and one often seen by patients and visitors. The vacuum is created by running a mechanical pump like a compressor in many regards, but instead of creating a high pressure in the pump and sending that compressed gas to the receiver tank, this pump sucks the gases out of the receiver tank and forces the compressed air outside leaving a vacuum in the receiving tank that is connected to the house piping . Vacuum pumps come in several mechanical designs and must be redundant. Since they may be running 24/7 under varying loads they will have various controls and alarms to maintain the pressure, but also to activate the second (or third) pump if needed.

In some cases, the running of these pumps is alternated to provide equal wear. The vacuum pressure is metered and sent to the master alarms. Commonly, zone valve boxes will have a

vacuum line valve, gauge and perhaps a sensor inside along with the oxygen equipment. There may be other pipes, valves, gauges and sensors for additional gases in the zone box depending on the setup . Patient area vacuum is connected by inlets with the same gas specific quick connect set up as the oxygen. Each gas has its own unique kind of hose connection. Therefore, you cannot plug a vacuum device into an oxygen outlet or any other.

These unique fittings are meant to protect against cross connections where the wrong gas could be inadvertently sent to the patient. The vacuum inlets and connectors are white. In most cases, patient use of vacuum is done having a regulator plugged into the wall inlet and the regulator displays the strength of the vacuum and acts as the on/off valve at the site . One of the challenges of maintaining vacuum is that in actual use it draws fluids and solids out of bodies to make surgery and breathing easier. Inherently, this means “gunk” of many kinds and consistencies is pulled into the plumbing. In surgery, there are gravity traps called canisters that capture most of the liquids and solids, but cannot stop the matter that has been aerosolized.

At the point of use, these fine particles are hardly visible, but as the material gets pulled through the system they may accumulate inside the piping even getting into receiving tank and the pump itself. This is most often a problem in surgery where the greatest amount of matter is suctioned. The lines from the inlets, and even the plumbing in the operating room can occlude which reduces the volume and pressure the inlet can deliver to the surgical staff. Typically, the remedy when this happened would be to replace the plumbing in the wall which was expensive, time consuming and took the operating room and adjacent areas out of service. Today CHT has developed a patented VacWash machine that allows the surgical vacuum system to be cleaned during off hours without replacing any inlets or plumbing .

Waste Anesthetic Gas Disposal

The Waste Anesthetic Gas Disposal system is also considered a medical gas though it really is a special vacuum system for surgery or procedure areas. Anesthesia gases put patients out

during their surgery and the anesthesiologist will mix the anesthetic gas with nitrous and oxygen to get the right combination of sedation while maintaining breathing.

This is very tricky and requires the doctor to monitor respiration and heart rate very closely while administering gases to the patient breathing mask or equipment. Not all these gases are consumed by the patient, in fact with every exhale the patient returns some of the anesthesia to the mask. Exposure of even small amounts of these anesthesia gases over a long period of time can be harmful to the staff doing the surgery so the WAGD system uses vacuum pumps to draw the excess and exhaled gases away from the patient, the anethesiologist and the others in the operating room .

Depending on the volume of surgeries performed the WAGD system may be plumbed completely separately from the vacuum system or merged with the general vacuum piping at some point outside the operating room. The focus is to draw away these excess gases and pump them outside the building usually through a roof vent that is placed away from people and any other air intakes .

WAGD inlets, tubing and piping will be labeled and colored purple. The fittings for WAGD are gas specific unique and cannot be connected to any other outlet or inlet. The vacuum pumps for the WAGD system are inspected like the other mechanical equipment in the source equipment room. The only concern for this system is that the vacuum pressure is maintained at a level strong enough to pull the flammable mixture of anesthesia, nitrous and oxygen through the system and out of the building before it can ignite.

Medical Air

Medical air is the only gas we manufacture on site and deliver to the patient for breathing purposes. Medical air is a prescribed drug by a doctor, because of that the air quality of the gas must meet the United States Pharmacopeia (USP) requirements. Medical air is created centrally to provide a reliable supply of breathing air that has the right humidity for breathing.

Medical air is drawn from outside air using an intake vent away from other gas activity and pulled into a compressor to boost its pressure. The compressed air is sent through an aftercooler to the receiver tank. On the way to the receiver tank the medical air goes through a drier that removes moisture that accumulates during the compression process. The medical air passes through a “dew point” sensor that adjusts how much the drier has to do to make air comfortable for breathing. There is likewise a sensor in the medical air line to check for Carbon Monoxide which could be fatal if administered during surgery. As it is used the medical air comes from the receiver tank through a one micron filter, and past a test port. The medical air flows into the house system through a valve, sensor, alarm and mechanical gauge in the source equipment room. Medical air fittings are colored yellow and will only fit medical air outlets .

Like vacuum, medical air needs to be available 24/7 so the compressor has to have at least one redundant partner. These pumps are typically inspected every three months or 300 running hours. The preventative maintenance inspector measures electrical inputs to diagnose any internal friction in the pump as well as visually inspecting belts, driveline parts and the sensors in and around the pump to make sure they are sending the proper signals to the alarms .

A compressed air dryer is used to remove water vapor from compressed air. Redundant compressed air dryers are mandatory for medical usage. The process of air compression concentrates atmospheric contaminants, including water vapor. This raises the dew point of the compressed air relative to free atmospheric air and leads to condensation within pipes as the compressed air cools downstream of the compressor. Excessive water in compressed air, in either the liquid or vapor phase, can cause a variety of operational problems for users of compressed air especially breathing medical air .

The dryer’s performance is measured by the dew point or the amount of water contained in the air coming out of the dryer. Too much water in the air (dew point too high) will trigger alarms. All driers require a drain to evacuate the water taken from the compressed air and these drains must be kept clear.

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موضوعات المحاضرة السابعة وعشرون:

Medical gases system– part 3

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
27	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

Medical Gas Alarm Systems

Medical gas alarm systems can vary in what they report and measure, NFPA and other agencies set the minimum standards, but with current technologies many alarm panels display more than the minimum requirements. Medical gas alarm panels come in three general descriptions or level of protection :

Master alarm panels that monitor source equipment, manifolds and main oxygen supply .

Zone alarms that will protect a section of the hospital and typically monitor the presence and pressure of oxygen .

Area alarms that monitor at least oxygen and vacuum in surgical, procedure and recovery rooms. Critical care and anesthizing locations are required to have area alarms to monitor each gas in that zone. With newer sensors and digital internal components, pressures can be read directly on the alarm screen along with other values .

Each kind of alarm is associated with a valve and a visual gauge to allow isolation of part of the system in emergency or for maintenance purposes. Modern alarms can be connected by wireless signals to the sensors and to other alarm panels. There are a multitude of restrictions and safety requirements with this method to avoid radio frequency interference and even hacking .

Each pipeline coming to the valve has a sensor of some sort in it. The kind of sensor will determine what values are measured. At least the presence of the required gas and the pressure of it supplied are determined and that information sent to the alarm panel. The alarm is required to show a light or signal when the pressure is not correct and sound an audible alarm. Alarms can be silenced to reduce stress, but will sound again when another signal is activated. Some alarms can be programmed to resume sounding if the out of spec condition continues .

Master Alarm panels are redundant: one in the area of responsible surveillance like the facility's office or engineering office and one in a place monitored 24/7 like a security office. If there is a break in the supply of any these life-saving gases the alarm needs to warn everyone .

For most hospitals with cryogenic oxygen in an outdoor tank farm the master alarm will have lights to show :

Oxygen :

High main line pressure
Low main line pressure
Primary liquid level low (Less than an average day's supply)
Reserve in use
Reserve liquid level low (Less than an average day's supply)
Reserve low pressure

Manifolds with dewars or cylinders (usually Nitrogen, Nitrous, CO2,) each gas will most often have lights for:

High main line pressure

Low main line pressure

Secondary in use (changeover)

Reserve in use

Reserve low pressure

Medical Air :

High main line pressure

Low main line pressure

High dew point

Carbon monoxide level*

High temperature* (operating temperature of the compressor)

Lag*

*if using liquid ring compressors there must also be a high water in the tank

)LPM* & high water in the separator (

Vacuum :

Low vacuum pressure

Lag *

Instrument Air :

High main line pressure

Low main line pressure

High dew point

High temperature at compressor*

Lag*

*These signals can be listed on the master alarm as a common alarm like “Maintenance required ”.

The number of lights and the arrangement can vary depending on the details of the source equipment being used. Some types of pumps require extra alarms and some backup systems will also require alerting the 24/7 station. Alarms must be powered by the emergency back up supply circuit so they work even if outside power is interrupted .

Where there are multiple sources, perhaps in multiple buildings, these sources will also need to be identified on a master alarm. In those cases, facilities should be told which system is alarming as well as the symptom .

The most important action to be taken by the person that monitors a master alarm is to ensure maintenance is immediately called to look into any alarm sounding. Telling the person which light is on can save them time to confirm the life sustaining medical gas continues to flow .

Annual and CMS inspections will go over the panel to make sure the correct signals are available and all lights are working. While not part of a regular inspection the sensors on the pipeline can and should be tested.

JC, CMS also require that the facility demonstrate reporting that the alarms are not only there, but they are properly monitoring the equipment and activating the proper alarms. NFPA and ASSE require alarm sensors and switches to be tested to ensure functionality of the signals. Since these tests may involve interrupting the flow of gas they are done with advance warning, by certified people under special conditions .

The zone alarm typically covers a floor or part of a floor of patient rooms. Likewise, it alerts if the supply drops for some reason with lights and sound.

The area alarm is placed close to, but not in the same room as the gases being used to allow people outside the operating rooms to attend to alarms and the associated valve and gauge inside the wall box.

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موضوعات المحاضرة الثامنة وعشرون:

Medical gases system– part 4

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
28	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

Hoses, Pigtails and Connectors

There may be hoses that connect equipment to the wall that get reused and these lines should be inspected by the hospital staff to make sure they are not kinked or cracked. This would lower the system pressure or cause vacuum pumps to run excessively by sucking the air out of the room .

More common is the concern about the hoses in surgery areas. They can get bent, stepped on and pinched by equipment. In the case of vacuum, they can also accumulate debris that reduces the efficiency of the system to help the surgical staff. The standard recommendation is that the booms and boom hoses get inspected or replaced every 18 months. Of course, each hose has its own color to indicate the kind of gas it carries and will have connectors at either end unique to the type of gas conveyed .

“Pigtails” or the connecting lines from the gas cylinders to the manifold will usually be inspected and leak tested every 6 months. Since the cylinders containing the various gases run out and must be replaced on a regular basis these fittings and hoses do get worn.Most of the non-oxygen pigtails (connecting hoses) are stainless steel reinforced plastic to protect them from pinching and kinking among these bulky cylinders and in the tight spaces to connect and use wrenches to tighten fittings. The hoses are inspected for cracks and broken outside fibers. Replacement hoses must match fittings for each kind of gas .

Medical gas systems in healthcare facilities are regulated drugs. The actual molecules are provided by outside vendors in liquid or gaseous state. The delivery system is highly regulated and the technologies used to deliver and monitor the administration of these drugs has multiple levels of supervision from the hospital, the industry and the government.

Medical gas systems must be built by certified installers and then verified by a specially trained verifier before they can be used. Once the system is up and running annual inspections make sure the patients and the staff are being protected and served well by the system.

The information in this overview is believed to be accurate at the time of publication. Standards and rules are constantly evolving and each facility may have special requirements that require accommodations. The best procedure for any specific question about medical gas is to consult a certified expert like those at CHT. More complete and detailed descriptions of these systems, their mechanisms and the required safeguards can be found in the publications and web sites of:

Center for Medicare and Medicaid Services
The Joint Commission
Occupational Safety and Health Administration
American Society of Sanitary Engineers
National Fire Protection Association
American Society of Healthcare Engineering

الوحدة التاسعة وعشرون - المحاضرة التاسعة وعشرون- الزمن: 120دقيقة

أهداف المحاضرة التاسعة وعشرون:

يتوقع في نهاية الجلسة أن يكون الطالب قادراً على معرفة ماهو rehabilitation equipment واستخداماته وطرق تشغيله.

موضوعات المحاضرة التاسعة وعشرون:

rehabilitation equipment – part 1

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
29	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

As of the late 1970s, medical care in Indonesia was not sufficient compared to the situation in other Asian countries, especially in the three provinces of Northern Sumatera, South Sulawesi and North Sulawesi. In order to upgrade the medical facilities in these three provinces, and thereby improve medical services in the areas, the Government of Indonesia (GOI) requested the Japanese Government (GOJ) for its cooperation. As a result, the preceding project, "Development of Medical and Hospita Facilities Project," was implemented with financing from Japan's ODA loan agreed to in 1979, to supply medical equipment to 20 hospitals in North Sumatera, South Sulawesi and North Sulawesi (hereafter referred to as the "target provinces"). However, some of the procured equipment was left abandoned for more than two years owing to delays in construction of hospital buildings and arrangement of other infrastructure such as electricity, due to insufficient local funds. The equipment supplied under the preceding project was, therefore, not effectively utilized, mainly as a result of deterioration resultin from abandonment. Other problems contributing to inadequate equipment utilization

were insufficient infrastructure, insufficient knowledge concerning the equipment, and inadequate operational manuals. There were no alternative medical facilities near 20 hospitals where the medical equipment supplied; therefore, rehabilitation of the existing equipment in these hospitals was urgently needed in order to facilitate its intended effect and thereby to improve medical services in the target provinces.

The benefits of rehabilitation

Rehabilitation can reduce the impact of a broad range of health conditions, including diseases (acute or chronic), illnesses or injuries. It can also complement other health interventions, such as medical and surgical interventions, helping to achieve the best outcome possible. For example, rehabilitation can help to reduce, manage or prevent complications associated with many health conditions, such as spinal cord injury, stroke, or a fracture.

Rehabilitation helps to minimize or slow down the disabling effects of chronic health conditions, such as cardiovascular disease, cancer and diabetes by equipping people with self-management strategies and the assistive products they require, or by addressing pain or other complications.

Rehabilitation is an investment, with cost benefits for both the individuals and society. It can help to avoid costly hospitalization, reduce hospital length of stay, and prevent re-admissions. Rehabilitation also enables individuals to participate in education and gainful employment, remain independent at home, and minimize the need for financial or caregiver support.

Rehabilitation is an important part of universal health coverage and is a key strategy for achieving Sustainable Development Goal 3 – “Ensure healthy lives and promote well-being for all at all ages”.

Misconceptions about rehabilitation

Rehabilitation is not only for people with long-term or physical impairments. Rather, rehabilitation is a core health service for anyone with an acute or chronic health condition, impairment or injury that limits functioning, and as such should be available for anyone who needs it.Rehabilitation is not a luxury health service that is available only for those who can afford it. Nor is it an optional service to try only when other interventions to prevent or cure a health condition fail.

For the full extent of the social, economic and health benefits of rehabilitation to be realized, timely, high quality and affordable rehabilitation interventions should be available to all. In many cases, this means starting rehabilitation as soon as a health condition is noted and continuing to deliver rehabilitation alongside other health interventions.

الوحدة الثلاثون - المحاضرة الثلاثون- الزمن: 120دقيقة

أهداف المحاضرة الثلاثون:

يتوقع في نهاية الجلسة أن يكون الطالب قادراً على معرفة ماهو rehabilitation equipment واستخداماته وطرق تشغيله.

موضوعات المحاضرة الثلاثون:

rehabilitation equipment – part 2

الأساليب والأنشطة والوسائل التعليمية

م	الأساليب والأنشطة التدريبية	الوسائل التدريبية
30	• محاضرة • مناقشة • سؤال وجواب	• جهاز حاسوب • جهاز عرض • سبورة • اوراق واقلام

المادة العلمية:

Unmet global need for rehabilitation

Globally, about 2.4 billion people are currently living with a health condition that benefits from rehabilitation. With changes taking place in the health and characteristics of the population worldwide, this estimated need for rehabilitation is only going to increase in the coming years.

People are living longer, with the number of people over 60 years of age predicted to double by 2050, and more people are living with chronic diseases such as diabetes, stroke and cancer. At the same time, the ongoing incidence of injury (such as a burn) and child developmental conditions (such as cerebral palsy) persist. These health conditions can impact an individual's functioning and are linked to increased levels of disability, for which rehabilitation can be beneficial.

In many parts of the world, this increasing need for rehabilitation is going largely unmet. More than half of people living in some low- and middle-income countries who require rehabilitation services do not receive them. Rehabilitation services are consistently amongst the health services most severely disrupted by the COVID-19 pandemic.

Global rehabilitation needs continue to be unmet due to multiple factors, including:

Lack of prioritization, funding, policies and plans for rehabilitation at a national level.
Lack of available rehabilitation services outside urban areas, and long waiting times.
High out-of-pocket expenses and non-existent or inadequate means of funding.
Lack of trained rehabilitation professionals, with less than 10 skilled practitioners per 1 million population in many low- and middle-income settings.
Lack of resources, including assistive technology, equipment and consumables.
The need for more research and data on rehabilitation.
Ineffective and under-utilized referral pathways to rehabilitation.

Rehabilitation in emergencies

Natural hazards such as earthquakes or disease outbreaks and human induced hazards including conflict, terrorism or industrial accidents can generate overwhelming rehabilitation needs as a result of injury or illness. They also simultaneously disrupt existing services and have the greatest impact on the most vulnerable populations and the weakest health systems.

While the important role of rehabilitation in emergencies is recognized in clinical and humanitarian guidelines, it is rarely considered as part of health system preparedness and early response. The result is that pre-existing limitations in rehabilitation services are magnified, health service delivery is less efficient, and people directly affected are at risk of increased impairment and disability.