Ministry of Higher Education & Scientific Research
Al-Rasheed University College
Department of Medical Equipment Technology Engineering

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

# حقيبة تعليمية

# بعنوان: الكيمياء السريرية – أجهزة وتقنيات

إعداد

م. د. سهيل نجم عبد الله

2023 - 2022

# المقدمة

يتسم البرنامج التعليمي لمقرر أجهزة الكيمياء السريرية بالتدريس باللغة الانكليزية لمدة ثلاثون اسبوعا بواقع ساعتين اسبوعيا حيث يتم تدريس الطلبة مبادئ الكيميائية السريرية والاختبارات المتعلقة بها ضمن منهج متكامل يتدرب فيه الطالب خلال هذه الفترة على إكتساب المعلومات والمهارات اليدوية المهمة وعلى فهم دور أجهزة الكيمياء الحياتية السريرية في تشخيص الحالة الصحية والمرضية في أجهزة الجسم المختلفة وكذلك فهم آلية عمل وتصميم تلك الأجهزة، كما يتضمن تعلم الأسس العلمية الصحيحة لمعايرة وتشخيص الخلل في دقة نتائج القياسات لتلك الأجهزة.

# فهرس المحتويات

# فهرس المحتويات (تتمه)

# فهرس المحتويات (تتمه)

# وصف المقرر الدراسي

وفر وصف المقرر هذا إيجازاً مقتضياً لأهم خصائص المقرر ومخرجات التعلم المتوقعة من الطالب تحقيقها مبرهناً عما إذا كان قد حقق الاستفادة القصوى من فرص التعلم المتاحة. ولابد من الربط بينها وبين وصف البرنامج.

| | | |
|---|---|---|
| .1 | المؤسسة التعليمية | كلية التقنية الهندسية الكهربائية |
| .2 | القسم العلمي / المركز | قسم تقنيات هندسة الأجهزة الطبية |
| .3 | اسم / رمز المقرر | أجهزة كيمياء سريرية |
| .4 | أشكال الحضور المتاحة | اسبوعي (عملي + نظري) |
| .5 | الفصل / السنة | 2023-2022 |
| .6 | عدد الساعات الدراسية (الكلي) | 120 ساعة (60 نظري + 60 عملي) |
| .7 | تاريخ إعداد هذا الوصف | 2022 |
| .8 | أهداف المقرر:<br>1. يتعرف الطالب على مفاهيم مادة الكيمياء السريريه.<br>2. يفهم التفاعلات الكيميائية التي تحدث داخل جسم الانسان.<br>3. يفهم تحليليات الكيمياء السريرية وطريقه الكشف عنها.<br>4. يشرح تقنية الاجهزة الطبية المختبرية السريرية ومبدأ عملها.<br>5. يفهم صيانة الاجهزة المختبرية السريرية ويعرف الاعطال الكهربائية والميكانيكية. | |
| .9 | مخرجات المقرر وطرائق التعليم والتعلم والتقييم | |
| | أ. الأهداف المعرفية:-<br>ب. 1.يحدد التركيب الكيمياوي للدم وسوائل جسم الانسان.<br>ب. 2.يعدد الاجهزة المختبرية الطبيه المستخدمة في التحليل الكيمياوي.<br>ب. 3.يفهم مواصفات الجهاز الطبي المختبري.<br>ب. 4.يشرح تقنية الجهاز الطبي المختبريومبدأ عمله.<br>ب. 5.يعدد طرق الكشف والتحليل عن العناصر والمواد الكيميائية داخل جسم الانسان. | |

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| | ب. الأهداف المهاراتية الخاصة بالمقرر:-<br>ب. 1. يستخدم تقنية الجهازالطبي المختبري ومبدأ عمله في التحليل.<br>ب. 2. يحضر المواد الكيميائية الخاصة بالتحليل.<br>ب. 3. يستخدم خطوات طريقة التحليل الكيمياوي.<br>ب. 4. يكتب نتائج التحليل المعروضة في الجهازالمختبري. |
| | ج. الأهداف الوجدانية والقيمية:<br>ج. 1. أن يصغي الطالب بأنتباه الى شرح الاستاذ.<br>ج. 2. أن يتعرف الطالب على اثر مادة الكيمياء السريرية في الحياة.<br>ج. 3. أن يصف الطالب اهمية تحليل العناصروالمواد الكيميائية في سوائل جسم الانسان.<br>ج. 4. أن يهتم الطالب بهدوء ونظام الصف. |
| | د. المهارات العامة والتأهيلية المنقولة (المهارات الأخرى المتعلقة بقابلية التوظيف والتطور الشخصي):<br>د. 1. قابلية الطالب على البحث العلمي.<br>د. 2. قابلية الطالب على المشاركة في النشاطات اللاصفية. |
| 10. | طرائق التعليم والتعلم |
| | محاضرات نظرية – مختبرات عمليه – تجارب كيميائية – ورش عمل – زيارات علمية |
| 11. | طرائق التقييم |
| | اختبارات يومية – اختبارات سنوية – أنشطة علمية |

12. بنية المقرر

| الأسبوع | الساعات | مخرجات التعلم المطلوبة | اسم الوحدة / أو الموضوع | طريقة التعليم | طريقة التقييم |
|---|---|---|---|---|---|
| الأول | 2 نظري + 2 عملي | الطالب يفهم الدرس | Work security in laboratories | محاضرة نظرية | اختبارات أسبوعية |
| الثاني | 2 نظري + 2 عملي | الطالب يفهم الدرس | Quality control | محاضرة نظرية | اختبارات أسبوعية |
| الثالث | 2 نظري + 2 عملي | الطالب يفهم الدرس | Best laboratory use | محاضرة نظرية | اختبارات أسبوعية |

| | | | | | |
|---|---|---|---|---|---|
| الرابع والخامس | 4 نظري + 4 عملي | الطالب يفهم الدرس | Spectrum instrument and uses | محاضرة نظرية + مختبر عملي | اختبارات أسبوعية |
| السادس والسابع | 4 نظري + 4 عملي | الطالب يفهم الدرس | Ion measurement instrument | محاضرة نظرية + مختبر عملي | اختبارات أسبوعية |
| الثامن والتاسع | 4 نظري + 4 عملي | الطالب يفهم الدرس | Salt measurement instrument and it uses | محاضرة نظرية + مختبر عملي | اختبارات أسبوعية |
| العاشر والحادي عشر | 4 نظري + 4 عملي | الطالب يفهم الدرس | Auto-Analysis instrument | محاضرة نظرية + مختبر عملي | اختبارات أسبوعية |
| الثاني عشر والثالث عشر | 4 نظري + 4 عملي | الطالب يفهم الدرس | Mineral's measurement instrument | محاضرة نظرية + مختبر عملي | اختبارات أسبوعية |
| الرابع عشر والخامس عشر | 4 نظري + 4 عملي | الطالب يفهم الدرس | Elisa instrument and its uses | محاضرة نظرية | اختبارات أسبوعية |
| السادس عشر والسابع عشر | 4 نظري + 4 عملي | الطالب يفهم الدرس | Electrical conduction | محاضرة نظرية | اختبارات أسبوعية |
| الثامن عشر والتاسع عشر | 4 نظري + 4 عملي | الطالب يفهم الدرس | Osmotic conduction | محاضرة نظرية + مختبر عملي | اختبارات أسبوعية |
| العشرون والواحد وعشرون | 4 نظري + 4 عملي | الطالب يفهم الدرس | Enzymes and their measurements | محاضرة نظرية + مختبر عملي | اختبارات أسبوعية |
| الثاني والعشرون والثالث والعشرون | 4 نظري + 4 عملي | الطالب يفهم الدرس | Protein and importance | محاضرة نظرية | اختبارات أسبوعية |

| | | | | | |
|---|---|---|---|---|---|
| الرابع والعشرون والخامس والعشرون | 4 نظري + 4 عملي | الطالب يفهم الدرس | Fats and importance | محاضرة نظرية | اختبارات أسبوعية |
| السادس والعشرون | 2 نظري + 2 عملي | الطالب يفهم الدرس | Maemoglobin | محاضرة نظرية | اختبارات أسبوعية |
| السابع والعشرون والثامن والعشرون | 4 نظري + 4 عملي | الطالب يفهم الدرس | Minerals and neutrition | محاضرة نظرية | اختبارات أسبوعية |
| التاسع والعشرون والثلاثون | 4 نظري + 4 عملي | الطالب يفهم الدرس | Immunological | محاضرة نظرية | اختبارات أسبوعية |

| 13. البنية التحتية | |
|---|---|
| 1. الكتب المقررة المطلوبة | |
| 2. المراجع الرئيسية (المصادر) | • Burtis CA, Bruns DE. Tietz fundamentals of clinical chemistry and molecular diagnostics-e-book. Elsevier Health Sciences; 2014 Aug 14.<br>• Clinical Chemistry: Principles, Techniques, and Correlations by Michael L. Bishop 7th Edition. |
| 3. الكتب والمراجع التي يوصى بها (المجلات العلمية ، التقارير ، ... ) | • Luppa, P. B., Sokoll, L. J., & Chan, D. W. (2001). Immunosensors—principles and applications to clinical chemistry. *Clinica chimica acta*, *314*(1-2), 1-26.<br>• Cooper, Gerald R., ed. *Standard methods of clinical chemistry: By the american association of clinical chemists*. Elsevier, 2013. |
| 4. المراجع الالكترونية | https://www.labcompare.com/Clinical-Diagnostics-Equipment/ |
| خطة تطوير المقرر الدراسي: | |
| توفيرمختبركيمياء سريرية يقوم بالتحليلات الكيميائية. | |

# 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 | Al-Rasheed University College |
| 3. | Course title/code | Instrumentation of Clinical Chemistry |
| 4. | Programme(s) to which it contributes | Medical Equipment Technology Engineering |
| 5. | Modes of attendance offered | Yearly |
| 6. | Semester/Year | Year |
| 7. | Number of hours tuition (total) | 120 hrs (60 theortical + 60 practical) |
| 6. | Aims of the Course:<br>1. Preparation of engineers applied in the field of engineering, electrical and electronic technology.<br>2. Graduation of the request to be able to know the parts of different medical devices and the evolution of what happens in the techniques.<br>3. Manages the networks of engineering and technical to operate and maintain medical devices.<br>4. Prepare research and studies to improve and develop medical services.<br>5. Develop proposals and alternatives for medical devices. | |
| 7. | Learning Outcomes, Teaching ,Learning and Assessment Method | |

| | |
|---|---|
| | **A.** Knowledge and Understanding<br>A1. Develop plans and programs of work especially in the maintenance of medical equipment.<br>A2. Supervising the site on the implementation of the work.<br>A3. Preparation of research and studies to improve the development of the work of medical devices.<br>A4. Participation in committees related to the activity of medical devices.<br>A5. Participate in the analysis of tenders for medical devices and alternative selection. |
| | **B.** Subject-specific skills:<br>B1. Training of engineers and technicians on the operation and maintenance of medical devices.<br>B2. Installation and operation of medical devices (supervision and implementation). Provide consultation in the field of medical devices. |
| | **C.** Thinking Skills:<br>C1. Submit scientific projects in the design of circuits for medical devices.<br>C2. Designed electronic board.<br>C3. Sets plans and ideas for the future, which is appropriate to the needs in the field of medical devices. |
| | **D.** General and Transferable Skills (other skills relevant to employability and personal development):<br>D1. The graduate provides scientific and applied skills that enable him to diagnose the resulting malfunctions in medical devices.<br>D2. The ability of the graduate to work electronic boards in the medical devices.<br>D3. The ability of the graduate to train technical personnel in the field of medical devices.<br>D4. Design of alternative electronic circuits. |
| 8. | Teaching and Learning Methods: |
| | Lectures, scientific laboratory, data show, summer training, workshops, seminars, scientific trade shows. |
| 9. | Assessment methods: |
| | Daily evaluations, quarterly evaluations, finally evaluations, practical evaluations, presentation evaluations, attend daily, weekly reports. |

10. Course Structure

| Week | Hours | ILOs | Unit/Module or Topic Title | Teaching Method | Assessment Method |
|---|---|---|---|---|---|
| First | 2 n + 2 e | The student understands the lesson | Work security in laboratories | Theorical Lecture | Weekly test |
| Second | 2 n + 2 e | The student understands the lesson | Quality control | Theorical Lecture | Weekly test |
| Third | 2 n + 2 e | The student understands the lesson | Best laboratory use | Theorical Lecture | Weekly test |
| 4th and 5th | 4 n + 4 e | The student understands the lesson | Spectrum instrument and uses | Theorical Lecture | Weekly test |
| 6th and 7th | 4 n + 4 e | The student understands the lesson | Ion measurement instrument | Theorical Lecture | Weekly test |
| 8th and 9th | 4 n + 4 e | The student understands the lesson | Salt measurement instrument and it uses | Theorical Lecture | Weekly test |
| 10th and 11th | 4 n + 4 e | The student understands the lesson | Auto-Analysis instrument | Theorical Lecture | Weekly test |
| 12th and 13th | 4 n + 4 e | The student understands the lesson | Mineral's measurement instrument | Theorical Lecture | Weekly test |

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|---|---|---|---|---|---|
| 14th and 15th | 4 n + 4 e | The student understands the lesson | Elisa instrument and its uses | Theorical Lecture | Weekly test |
| 16th and 17th | 4 n + 4 e | The student understands the lesson | Electrical conduction | Theorical Lecture | Weekly test |
| 18th and 19th | 4 n + 4 e | The student understands the lesson | Osmotic conduction | Theorical Lecture | Weekly test |
| 20th and 21st | 4 n + 4 e | The student understands the lesson | Enzymes and their measurements | Theorical Lecture | Weekly test |
| 22nd and 23rd | 4 n + 4 e | The student understands the lesson | Protein and importance | Theorical Lecture | Weekly test |
| 24th and 25th | 4 n + 4 e | The student understands the lesson | Fats and importance | Theorical Lecture | Weekly test |
| 26th and 27th | 4 n + 4 e | The student understands the lesson | Maemoglobin | Theorical Lecture | Weekly test |
| 28th and 29th | 4 n + 4 e | The student understands the lesson | Minerals and neutrition | Theorical Lecture | Weekly test |
| 30th | 2 n + 2 e | The student understands the lesson | Immunological | Theorical Lecture | Weekly test |

Infrastructure:

| | |
|---|---|
| 1. Textbooks and References | • Burtis CA, Bruns DE. Tietz fundamentals of clinical chemistry and molecular diagnostics-e-book. Elsevier Health Sciences; 2014 Aug 14.<br>• Clinical Chemistry: Principles, Techniques, and Correlations by Michael L. Bishop 7th Edition. |
| 2. Recommended References for reporting | • Luppa, P. B., Sokoll, L. J., & Chan, D. W. (2001). Immunosensors—principles and applications to clinical chemistry. *Clinica chimica acta*, *314*(1-2), 1-26.<br>• Cooper, Gerald R., ed. *Standard methods of clinical chemistry: By the american association of clinical chemists*. Elsevier, 2013. |
| 3. Electronic reference: | https://www.labcompare.com/Clinical-Diagnostics-Equipment/ |

# 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 بالمحاضرة

ملاحظة: موحدة تعتمد لجميع الاقسام

# الوحدة الأولى - المحاضرة الأولى - الزمن: 90 دقيقة

## أهداف المحاضرة الاولى:

**يتوقع في نهاية الجلسة أن يكون الطالب قادراً على:**

1. **معرفة موضوع الكيمياء السريرية ودورها في المجال التشخيصي والعلاجي.**
2. **التفريق بين البلازما ومصل الدم.**
3. **معرفة مجموعة من مؤشرات مسببات بعض الأمراض مثل الكلوكوز والألكترولايتات والأنزيمات والهرمونات والبروتينات والدهون وبعض مؤشرات المواد الأيضية.**
4. **التفريق بين الـ safety والـ security للمختبرات.**
5. **التعريف بأنواع المخاطر والمخاطرات التي تخص العمل في مختبرات الكيميا السريرية.**
6. **التعريف بالمبادئ الأساسية التي وراء lab safety.**

## موضوعات المحاضرة الاولى:

- **مقدمة عن الكيمياء السريرية.**
- **الدم (البلازما والمصل) وبعض المؤشرات المرضية الموجودة في مصل الدم.**
- **سلامة وأمن المختبرات.**
- **أنواع المخاطر المختبرية.**
- **المبادئ الرئيسية للسلامة المختبرية.**

## الأساليب والأنشطة والوسائل التعليمية

| م | الأساليب والأنشطة التدريبية | الوسائل التدريبية |
|---|---|---|
| 1 | • نشاط التعارف (1/1/1)<br>• محاضرة<br>• مناقشة<br>• سؤال وجواب | • جهاز حاسوب<br>• جهاز عرض<br>• سبورة<br>• اوراق واقلام |

ملاحظة: للتدريسي حرية في تغيير الاساليب والانشطة والوسائل حسب ما يراه مناسبا

الوحدة الأولى جلسة واحدة

المادة العلمية:

# Work Security in Laboratories

## 1.1. Introduction to clinical chemistry

**Clinical chemistry** is known as **clinical biochemistry**, **chemical pathology**, **medical biochemistry** or **pure blood chemistry**) is the area of pathology that is generally concerned with analysis of body fluids such as blood (serum and plasma), urine, spinal fluid, saliva, milk, and sweat. Therefore, it has a primary role in diagnosing many diseases by knowing the connotations of changes in the natural levels of these chemicals in the human body. Any change in any chemical substance inside any organ or any human body fluid indicates a change in the health condition of that part; for example, the pH of the venous (الدم الوريدي) has a standard range between pH = 7.35 to pH = 7.45; rising or decreasing beyond this range would causes death.

A **laboratory** (informally, **lab**) is a facility that provides controlled conditions in which scientific research, experiments, and measurement may be performed. The title of *laboratory* is also used for certain other facilities where the processes or equipment used are similar to those in scientific laboratories.

***Biochemical test:*** All biochemical tests come under chemical pathology. These are performed on any kind of body fluid, but mostly on **serum or plasma**.

**Serum** is the yellow watery part of blood that is left after blood has been allowed to clot and all blood cells have been removed. This is most easily done by centrifugation which packs the denser blood cells and platelets to the bottom of the centrifuge tube, leaving the liquid serum fraction resting above the packed cells. Serum is mixed with different

reagents in order to obtain the concentration of a specific substances in the blood serum, where each substance has its own mixture of reagents comes with a complete kit with its guidance.

**Plasma** is essentially the same as serum, but is obtained by centrifuging the blood without clotting. Plasma therefore contains all of the clotting factors, including **fibernogine**.

- A large medical laboratory will accept samples for up to about 700 different kinds of tests. Even the largest of laboratories rarely do all these tests themselves and some need to be referred to other labs.
- The Common chemical pathology tests include: Sodium, potassium, chloride, Bicarbonate, Urea, Creatinine, Calcium, Phosphate, Albumin, Bilirubin.

The following are some of most common clinical chemistry tests (used on blood and urine specimens) and their clinical significations.

- **Glucose**, or blood sugar, levels indicate how the body handles glucose. Measuring glucose levels can help diagnose diabetes or hypoglycaemia (low blood sugar). Glucose can also be measured using urine (healthy people should have no glucose in urine).
- **Electrolytes** include sodium, potassium, chloride, bicarbonate, calcium, phosphorus, and magnesium. Measuring electrolytes can specifically indicate **certain metabolic and kidney disorders.**
- **Special enzymes** would be released into the blood by organs that are damaged or diseased. The type of enzyme released can indicate which organ is affected, as shown in Table (1.1).

*Table (1.1): Examples of released enzymes inside the blood indicate illness.*

| Enzyme released | Disease indication |
|---|---|
| Creatine kinase | CK-MB, an isoenzyme of CK, is used to distinguish heart muscle damage. |
| Aminotransferase (ALT), Aspartate aminotransferase (AST, SGOT, GPT) | Carry indication of liver disorder |
| Amylase and lipase | Indicates to an inflammation or the possibility of cancer of the pancreas. |

- **Hormones** are secreted by the various endocrine glands to regulate the processes of the body. Increasing or decreasing the levels of certain hormones may indicate over- or under-activity of those glands. Table (1.2) presents examples of these cases.

*Table (1.2): Examples of using hormones tests as an indication of organ disorder.*

| Hormone released | Disease indication |
|---|---|
| Cortisol | Adrenal glands الغدة الكضرية فوق الكلى |
| Thyroxine (T4, T3), TSH يفرز من الغدة النخامية لتنظيم عمل الغدة الدرقية | Thyroid gland الغدة الدرقية |
| LH, FSH هرمونات تنظيم عمل المبايض , ACTHمنظم عمل الغدة الكضرية , growth hormonesهرمون النمو | Pituitary gland الغدة النخامية (وحدة السيطرة المركزية لجميع الغدد بالجسم) |

- **Lipids** are fatty substances such as triglycerides (body fat). Measuring Lipids can

be an indication (دلالة) for coronary heart disease , liver disease, and stroke. There are four types of lipids tests, as presented in Table (1.3).

*Table (1.3): Examples of hormone tests indicate organ disorder.*

| Lipid type | Disease indication |
|---|---|
| Total cholesterol | High total cholesterol indicates a risk for cardiovascular disease (CVD). |
| High-density lipoprotein (HDL or "Good" cholesterol)<br><br>Low-density lipoprotein (LDL or "bad" cholesterol) | High HDL cholesterol is a protective factor against CVD.<br><br>High LDL cholesterol is also a risk factor for CVD. |
| Triglycerides | High triglycerides are another independent risk factor for CVD. |

Ischemic heart disease – الأمراض الناتجة عن نقص مرور الدم الى القلب بسبب انسداد الشرايين المغذية للقلب بالدهون.

- **Other Metabolic substances** can be measured to evaluate organ function.

*Table (1.4): Metabolic substances and their importance in diagnoses.*

| Metabolic substance (metabolite) | Organ affected |
|---|---|

| | |
|---|---|
| BUN (blood urea nitrogen) اليوريا هي المادة الناتجة عن العلميات الأيضية للبروتين. زيادتها في الدم تصعد الى الدماغ وتسبب الاغماء.<br><br>Creatinine وتكون نسبة وجوده بالدم ضئيلة جدا لأن الكلى تقوم بترشيحه من الدم وطرحه الى البول. | Kidney function |
| Uric acid حمض اليوريك – ترسبه في الكلية يسبب الحصى ويترسب في المفاصل مسببا التهاب داء النقرص. | It can signal gout, kidney disease, and other tissue damage. |

**Proteins** can indicate metabolic and nutritional disorders, as well as certain cancers.

*Table (1.4): Proteins and their importance in diagnoses.*

| Protein type | Organ affected |
|---|---|
| Total protein and albumin | It can signal liver or kidney disease or malnutrition. |
| Globulins and the A/G (Albumin to globulin ratio) | It can signal infection, autoimmune disease, and certain blood cancers |

## 1.2. Lab safety and security

**Laboratory safety** keeps people safe from chemicals, and **laboratory security** keeps chemicals safe from people. In some laboratories, the conditions are no more dangerous

than in any other room. In many labs, though, hazards are present. Laboratory hazards are as varied and might include **poisons**, **infectious agents**, **flammable**, **explosive**, or **radioactive materials**, **moving machinery**, **extreme temperatures**, **lasers**, **strong magnetic fields** or **high voltage**. In laboratories where dangerous conditions might exist, safety precautions are important.

## Classification of Hazards and Risks in the Chemical Laboratory

### 1. Large-Scale Emergencies and Sensitive Situations

Different kinds of risks are involved such as fire, flooding, and earthquakes; power outages; hazardous material spill or release; loss of laboratory materials or equipment.

### 2. Security Breach

Possible breaches include theft or diversion of high-value equipment or dual-use chemicals or materials that may be utilized for illegal activities; as well as unauthorized laboratory experimentation.

### 3. Toxic Chemical Exposure

In the chemistry laboratory, no substance is entirely safe and all chemicals result in some toxic effects if a large enough amount of the substance comes in contact with a living system. For example, some chemicals can cause a harmful effect after a single exposure, such as corrosive nitric acid.

### 4. Flammable, Explosive, and Reactive Chemicals

**Flammable chemicals** may be solid, liquid, or gaseous; for example Kerosene, Polystyrene, Gasoline,

**Reactive chemicals** are substances that react violently in combination with another substance, for example water-reactive alkali metals such as Na, K, Li; or incompatible strong acids and bases.

**Explosive chemicals** include a variety of substances that can explode under certain conditions such as oxidizing agents for example: peroxides, and acetone peroxide; as well as certain powders and dust.

**5. Biohazards**

Biohazards are a concern in laboratories that handle microorganisms or materials contaminated with them. Risk assessment for biohazardous materials requires the consideration of a number of factors, including the organism being manipulated, any alterations made to the organism, and the activities that will be performed with the organism.

**6. Hazardous Waste**

Waste is material that is discarded or intended to be discarded, or is no longer useful for its intended purpose. It includes abandoned chemicals and spilled chemicals. Waste is considered hazardous if has one or more of the following properties: **ignitable**, **corrosive**, **reactive**,or **toxic**.

*Why studying Lab safety?*

Lab safety includes rules to minimize the individual's risk, i.e., safety equipment is used to protect the lab user from injury or to assist in responding to an emergency.

**The basis of safety in the chemistry lab depends on:**

1. The desire to protect yourself and your lab-mates from potential hazards,
2. preparation and planning for your laboratory work by being familiar with chemical and instrumental hazards before beginning an experiment.
3. Using protective equipment – goggles, gloves, lab coats, etc.

4. Anticipating potential hazards by asking "what would happen if...?".
5. Minimizing exposure to chemicals.
6. Knowing how to get help in case of an accident.
7. knowing how to properly dispose of any waste you generate.

# Test for Unit One

1. **The primary objective of studying clinical chemistry is to:**
   (a) Study the biochemical reactions inside the body.
   (b) Diagnose diseases based on clinical chemistry tests.
   (c) Measure the liquids of the human body, such as blood.
   (d) Isolate plasma from the blood.
2. **The primary objective of studying clinical chemistry – instrumentation and technology.**
   (a) Measure the liquids of the human body, such as blood.
   (b) Study the biochemical reactions inside the body.
   (c) Repair the equipment used in clinical chemistry.
   (d) Design, maintain, and repair the types of equipment used in clinical chemistry and carry-on calibration and testing.
3. **The blood is composed of:**
   (a) Liquid parts called RBC, WBC, platelets, and plasma.
   (b) Cells are called serum and plasma, with liquids called RBC, WBC, and platelets.
   (c) Cells RBC, WBC, and platelets, with clot.
   (d) The liquid part is called plasma, and the cells are called RBC, WBC, and platelets.
4. **One of the following statements is true:**
   (a) The serum needs centrifugation to be separated.
   (b) Plasma does not contain anti-clot substances.
   (c) The serum contains fibrinogen.
   (d) Red blood cells are clustered at the top of the tube during the serum extraction process.
5. **One of the following statements is true:**

(a) The serum is formed after plasma and contains anti-clotting factors.

(b) The serum is formed before plasma and does not contain fibrinogen.

(c) The serum is formed after plasma and does not contain fibrinogen.

(d) The serum is formed before plasma and contains fibrinogen.

**6. Which test should be conducted to diagnose hypoglycaemia:**

(a) Enzymes

(b) Electrolytes

(c) Blood glucose

(d) Hormone

**7. Serum isolation is important because:**

(a) Maintains the same concentration of the minerals and other blood chemical components for 24 hours.

(b) Maintains the same concentration of the minerals and other blood chemical components for 24 min.

(c) It is isolated using centrifugation.

(d) The serum is plasma without clotting factors, mainly fibrinogen.

**8. Measuring the electrolytes such as chloride, calcium, and potassium can help us in diagnosing:**

(a) kidney and specific metabolic disorders

(b) diabetes

(c) heart muscle damage

(d) Brain tissues

**9. Which statement(s) of the following is(are) true:**

(a) CK-MB is an isoenzyme of creatine kinase used to distinguish the damage in brain cells

(b) Amylase and lipase carry an indication of liver disorder.

(c) Hormones are secreted by various endocrine glands.

(d) Releasing growth hormones in the blood refers to a problem in the Thyroid gland.

**10. Which of the following statement(s) is (are) true:**

(a) High LDL cholesterol and HDL cholesterol in the blood indicates a risk for cardiovascular disease (CVD)

(b) High LDL cholesterol in the blood indicates a risk for cardiovascular disease (CVD)

(c) High HDL cholesterol is a protective factor against CVD

(d) Triglycerides are like HDL, which indicates a high risk of CVD

**11. Which of the following statement(s) is (are) true:**

(a) Measuring the protein helps us in an indication of metabolic disorder only.

(b) Measuring the protein helps us in an indication of some cancer.

(c) Measuring the protein helps us indicate blood cancer and metabolic disorder.

(d) Measuring the protein helps us an indication of autoimmune disease.

12. **Define the following: (** Clinical chemistry, serum, laboratory).

**13. List the clinical significance of increased cholesterol.**

**14. Give the clinical significance of the following: adrenal glands, thyroid gland, and pituitary gland, respectively.**

**15. Why is the serum used instead of plasma in the clinical chemistry tests?**

# الوحدة الثانية – المحاضرة الأولى - الزمن: 90 دقيقة

## أهداف المحاضرة:

**يتوقع في نهاية الجلسة أن يكون الطالب قادراً على:**

1. **التعريف بالسيطرة النوعية للأجهزة المختبرية، وأثرها على دقة نتائج الأجهزة.**
2. **معرفة كيفية ضبط السيطرة النوعية للأجهزة المختبرية، باستخدام منتجات مراقبة الجودة.**
3. **استخدام الطرق الإحصائية لإدارة وتحقيق السيطرة النوعية للأجهزة المختبرية.**
4. **المعرفة والتفريق بين الدقة Accuracy والإحكام Precision.**
5. **التعريف بتقنيات ضمان الجودة ونظام CHP.**

## موضوعات المحاضرة:

- **مقدمة عن السيطرة النوعية.**
- **منتجات مراقبة الجودة.**
- **الطرق الإحصائية في السيطرة النوعية.**
- **الفرق بين الدقة والإحكام.**
- **إدارة وضمان الجودة.**

## الأساليب والأنشطة والوسائل التعليمية

| م | الأساليب والأنشطة التدريبية | الوسائل التدريبية |
|---|---|---|
| 1 | • نشاط التعارف (1/1/1)<br>• محاضرة<br>• مناقشة<br>• سؤال وجواب | • جهاز حاسوب<br>• جهاز عرض<br>• سبورة<br>• اوراق واقلام |

ملاحظة: للتدريسي حرية في تغيير الاساليب والانشطة والوسائل حسب ما يراه مناسبا

الوحدة الثانية جلسة واحدة

المادة العلمية:

# Quality Control

## Quality Control for Equipments

**Quality control** in the medical laboratory is a statistical process used to monitor and evaluate the analytical process that produces patient results.

QC results are used to validate whether the instrument is operating within pre-defined specifications, inferring that patient test results are reliable. Once the test system is validated, patient results can then be used for diagnosis. For example, when a patient's serum is assayed (tested) for potassium, the test result tells us how much potassium (concentration) is present in the blood. This result is then used by the physician to determine whether the patient has a low, normal or high potassium. For example, the normal range for a potassium level is about 3.5 – 5.0 mmol/L. A normal control would contain potassium at a level within this range. An abnormal control would contain potassium at a level below 3.5 mmol/L or above 5.0 mmol/L.

Let's assume the measured value of potassium in a patient's serum is 2.8 mmol/L (a unit of measure: millimoles per liter) This result is abnormally low and indicates an inappropriate loss of potassium. But how does the person performing the test know that this result is truly reliable? It could be possible that the instrument is out of calibration and the patient's true potassium value is 4.2 mmol/L – a normal result. The reliability validation for most testing can be resolved by regular use of quality control materials and statistical process control.

## Quality Control Products

A quality control product is a patient-like material ideally made from human serum, urine or spinal fluid. A control product can be a liquid or freeze-dried (lyophilized) material. Control products should be tested in the same manner as patient samples. **A normal control product** contains normal levels for the analyte being tested. **An abnormal control product** contains the analyte at a concentration above or below the normal range for the analyte. For example, the normal range for a potassium level is about 3.5 – 5.0 mmol/L. A normal control would contain potassium at a level within this range. An abnormal control would contain potassium at a level below 3.5 mmol/L or above 5.0 mmol/L.

Good laboratory practice requires testing normal and abnormal controls for each test at least daily to monitor the analytical process. Regular testing of quality control products creates a QC database that the laboratory uses to validate the test system. Validation occurs by comparing daily QC results to a laboratory-defined range of QC values. The lab-defined range is calculated from QC data collected from testing of normal and abnormal controls.

**Table 3.1: An example of a quality control (QC) Log with Patient Results**

| Test: Potassium | Instrument: Instrument No. 1 | | Unit of Measure: mmol/L |
|---|---|---|---|
| Range ▸ | Level I Normal Control 3.7 – 4.3 mmol/L | Level II Abnormal Control 6.7 – 7.3 mmol/L | Patient Results |
| 1 November | 4.0 | 7.0 | 4.2, 4.0, 3.8, 5.0, 5.8, 4.2 |
| 2 November | 4.1 | 7.0 | 3.8, 4.4, 4.6, 3.9, 4.8, 4.4, 3.9 |
| 3 November | 4.0 | 6.9 | 4.4, 3.9, 3.7, 4.7 |
| 4 November | 4.2 | 7.1 | 4.7, 5.6, 4.2, 3.7, 4.3 |
| 5 November | 4.1 | 7.0 | 4.2, 4.3, 4.1, 4.3 |
| 6 November | 4.1 | 7.0 | 4.6, 4.4, 5.5, 3.8, 3.2 |
| 7 November | 4.2 | 8.0 | 2.8, 4.6, 4.2, 3.2, 3.9, 4.1, 6.0, 4.3 |

In Table 3.1, there are two ranges reported. The acceptable range for the Level I (Normal Control) is 3.7 – 4.3 mmol/L. The range for Level II (Abnormal Control) is 6.7 – 7.3 mmol/L. When the daily QC result obtained for the normal control is compared to the range calculated for the normal control, it becomes apparent that each result lies somewhere within the expected range. This indicates that the analytical process is “in control” at the normal level on that day of testing.

When the daily QC result for the abnormal control (high potassium) is compared to the defined range for the abnormal control, the analytical process is shown to be “in control” for each day of testing except for the last day (11/7). On November 1 through November 6, both controls were “in control” and patient values could be reliably reported. However, the laboratory was “out of control” for abnormal high potassiums on November 7 because the value obtained for the QC material (8.0 mmol/L) was outside the acceptable range (6.7 – 7.3 mmol/L). This means that some error occurred which may have made some patient results unreliable. The laboratory should not report any patient samples with an abnormally high potassium result until the error is resolved and the abnormally high samples are re-tested.

## Calculations and Use of QC Statistics

QC statistics for each test performed in the laboratory are calculated from the QC database collected by regular testing of control products. The data collected is specific for each level of control. Consequently, the statistics and ranges calculated from this data are also specific for each level of control and reflect the behavior of the test at specific concentrations. The most fundamental statistics used by the laboratory are the mean [ $\bar{x}$ ] and standard deviation [ S ].

**Mean:** The mean value (average) for a control material provides an estimate of the central tendency of the distribution that is expected if method performance remains stable. Any change in accuracy, such as a systematic shift or drift, would be reflected in a change in the mean value of the control, which would be shown by a shift or drift of the distribution of control results. The general formula of the mean is being as the following:

$$\bar{x} = \frac{\sum_{i=1}^{n} \bar{X}_i}{n}$$

**Standard Deviation:** The standard deviation is related to the spread or distribution of control results about the expected mean, whereas the mean is an indicator of central tendency. The standard deviation is a measure of the width of the distribution and is related to imprecision. The bigger the standard deviation, the wider the distribution, and the poorer the precision of the method; the smaller the standard deviation, the narrower and sharper the distribution, and the better the precision of the method.

$$S = \sqrt{\frac{\sum_{i=1}^{n} (X_i - \bar{X})^2}{n-1}}$$

Standard deviation may also be used to monitor on-going day-to-day performance. For instance, if during the next week of testing, the standard deviation calculated in the example for the normal potassium control increases from .08 to 0.16 mmol/L, this indicates a serious loss of precision. This instability may be due to a malfunction of the analytical process.

## Accuracy and Precision

**Accuracy** refers to the closeness of a measured value to a standard or known value.

**Precision** refers to the closeness of two or more measurements to each other.

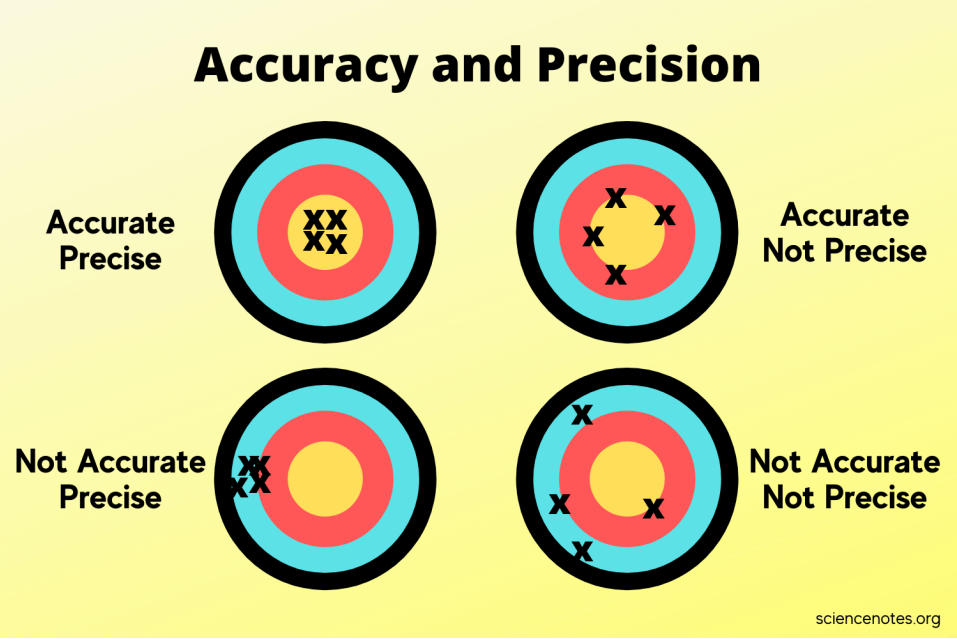


Illustration of accuracy versus precision.

It is desirable to get repeated measurements of the same specimen as close as possible. Good precision is especially needed for tests that are repeated regularly on the same patient to track treatment or disease progress. For example, a diabetic patient in a critical care situation may have glucose levels run every 2 to 4 hours. In this case, it is important for the glucose test to be precise because lack of precision can cause loss of test

reliability.

If there is a lot of variability in the test performance (high standard deviation), the glucose result at different times may not be true.

## Chemical Hygiene Plan (CHP)

**Quality assurance techniques**: all measures taken to ensure good clinical chemistry practice from preparation of the patient before collection of a specimen to correct interpretation of a result.

The chemical hygiene plan, (CHP) includes reviewing of the standard hygiene requirements for the specific lab, evaluating the current situation of lab safety, health, and environmental practice, and hazard assessment. For the companies and hospitals, they mostly assign specialist called Chemical Hygiene Officer (CHO), which is responsible for CHP evaluation, development, and management.

The third-party assessment is also important, to have a fresh "outside view" assessment to cover some points that are left a side due to habits.

# الوحدة الثالثة – المحاضرة الأولى - الزمن: 90 دقيقة

## أهداف المحاضرة:

**يتوقع في نهاية الجلسة أن يكون الطالب قادراً على:**

1. **معرفة وتعداد الإجراءات اللازمة لضمان سلامة المختبر.**
2. **معرفة وتعداد الإجراءات اللازمة لضمان السلامة في التعامل مع المواد الكيميائية.**
3. **معرفة والتفريق بين مختبرات التدريس ومختبرات الأبحاث.**

## موضوعات المحاضرة:

- **الإجراءات اللازمة لضمان سلامة المختبر.**
- **الإجراءات اللازمة لضمان السلامة في التعامل مع المواد الكيميائية.**
- **الفرق بين مختبرات التدريس ومختبرات الأبحاث.**

## الأساليب والأنشطة والوسائل التعليمية

| م | الأساليب والأنشطة التدريبية | الوسائل التدريبية |
|---|---|---|
| 1 | • نشاط التعارف (1/1/1)<br>• محاضرة<br>• مناقشة<br>• سؤال وجواب | • جهاز حاسوب<br>• جهاز عرض<br>• سبورة<br>• اوراق واقلام |

ملاحظة: للتدريسي حرية في تغيير الاساليب والانشطة والوسائل حسب ما يراه مناسبا

الوحدة الثالثة جلسة واحدة

المادة العلمية:

## Best Laboratory Use

The best laboratory use should be applied to avoid the risk of diseases that transfer to human during the clinical analysis and to ensure accurate measurements and better diagnosis. The Micro Lab should practice aseptic techniques during testing in general, to avoid microbial contamination and false positives. In the Micro Lab, areas where EM, water, or product samples are handled/incubated must be adequately separated from areas where there are tests that involve live cultures or sub culturing, microbial ID, or investigations.

### The most important features of laboratory use:

1. Training and verification of proficiency.
2. Equipment validation, calibration, and maintenance.
3. Equipment performance during test.

Housekeeping must be properly maintained to prevent use of expired or contaminated testing materials (mat's).

### BEST LABORATORY USE TO ENSURE LAB SAFETY:

| | |
|---|---|
| 1. | Never eat or drink while working in the laboratory. |
| 2. | Read labels carefully. |
| 3. | Do not use any equipment unless you are trained and approved as a user by your supervisor. |
| 4. | Wear safety glasses or face shields when working with hazardous materials and/or equipment. |

| | |
|---|---|
| 5. | Wear gloves when using any hazardous or toxic agent. |
| 6. | Clothing: When handling dangerous substances, wear gloves, laboratory coats, and safety shield or glasses. Shorts and sandals should not be worn in the lab at any time. |
| 7. | If you have long hair or loose clothes, make sure it is tied back or confined. |
| 8. | Keep the work area clear of all materials except those needed for your work. Coats should be hung in your room or placed in locker. Extra books, purses, etc. should be kept away from equipment that requires air flow or ventilation to prevent overheating. |
| 9. | Disposal - Students are responsible for the proper disposal of used material if any in appropriate containers. |
| 10. | Equipment Failure - If a piece of equipment fails while being used, report it immediately a technician. Never try to fix the problem yourself because you could harm yourself and others. |
| 11. | If leaving a lab unattended, turn off all ignition sources and lock the doors. |
| 12. | Clean up your work area before leaving. |
| 13. | Wash hands before leaving the lab and before eating. |

## BEST LAB USES TO ENSURE CHEMICAL SAFETY

| | |
|---|---|
| 1. | Fill in an “experiment information chart” before conducting an experiment in the chemical lab and let it check and sign by the safety coordinator. |
| 2. | Treat every chemical as if it were hazardous. |

| | |
|---|---|
| 3. | Make sure all chemicals are clearly and currently labeled with the substance name, concentration, date, and name of the individual responsible. |
| 4. | Never return chemicals to reagent bottles. (Try for the correct amount and share any excess.) |
| 5. | Use volatile and flammable compounds only in a fume hood to prevent inhalation of hazardous material. |
| 6. | Never allow a solvent to come in contact with your skin. Always use gloves. |
| 7. | Never "smell" a solvent!! Read the label on the solvent bottle to identify its contents. |
| 8. | Dispose of waste and broken glassware in proper containers and report it to a lab technician. |
| 9. | Clean up spills immediately. |

**Teaching labs.** Laboratory courses in the department provide opportunities to learn about safety in setting of structured activity and direct oversight. Each person working in a laboratory is responsible for the safety of *everyone present*.

**Research labs.** Safety can be an even more important issue when working in research labs, as you may encounter more caustic chemicals and more potentially hazardous equipment. Also, students may have less direct guidance when working in a research lab.

# الوحدة الرابعة – المحاضرة الأولى - الزمن: 90 دقيقة

## أهداف المحاضرة الأولى:

يتوقع في نهاية الجلسة أن يكون الطالب قادراً على:

1. التعريف بأجهزة المطايف ودورها في تحليلات الكيمياء السريرية.
2. معرفة المبادئ الأساسية لعمل المطياف الضوئي.
3. التعريف بالمطياف الضوئي colorimeter ومكوناته وآليه عمله
4. التعريف بالمطياف الضوئي spectrophotometer ومكوناته وآليه عمله
5. معرفة أنواع الفلاتر المستخدمة في تصميم المطاييف الضوئية وكيفية أختيار المناسب.
6. التعريف بأنواع الـ spectrophotometer
7. التفريق بين الـ single beam و الـ double beam reflectometer.
8. معرفة وتفريق بين الـ slit beam و الـ double beam reflectometer.
9. معرفة كل من Fluorescence والـ infra-red reflectometer.
10. معرفة Atomic Spectroscopy وأنواعهم والعناصر المكونة لتلك الأجهزة وآلية العمل لكل نوع
11. معرفة وفهم آلية معايرة انظمة المطايف في تحليلات المختبرات السريرية.

## موضوعات المحاضرة الأولى:

- مقدمة عن المطايف.
- مبدأ المطياف الضوئي.
- أنواع المطايف الضوئية.
- أختيار الأطوال الموجية.
- المطايف الذرية.
- معايرة المطايف الذرية.

## الأساليب والأنشطة والوسائل التعليمية

| م | الأساليب والأنشطة التدريبية | الوسائل التدريبية |
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| 1 | • نشاط التعارف (1/1/1)<br>• محاضرة<br>• مناقشة<br>• سؤال وجواب | • جهاز حاسوب<br>• جهاز عرض<br>• سبورة<br>• اوراق واقلام |

ملاحظة: للتدريسي حرية في تغيير الاساليب والانشطة والوسائل حسب ما يراه مناسبا

الوحدة الرابعة الجلسة الأولى

المادة العلمية:

# Spectrum Instruments and Uses

## Introduction

Spectrum instruments in clinical chemistry laboratory are important for the use of quantitative method such as photometry which measure the radiant energy at certain ranges of the electromagnetic radiation. There are many types of spectrum instrument (colorimeter, spectrophotometer, flame photometer). One of the standard methods used in clinical chemistry is photometry.

**A photometer** is a colourimetric device that can select and apply a single beam of light (with one wavelength $\lambda$) to determine the concentration of known components in serum or liquid based on colour-light absorption. It is achieved by measuring colour solutions absorbance, which is most intense at a specific wavelength, $\lambda$.

The spectrophotometers operate on two modes of wavelength bands; visible and ultraviolet (UV). UV light cannot be seen by the human eyes, while the visible ranges from its name are visible. The UV wavelengths, $\lambda$ range from 190 nm to 380 nm, while the visible light wavelengths, $\lambda$ range ranges between 380 – 750 nm. Table (1) explain the relationship between the wavelength and colour absorbed.

*Table (1): The wavelength and the colour absorbed.*

| Wavelength, $\lambda$ | Name | Color absorbed |
|---|---|---|
| 180-320 | Short UV | Not visible |
| 320-380 | Long UV | Not visible |

| | | |
|---|---|---|
| 380-440 | Visible | **Blue** |
| 500-580 | Visible | **Green** |
| 580-600 | Visible | **Yellow** |
| 600-620 | Visible | **Orange** |
| 620-750 | Visible | **Red** |
| 750-2000 | Short infrared | Not visible |

The sunlight or light that emits from the filament source is a mixing of many radiant energies called a spectrum with different wavelengths that human eyes respond to as white light, but the truth is a spectrum group. The solution appears green as an example because of its ability to transmit the light at 500-580 nm wavelengths but absorbs other wavelengths of the spectrum.

## The Principle of Photometer

It measures the concentration of coloured solutions at a specific wavelength based on colour-light absorption. The general measurement steps of photometer chemical photometry are:

1. The solution to be measured must be coloured, and if it is not coloured, then it should be treated chemically to be coloured. The colour grading should represent the concentration of the solution. Therefore, the light intensity increases proportionally with solution concentration.
2. Passing single light through the solution determines the intensity of the light passing through and exiting the solution (transmitted). In other words, the darker the colour solution, the more concentration and then more absorbance and less

transmittance.

The basic concept of spectrophotometer devices depends on Beer-Lambert law. Spectrophotometry is based on two principles: (1) substances absorb light at unique wavelengths, and (2) the amount of light absorbed is proportional to the amount of substance present.

## Types of Photometers

**A colorimeter** is one of the types of photometric analysis techniques, i.e., it is a light measuring analytical procedure. It uses an optical filters; therefore, it is called a colorimeter, and it works on the Visible light range only (modern one includes two light sources which supports both UV and Visible ranges). The most important parts of a colorimeter are:

(a) **A light source** is usually an ordinary filament lamp (white light), such as **Tungsten lamps.**

(b) An aperture (exit **slit**): it allows only one wavelength (colour) to exit toward the sample. Therefore, a smaller slit opening makes the colorimeter more accurate.

(c) A set of optical **filters** in different colors is used to select the wavelength of light that the solution absorbs the most (wavelegnth can be selected through wavelength selection knob).

(d) A **detector** (photocell) receives the transmitted light and converts its intensity to electrical energy.

(e) A **Cuvette** is a sample container made of quartz, plastic, or glass (Visible range only).

(f) **Output**: The output of the colorimeter may be shown in graphs or tables by an

analogue or digital meter. The data may be printed on paper or stored on a computer.

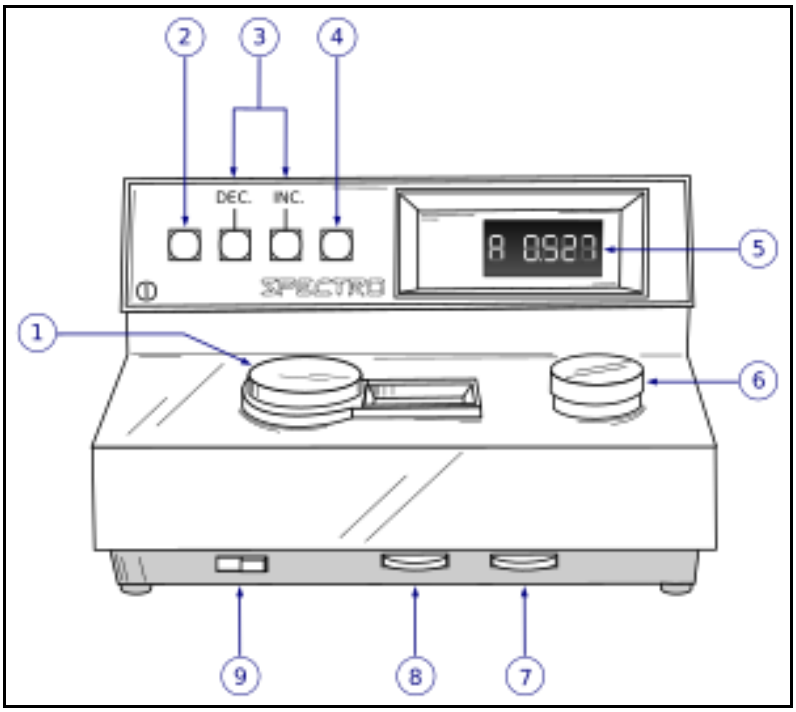



Figure 1: (1) Wavelength selection, (2) Printer button, (3) concentration factor adjustment, (4) UV mode selector (Deuterium lamp) , (5) Readout, (6) Sample compartment, (7) Zero control (100% T), (8) Sensitivity switch, (9) ON/OFF switch.

**A spectrophotometer** is an instrument that measures light of specific wavelengths, where the light had passed through the coloured sample placed in the cuvette, as shown in Figure 2. Not much different from the photometer; only **optical filters** are replaced by **prisms** and **diffraction grating** to generate **monochromatic** light beams, as well as it covers both UV and Visible light ranges.

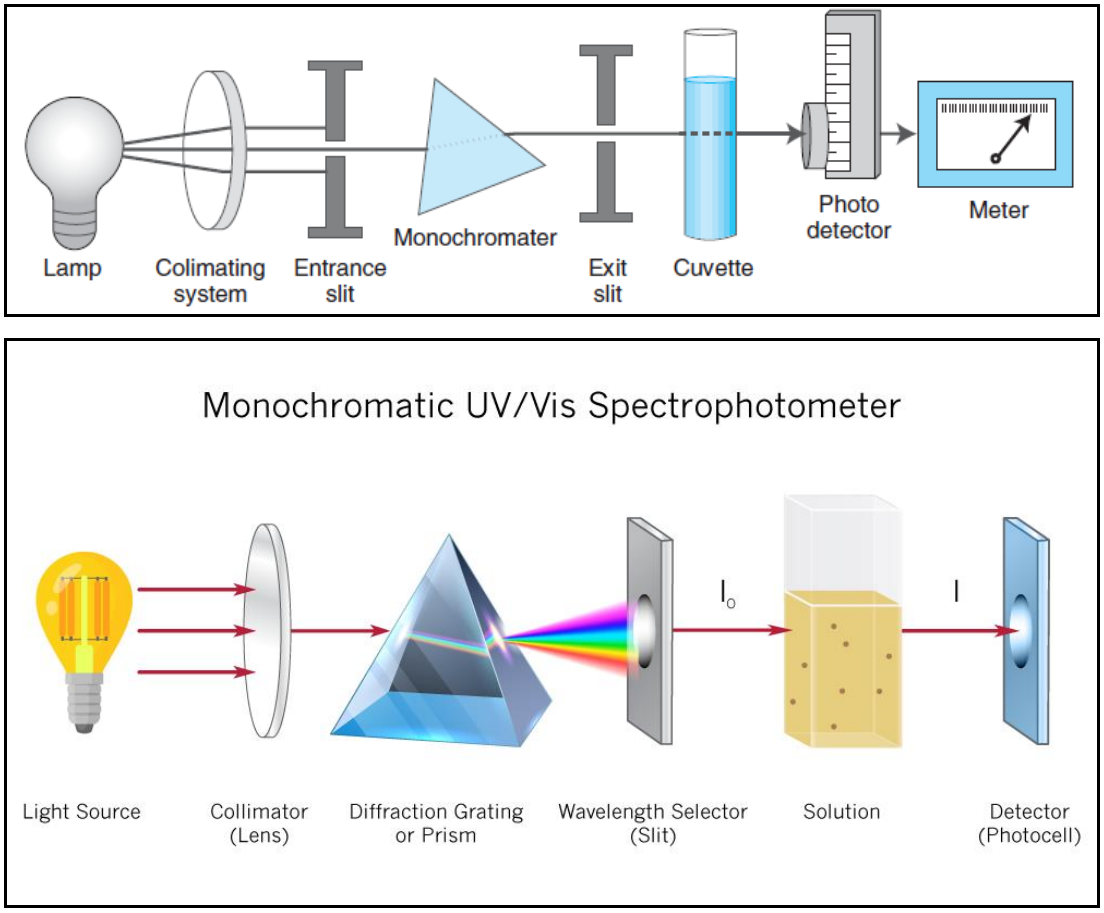



Figure 2: Components of a spectrophotometer.

The components of the spectrophotometers are:

1. **The light source**, or the lamp, provides wavelengths of light in the visible or ultraviolet (UV) range. **Tungsten lamps** are used for visible wavelengths (approximately 380 to 750 nm). **Deuterium** or **mercury-arc** lamps generate UV light. Some light sources such as **Xenon lamps** operate on both UV and visible light ranges.
1. **The monochromator**, such as a prism, or diffraction grating, is used to eliminate unwanted wavelengths of light and allow the desired light ($\lambda$) to reach the sample.
2. A **cuvette** is a sample holder containing the test solution.

3. **A photodetector** detects light transmitted through the sample (because it was not absorbed) and converts the light energy to electrical energy.
4. The readout device indicates the absorbance or concentration based on Beer-lambert's law calculations.
5. **Slit**: this is to adjust the intensity of light emitted through the monochromator, i. e., isolate a narrow beam of light and improve its chromatic purity.

There are two photodetectors; **Photocell** (phototube or photoelectric detector) (commonly used), and **photosensitive semiconductor device**.

**Photocell** is a device that converts incident light energy into electrical energy, the type of photocell is a photomultiplier tube, as shown in Figure 3.

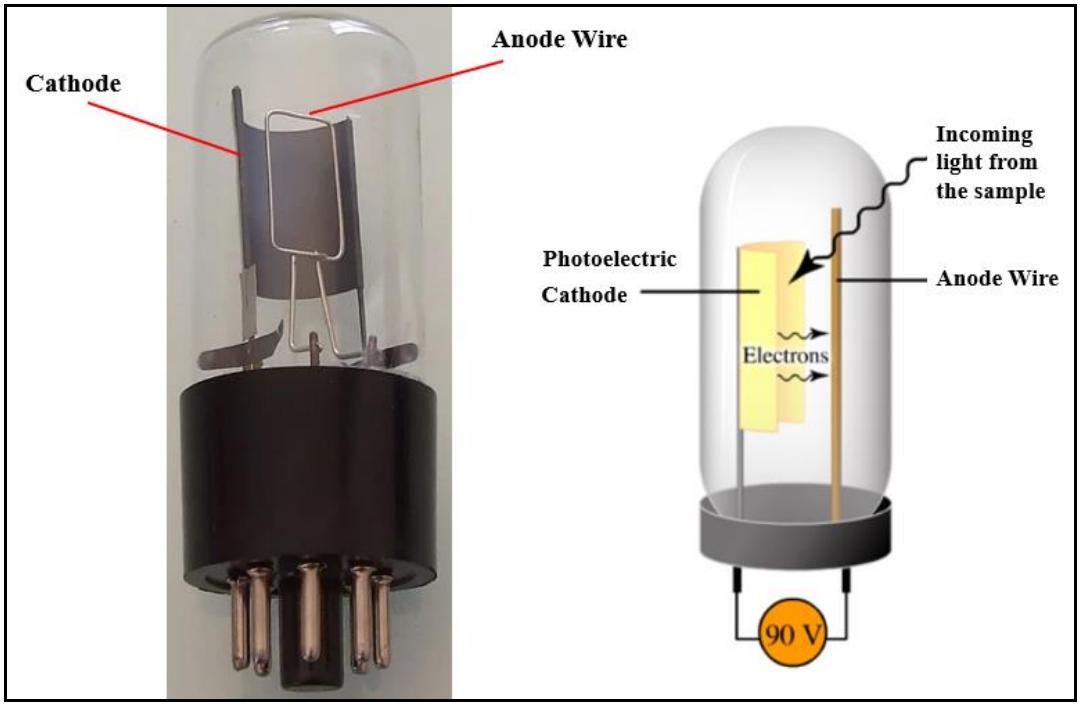



Figure 3: The photomultiplier tube.

The photocell cathode is made of photosensitive material (e.g. semiconductor – selenium). When a beam of light falls on the cathode, photoelectrons are ejected out and

are attracted by the anode generating an electric field. Thereby sending a current through the circuit measured by the galvanometer connected to the circuit.

## Wavelength Selection

Many instruments use a monochromator or a filter to isolate the desired wavelength band so that only the band of interest is detected and measured. Several options are available for the manufacturer of a colourimeter when deciding how to select the wavelength, i.e. produce monochromatic radiation (one wavelength band) from polychromatic radiation (white light). These basic options are:

a. Gelatin filter
b. Glass filter
c. Interference filter
d. Diffraction grating
e. Prism

**a. Gelatin Filters**: These are low-cost selection devices which produce or transmit a wide band of radiation, usually ą 20 nm. The most common gelatin filter is constructed by sandwiching a thin layer of dyed gelatin of the desired colour between two thin glass plates. They absorb approximately 30-40% of all incident radiation, thereby reducing energy throughput to the detector.

**b. Glass Filters**: Colored glass filters are now more or less historical selection devices in colourimeters and have wide bands, often up to 150nm. Specific wavelengths can be achieved by using a combination of glass filters.

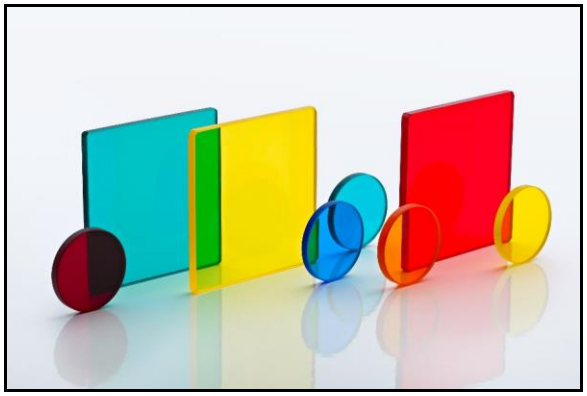


Figure 4: Colored glass filter.

c. **Interference Filters**: These are used to select wavelengths more accurately by providing a narrow bandpass of around 10nm. The interference filter only absorbs approximately 10% of the incident radiation over the whole spectrum, allowing higher intensity light to reach the detector.

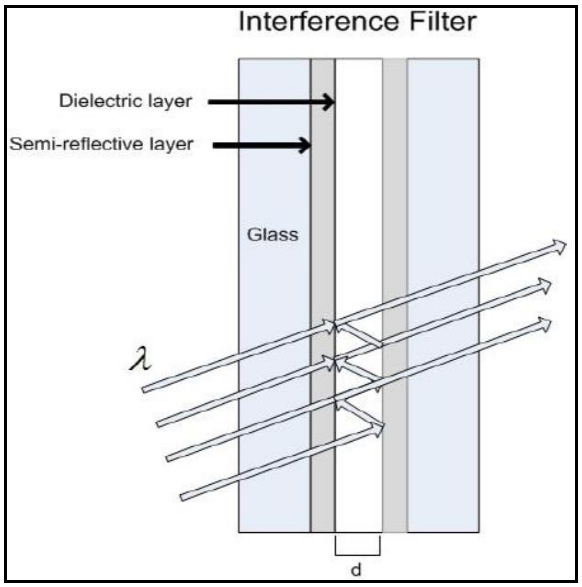



Figure 4: The concept of an interference filter.

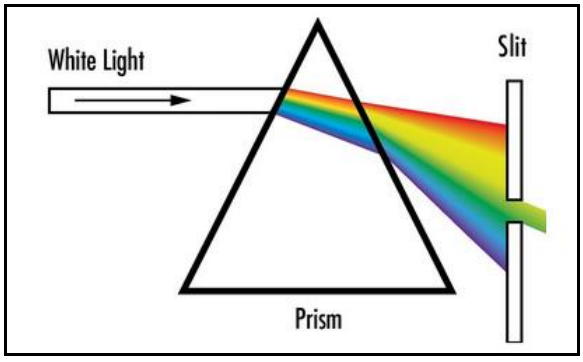
d. **Diffraction grating**

A diffraction grating consists of a series of small parallel groves, which splits the light

into different wavelengths. In a spectrometer in general reflective gratings are used. Rotating the grating makes different wavelengths pass the exit slit.

**e. Prism**

It is a dispersive element refracts light into its different colors (wavelengths). The dispersion occurs because the angle of refraction is dependent on the refractive index of the prism's material, which in turn is slightly dependent on the wavelength of light that is traveling through it.




## 2. Spectrophotometer Types

The spectrophotometer can be divided into five subcategories according to wavelength and application.

1. VIS spectrophotometer
2. UV-VIS spectrophotometer.
3. Infrared spectrophotometer.
4. Fluorescence spectrophotometer.
5. Atomic absorption spectrophotometer.

**VIS spectrophotometer** is an instrument used to measure absorbance and conduct quantitative analysis at the visible light (400 ~ 760nm), known as the visible

spectrophotometer. **Bacterial cell density can be determined at 600 nm.**

**UV-VIS spectrophotometer** is used to measure the material of absorbance and quantitative analysis at the visible or ultraviolet light (200 ~ 760nm). In addition, **nucleic acid** and **protein** concentrations can be measured, and **bacterial cell density** can also be determined. UV spectrophotometer can be divided into a ***single beam***, ***split beam***, and ***double beam*** for different applications.

- ***A single beam*** is an analytical instrument in which all the light waves coming from the light source pass through the sample. Therefore, the measurements are taken as light intensity passes through the sample. These single beam spectrophotometers are compact, optically simpler, and unsuitable for highly demanding pharmaceutical and quality inspection industries. The advantages of a single beam configuration are that there are often fewer moving parts, which makes the instrument simpler and less likely to have parts wear out or get out of alignment. In addition, this type of spectrophotometer is less expensive compared to the double beam. **The measurements taken from single beam spectrophotometers are less reproducible** because a single light beam is used at a two different times (not at the same time).

**Note:** In a conventional single-beam spectrophotometer, the blank and the sample are measured consecutively, with an interval of several seconds for a single wavelength measurement and up to several minutes for a full spectrum measurement with a single beam spectrometer. Lamp drift can result in significant errors over long time intervals. conventional instrument. Lamp drift can result in significant errors over long time intervals.

- ***A double beam*** UV-visible spectrophotometer utilizes a splitting mirror and exiting slits in one piece; see Figure 5(A) (the mirror and transparent splits and filter out all unwanted wavelengths) and forward the desired beam into two paths,

one through a reference cell (the transmission is 100%) and another path through the sample to be tested.

**The measurements taken from double beam spectrophotometers are highly reproducible** because electronic and mechanical effects on both sample and reference beams are equal (occur at the same time). In addition, it measures high-concentration, multi-component mixed samples and perform better in turbid samples with more sensitivity than the single beam machine.

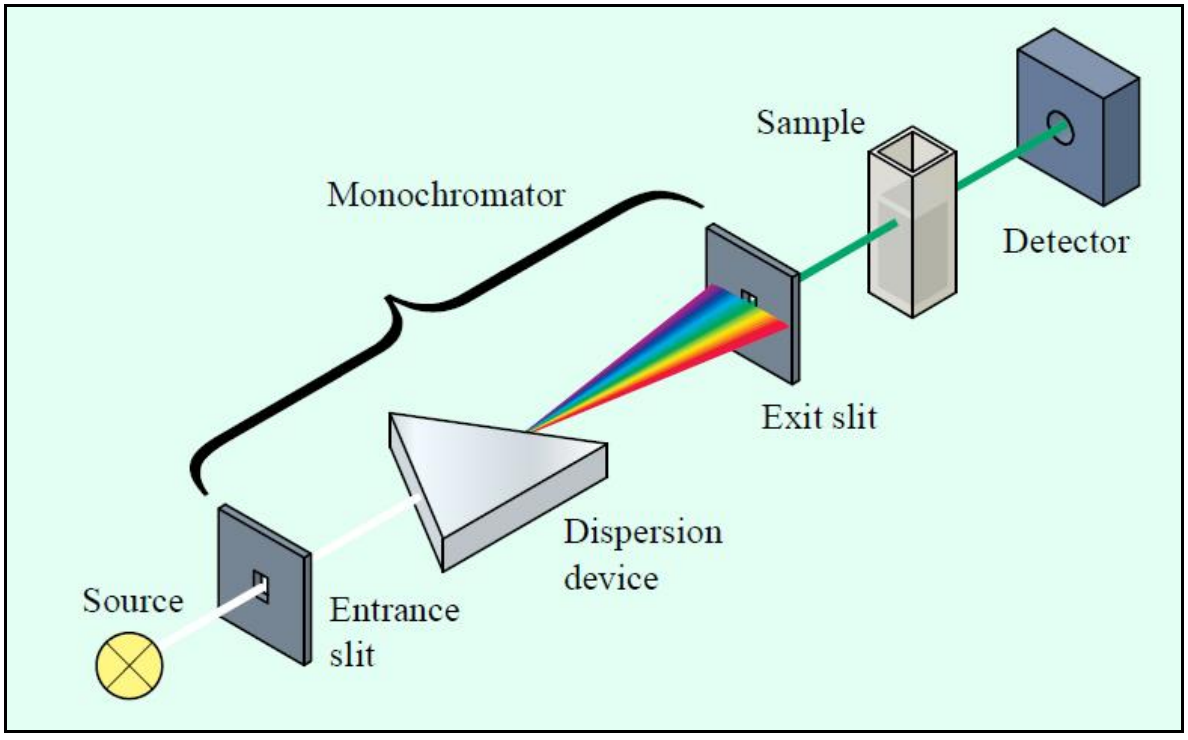



Figure 5(A): Schematic of a single beam spectrophotometer.

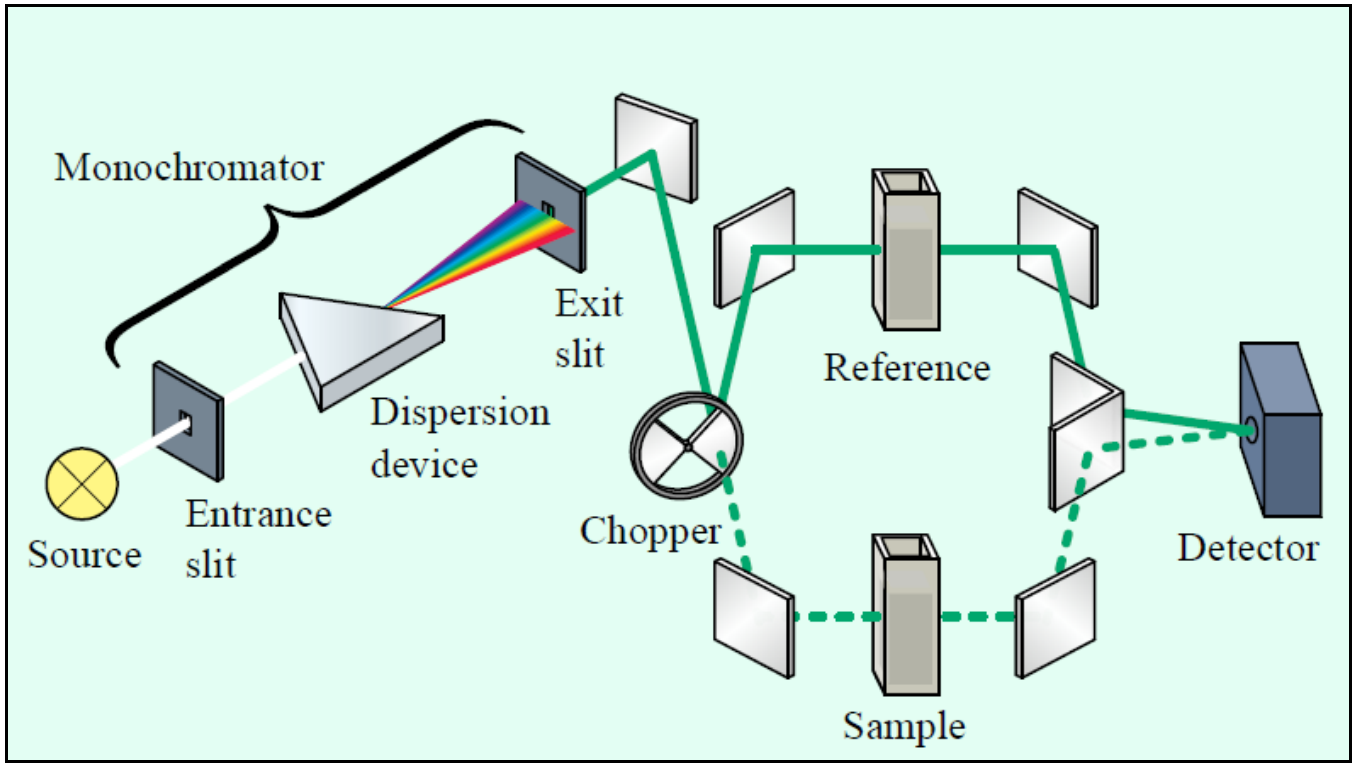



Figure 5(B): Schematic of a double beam spectrophotometer.

**Note:** Dual-beam instruments contain more optical components, which reduces throughput and sensitivity. For high sensitivity, long measurement times may be required. In addition, the more complex mechanical design of the dual-beam spectrophotometer may result in poorer reliability.

- ***Split beam*** spectrophotometer: The light emitted by the same monochromator is split into two beams, one of which reaches the detector directly, and the other passes through the sample and reaches the other detector. The advantage of this instrument is that it monitors errors in the light source but does not eliminate the effects of the reference. The split-beam design is mechanically simpler than the dual-beam instrument and requires fewer optical elements.

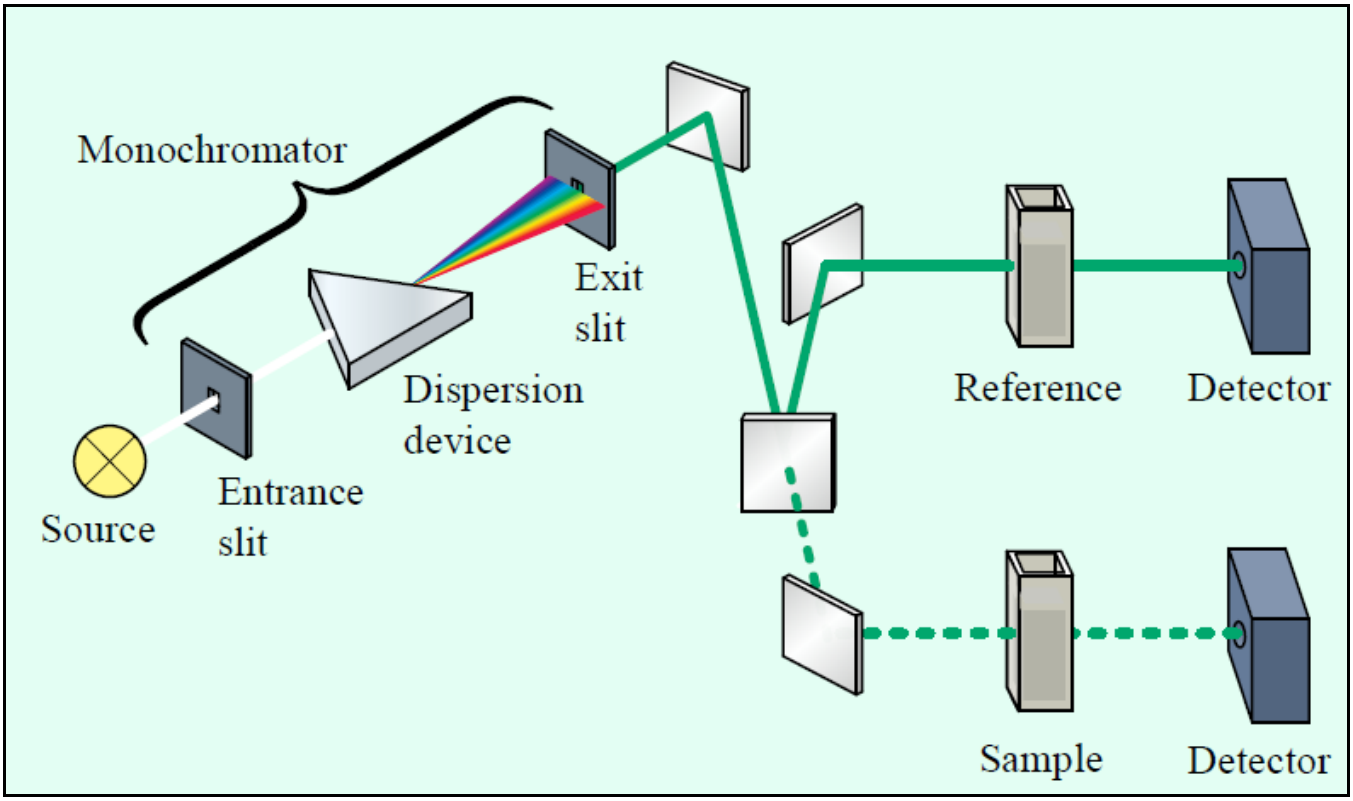



Figure 6: Split beam spectrophotometer.

**Note:** The split-beam spectrophotometer resembles the dual-beam spectrophotometer but uses a beam splitter instead of a chopper to send light along the blank and sample paths simultaneously to two separate but identical detectors. This configuration enables the blank and the sample to be measured at the same time.

**Note:** This design provides high stability, although not as high as a dual-beam instrument since two detectors can drift independently, and good noise, although not as good as a single-beam instrument since the light is split so that less than 100 % passes through the sample.

**Infrared spectrophotometer:** The broad infrared spectrum refers to the infrared spectrum **greater than 760nm**, the most commonly used spectral region of **organic compounds** and can analyze various conditions (**gas, liquid, solid**) of the sample. Infrared spectroscopy is characterized by fast, low sample volume (a few micrograms to a few milligrams) and strong characterization (various substances have their specific infrared spectrum).

**Fluorescence spectrophotometer**: it is spectroscopy depends on the analysis of fluorescence light. It can be used in chemistry, medicine and pharmacy, biomedical research and environmental monitoring. In many ways, the design of a fluorescence spectrophotometer is similar to a UV/VIS absorption spectrophotometer. The UV/Vis spectrometer detects light that has passed directly through the sample (absorption spectroscopy). In contrast, the spectrofluorometer detects fluorescent light emitted in the 90° direction and passed through an emission monochromator (emission spectroscopy), as shown in Figure 7.

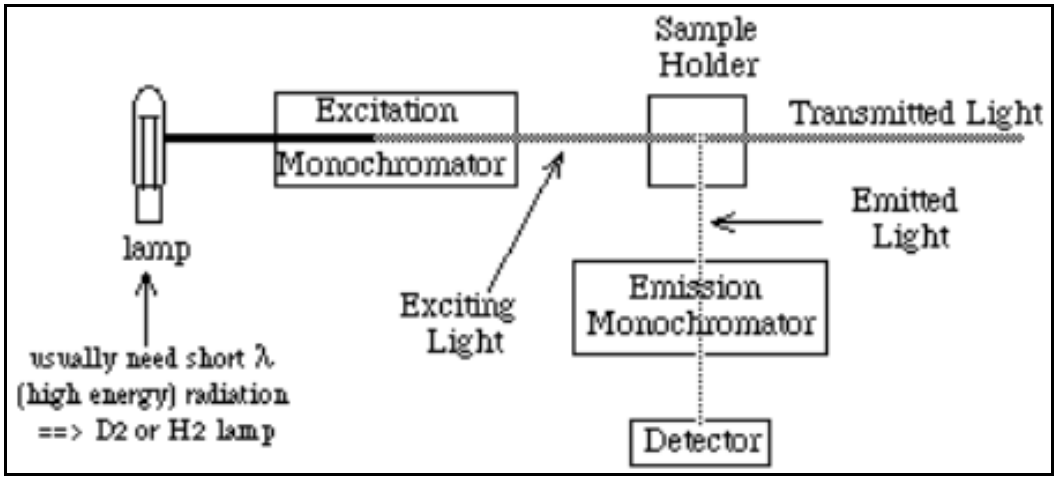



Figure 7: The principle components of the fluorescence spectrophotometer.

## Atomic Spectroscopy (Atomizing Techniques)

There are two techniques in atomization spectroscopy were used, **flame atomization** and **graphite furnace atomization**; both can be either an **absorbance** (**AAS**) based and **emission** (**AES**) based.

The compounds of the alkali and alkaline earth metals (Group II) – which also exist in human body – dissociate into atoms when introduced into the flame. Some of these atoms further get excited to even higher levels. But these atoms are not stable at higher levels. Hence, these atoms emit radiations when returning to the ground state. These radiations generally lie in the visible region of the spectrum. Each of the alkali and alkaline earth metals has a specific wavelength. For certain concentration ranges, the intensity of the emission is directly proportional to the number of atoms returning to the ground state. And the light emitted is in turn proportional to the concentration of the sample. Each of the alkali and alkaline earth metals has a specific wavelength, examples are shown in Table (1).

Table (1): Specific wavelengths correspond to specific materials.

| Element | Emitted wavelength | Flame color |
|---|---|---|
| Sodium | 589 nm | Yellow |
| Potassium | 766 nm | Violet |
| Barium | 554 nm | Lime green |
| Calcium | 622 nm | Orange |
| Lithium | 670 nm | Red |

## Atomic Emission Spectroscopy:

Vaporizing the atoms using flame excites the atom causes moving the electrons of some materials from the ground state to the excited state. However, these electrons must emit energy in order to return to the ground state, since the excited state is unstable. When the electron comes from an excited state to the ground state, it emits a photon of energy. The energy of this photon depends on the differences between the energy levels of the excited state and ground state of that electron.

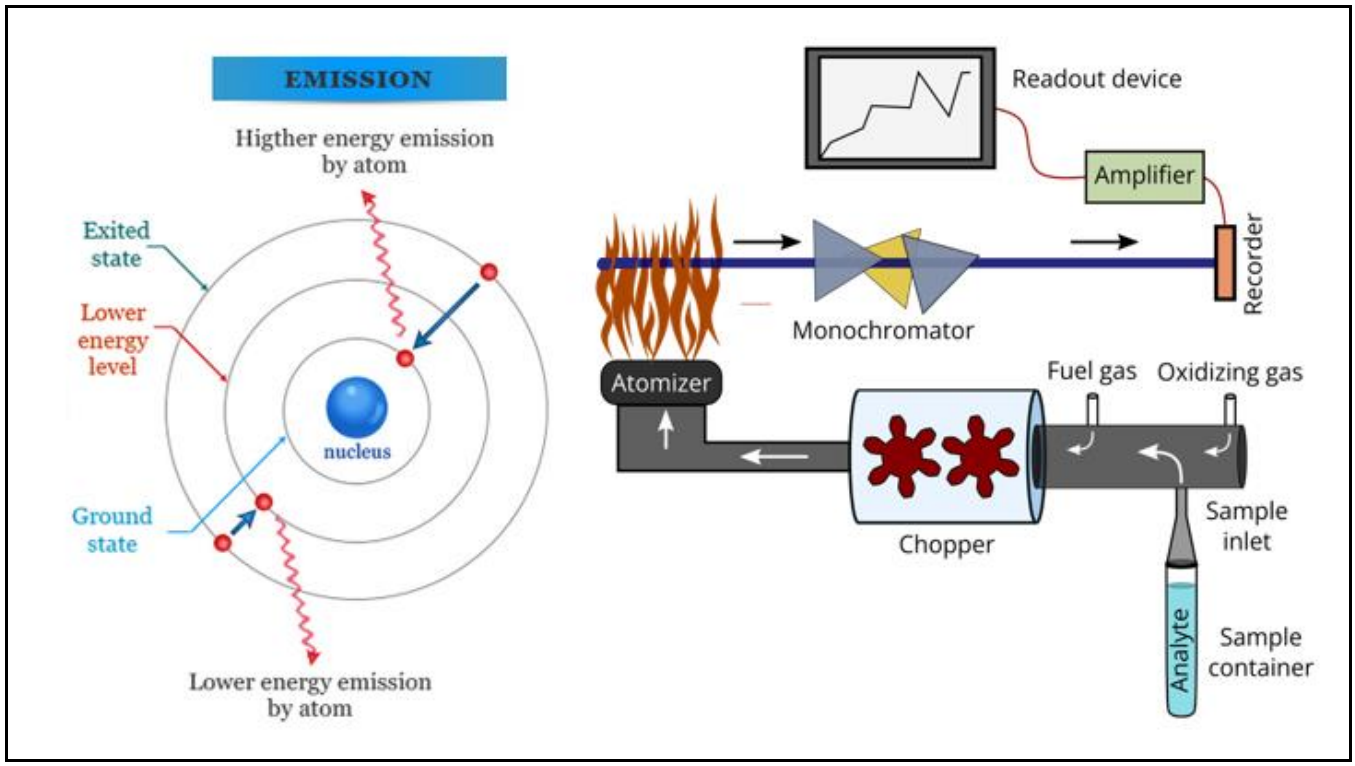



Figure 8: The principle components of flame based atomic emission spectroscopy.

## Atomic Absorption Spectroscopy:

Some material's atoms would not excite their electrons due to heating or vaporization, therefore, when a beam of electromagnetic radiation of a particular wavelength is passed

through the vaporized atoms present in the flame, then the atoms absorb the radiation and cause transitions of electrons from the ground state to excited state. The amount of energy been absorbed by the electrons for excitation causes a decrease the intensity of the applied radiation; hence, the more concentration of atoms exits in the radiation area, the more absorbance occurs and less energy will be penetrated out of the material (transmitted). The absorbance will directly proportional to the atoms present in the ground state. Therefore, the concentration of the atoms can be easily calculated using Beer-Lambert law of absorbance.

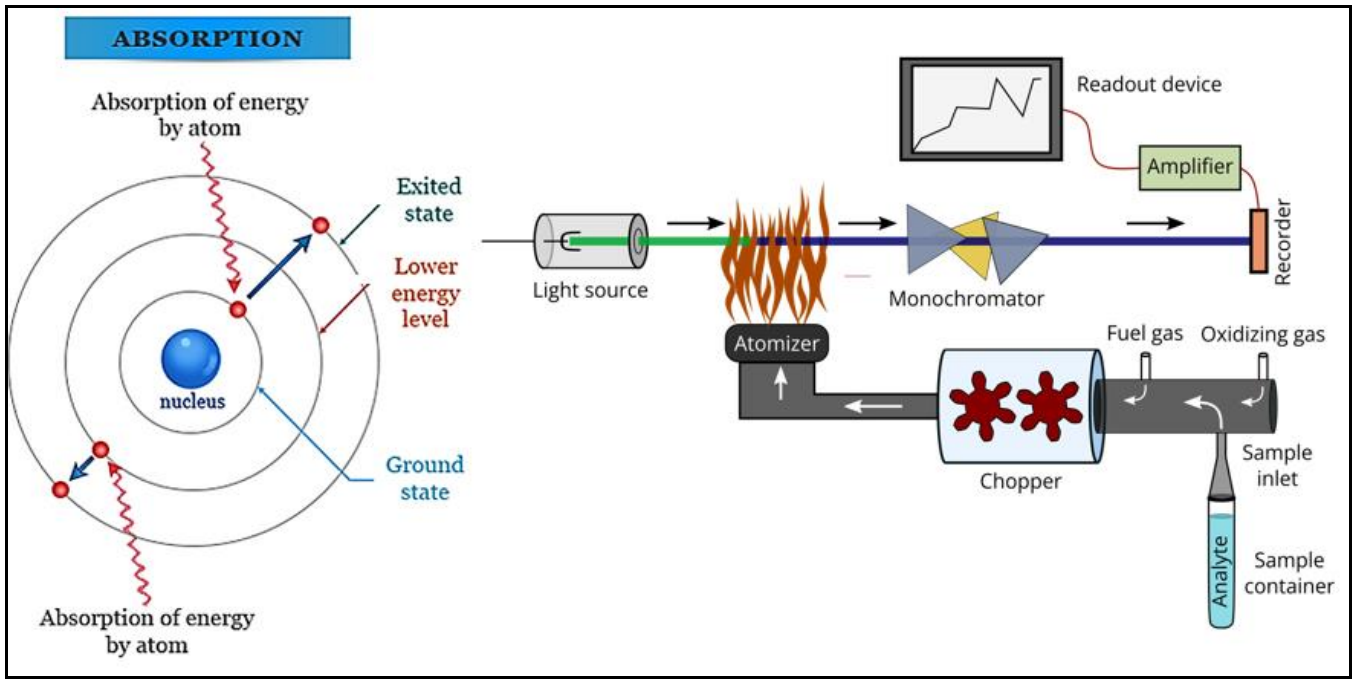



Figure 9: The principal components of Flame based atomic absorption spectroscopy.

## Parts of flame atomic photometer:

A simple flame photometer consists of the following basic components:

**Source of flame:** A Burner in the flame photometer is the source of flame. It can be maintained in at a constant temperature. The temperature of the flame is one of the critical factors in flame photometry. Table below contains a list of common use fuel to generate a heat flame.

| Fuel-Oxidant mixture | Temperature (°C) |
|---|---|
| Natural gas-Air | 1700 |
| Propane-Air | 1800 |
| Hydrogen-Air | 2000 |
| Hydrogen-Oxygen | 2650 |
| Acetylene-Air | 2300 |
| Acetylene-Oxygen | 3200 |
| Acetylene-Nitrous oxide | 2700 |
| Cyanogen-Oxygen | 4800 |

- ✓ In graphite furnace atomization, a graphite furnace used to hold and heat a 1 ppb (part per billion) of the solution (one tiny drop) and heating it till causes vaporization and disassociation of molecules.

**Nebuliser:** Nebuliser is used to send homogeneous solution into the flame at a balanced rate.

**Monochromator** (optical system)**:** used as a filtering system to isolate the wavelength to be measured from that of irrelevant emissions.

**Photo-detector** (recorder): The intensity of radiation emitted by the flame is measured by photo detector. Here the emitted radiation is converted to an electrical signal with the help of photo detector. These electrical signals are directly proportional to the intensity of

light.

*The processes occurring during flame photometer analysis are summarized below:*

**Desolvation**: involves drying a sample in a solution. The metal particles in the solvent are dehydrated by the flame and thus solvent is evaporated.

**Vaporization**: The metal particles in the sample are also dehydrated. This also led to the evaporation of the solvent.

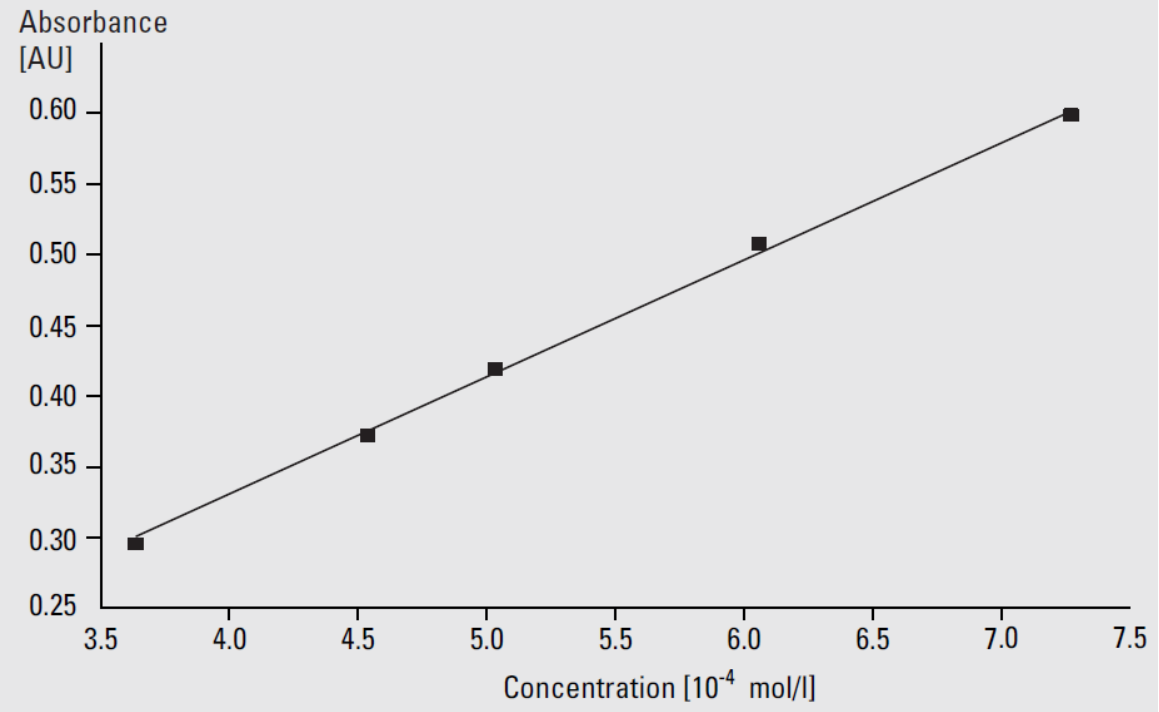
**Atomization**: Atomization is the separation of all atoms in a chemical substance. The metal ions in the sample are reduced to metal atoms by the flame.

**Excitation**: The electrostatic force of attraction between the electrons and nucleus of the atom helps them to absorb a particular amount of energy. The atoms then jump to the higher energy state when excited.

**Emission**: Since the higher energy state is unstable the atoms jump back to the ground state or low energy state to gain stability. This jumping of atoms emits radiation with characteristic wavelength. The radiation is measured by the photo detector.

## Calibration

The calibration process in atomic spectroscopy includes measurements of different known concentration of the metals need to be measured. A linear increasing in the absorbance supposed to be shown in the data gained, else, the system must be troubleshooted and maintain. By completing all measurements of the known solutions (Control), the equipment processor supposes to plot a calibration curve for the measured samples. The concentration of the control samples (calibration samples) must be within the range of the expected concentration of the solution need to be measured. If the measured data located within the calibration curve, then the absorbance will be calculated by either Beer-Lambert law or using calibration curve.




Example of a calibrated curve.

## Homework assignment:

**Group A:** Comparison between flame and graphite furnace atomization techniques? In terms of principle of work, efficiency, advantages and disadvantages, and its application.

**Group B:** Comparison between flame absorption and flame emission atomization techniques? In terms of principle of work, results efficiency, advantages and disadvantages, and its application.

# Test for Unit Four (1)

1. Define the following:

Colorimeter, Photomultiplier tube, diffraction grading, Interference filter, Photocell, Photometer.

2. Compare between single beam and double beam spectrophotometer?
3. Draw the block diagram of double beam spectrophotometer?
4. Is it true or false? When spectrophotometer is built into another device like microscope of telescope, only single beam machine will work. Explain?
5. Compare by drawing the difference between single beam and double beam spectroscopy?
6. The techniques used to isolate the proteins are ---------
7. Gelatine filter absorb approximately ---------- of the incident light.
8. Explain the principal work of single beam spectroscopy?
9. What is the function of blank in spectroscopy?
10. Draw the block diagram of UV-VIS spectrophotometer?
11. Why the double beam spectrophotometer gives more accurate, reproducible, and stable measurements compared to single beam?
12. Draw the principle components of the fluorescence spectrophotometer?
13. Explain the priciple work of the fluorescence spectrophotometer?
14. List the applications and advantages of infrared spectroscopy?
15. What is the advantages of slit beam spectrophotometer?
16. List of filters used in the spectroscopy, and explain two of them?

# الوحدة الرابعة – المحاضرة الثانية - الزمن: 45 دقيقة

## أهداف المحاضرة الثانية:

**يتوقع في نهاية الجلسة أن يكون الطالب قادراً على:**

1. **تعريف بقانون لمبرت وبيير للأمتصاصية الضوئية.**
2. **معرفة كيفية حساب تراكيز المادة داخل المطياف بالاعتماد على قانون لمبرت بيير .**
3. **أشتقاق قانون لمبرت بيير.**
4. **معرفة كيفية الحساب الكمي للتراكيز بالاعتماد على الكثافة الضوئية المستلمة في المطاييف الضوئية.**

## موضوعات المحاضرة الثانية:

- **قانون بير-لامبرت للإمتصاصية.**
- **اشتقاق قانون بير لامبرت.**
- **القياياسات الكمية للتراكيز.**

## الأساليب والأنشطة والوسائل التعليمية

| م | الأساليب والأنشطة التدريبية | الوسائل التدريبية |
|---|---|---|
| 1 | • نشاط التعارف (1/1/1)<br>• محاضرة<br>• مناقشة<br>• سؤال وجواب | • جهاز حاسوب<br>• جهاز عرض<br>• سبورة<br>• اوراق واقلام |

ملاحظة: للتدريسي حرية في تغيير الاساليب والانشطة والوسائل حسب ما يراه مناسبا

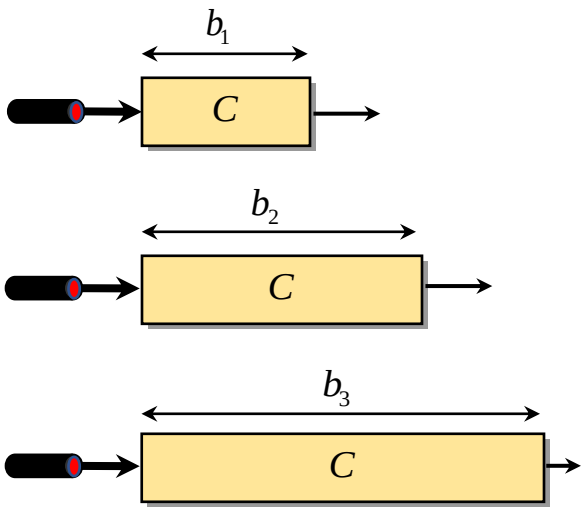
الوحدة الرابعة الجلسة الثانية

المادة العلمية:

## Spectrum Instruments and Uses

# Beer-Lambert's law (absorptivity law)

**Lambert's** –French mathematician – **law** states that absorbance of light in a homogenous solution is directly proportional to the length of sample in which the light passes.



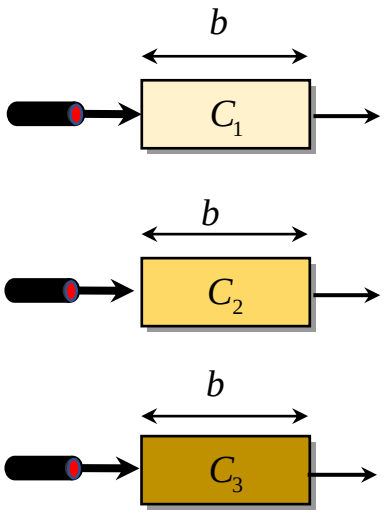

*We have three samples of a similar solution and concentration (C), but different thickness (path lengths). If* $b_3 > b_2 > b_1$ *then the absorptivity of the three solutions satisfies*

$$A_3 > A_2 > A_1$$

$$A = \log_{10}\left(\frac{I_\circ}{I}\right) \propto b$$

$$A = \varepsilon b$$

**Beer's law** (German physicist) states that the absorbance of light in sample/solution is directly proportional to the concentration of the solution in which light travels.




*We have three samples of a similar solution and thicknesses (b), but different concentrations (path lengths). If* $C_3 > C_2 > C_1$ *then the absorptivity of the three solutions satisfies* $A_3 > A_2 > A_1$

$$A = \log_{10}\left(\frac{I\circ}{I}\right) \propto C$$

$$A = \varepsilon C$$

**Beer-Lambert law:**

Absorbance is a combination of the two scientist laws, as shown in Equation below:

$$A = \varepsilon b C$$

Where $A$ is the **absorbance** and It is unitless, $\varepsilon$ is the **absorptivity constant** for the substance or **molar absorptivity** in a units of **L mol$^{-1}$ cm$^{-1}$**, $b$ is the length of the light path through the substance (**cuvette thickness of sample thickness**) or the path length of the cuvette in which the sample is contained, and $C$ is the concentration of the solution in **mol L$^{-1}$**.

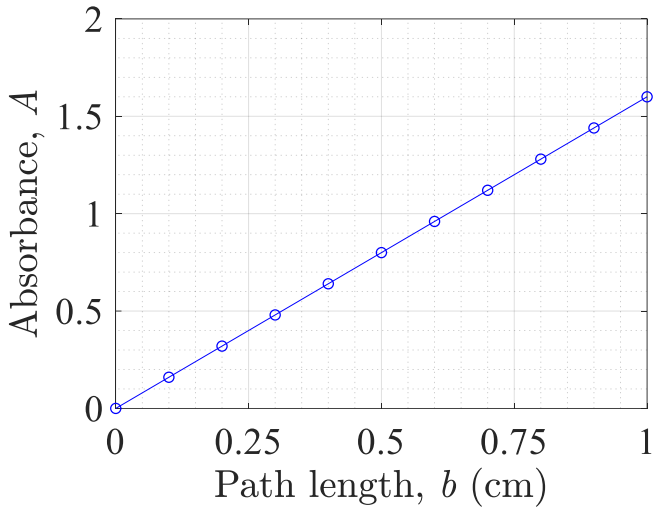



*Figure 1: The effect of path lengths on absorbance and transmittance.*

- **Absorb** - to take in or receive by chemical or molecular action.
- **Absorptivity** - the amount of absorbance specific for a certain substance.
- **Transmittance** - the amount of light not retained but passed through a test solution.

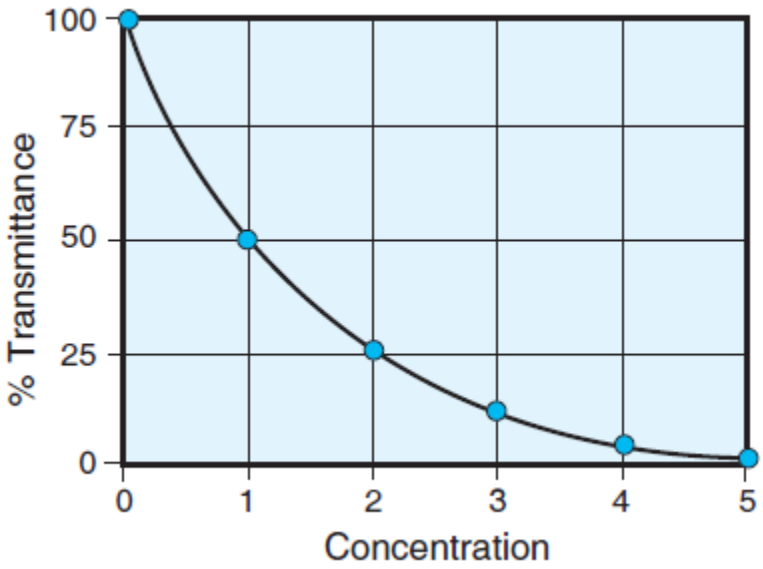



*Figure 2: The relationship between the concentration and percentage of transmittance %T .*

## Derivation of Beer-Lambert law:

Absorbance may be related to **transmittance**, $T$, the amount of light that is transmitted through the substance where $I_s$ = transmitted light through the test solution and $I_\circ$ is the total possible light to be transmitted from the incidence beam:

$$A = -\log\left(\frac{I}{I_\circ}\right) = -\log T$$

$$\text{since } A = \log\left(\frac{1}{T}\right)$$

By percentage:

$$A = \log 100 - \log \%T$$

$$\text{Then } A = 2 - \log \%T = \varepsilon bC$$

## Concentration Quantitative Measurements:

Before the analyst attempts to perform quantitative colorimetric analysis, it is important to understand the theoretical aspects of the technique. The relationship between concentration and the light absorbed is the basis of the following theoretical consideration; The seemingly obvious way of taking readings on a colorimeter is to measure % transmission and adjust the 'blank" to 100%. For example, consider a situation where a blank is measured followed by three standard solutions having concentrations of 1, 2 and 3 units respectively. Ideally, a colorimeter should be giving concentration readings directly, but consider the above solutions when analyzed. The solution with a concentration of 1 unit reduces the light to 50% therefore, the solution with a concentration of 2 units will reduce the light to 25% and the solution with a concentration of 3 units will reduce the light to 12.5%. To take measurements both directly and linearly in terms of concentration, %T readings must be converted into an

inverse logarithmic form which are called optical density units (OD) or absorbance (A). The formula is given below:

$$\mathrm{OD} = \log\left(\frac{100}{\%T}\right) \cong A$$

Therefore, for the given example, the relationship of OD to concentration is shown in the table below.

| **Concentration** | **% *T*** | **OD** |
|---|---|---|
| 0 | 100 | 0 |
| 1 | 50 | 0.3 |
| 2 | 25 | 0.6 |
| 3 | 12.5 | 0.9 |

Optical density (absorbance) is used for colorimetric analysis so that readings relate directly to concentration. The standard cuvette path length is 10 mm (1 cm).

# Test for Unit Four (2)

1. Homework Question: Why the absorbance does not exceed on 2? Hint: it depends on the relation A= - log (%T /100 )
2. What is the frequency and energy of a photon with a wavelength of the following?

   (a) 550 nm (b) 20 nm (c) 1,100 nm (d) 0.35 nm (e) 188 nm (f) 750 nm (g) 0.53 nm (h) 420 nm
3. To what part of electromagnetic spectrum do photons of the following frequencies belong?

   (a) $2.55 \times 10^{20}$ (b) $6.3 \times 10^{7}$ (c) $4.25 \times 10^{14}$
4. We have stated that the typical range of a UV-vis spectrophotometer is 195 nm to 900 nm. What is the corresponding frequency range?
5. Three peaks were noticed in the UV-vis spectrum measurements with $\lambda_{max}$ values of 238 nm, 270 nm, and 354 nm. (a) calculate the energy gap (in Joules) associated with each of these transitions. (b) calculate the frequency (in Hz) of the photon absorbed for each of these transitions.
6. A diluted hexane solution is used to obtain isoprene spectrum, as show in **Fig. 1** below. Determine the concentration of a diluted solution placed in 10 mm of spectrophotometer cuvette, consider the corresponding molar absorptivity equals to 20,000 at maximum wavelength?

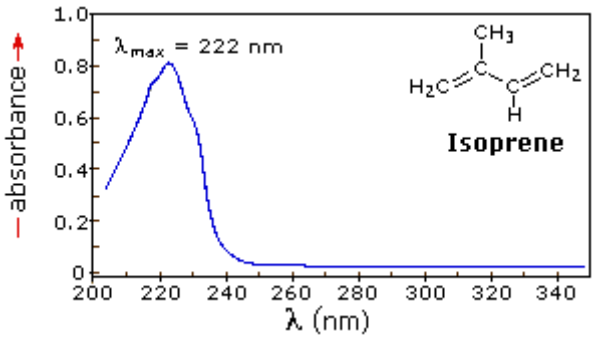



Fig. 1. Isolation of isoprene spectrum using diluted hexane solution.

**7.** Why the absorbance in UV-VIS spectrophotometer does not exceed 2, explain using equations?

**8.** Calculate the absorbance for the transmittance values: (40%, 55%, 78%, 80%)?

**9.** Derive Beer-Lambert law, $A = \varepsilon bC$ ?

**10.** Determine the energy of photon for 1 nm of optical monochromic light?

*Additional questions:*

**11.** Calculate the cross-section area through atoms if the molar absorptivity coefficient is $3\times10^{8}\,M^{-1}\,cm^{-1}$?

**12.** An aqueous solution with coefficient absorptivity 3200 L $mol^{-1}$ $cm^{-1}$ and its concentration is $3.4\times10^{-4}$ molar. Calculate the optical density an transmittance through the solution.

**13.** Define the following:

Beer's law, Lambert law, Beer-lambert law, absorptivity, transmittance, absorbance coefficient.

**14.** From the following table:

| Path length (cm) | 0 | 0.2 | 0.4 | 0.6 | 0.8 | 1 |
|---|---|---|---|---|---|---|
| Transmittance % | 100 | 50 | 25 | 15 | 10 | 0 |

(a) Calculate the absorbance (optical density)?

(b) Draw the relationship between the transmittance and path length?

(c) Draw the relationship between the absorbance and cuvette length?

**15.** Why is it a common design feature to see two different sources used in a UV-vis spectrophotometer?

**16.** Why is the regulation of the radiant source less critical in a dual-beam spectrophotometer than it is in a single-beam spectrophotometer?

# الوحدة الخامسة – المحاضرة الأولى - الزمن: 90 دقيقة

## أهداف المحاضرة الثانية:

**يتوقع في نهاية الجلسة أن يكون الطالب قادراً على:**

1. **معرفة جهاز الـ pH ودوره في قياس الأيونات**
2. **تذكر مستويات الحامضية لبعض سوائل الجسم.**
3. **معرفة آلية عمل الـ pH meter ، وكيف تتم عملية القياس**
4. **التعريف بتركيب الأجهزة الحديث المستخدمة في قياس نسبة الحامضية.**
5. **فهم آلية عمل معايرة للجهاز من أجل قراءة دقيقة، وكذلك صيانة الجهاز في حال حدوث خلل في أداء الجهاز.**

## موضوعات المحاضرة الثانية:

- **مقياس الـ pH meter.**
- **آلية عمل مقياس الـ pH.**
- **تنظيف جهاز الـ pH meter.**
- **معايرة جهاز pH meter.**
- **صيانة وتصفير جهاز الـ pH meter.**

## الأساليب والأنشطة والوسائل التعليمية

| م | الأساليب والأنشطة التدريبية | الوسائل التدريبية |
|---|---|---|
| 1 | • نشاط التعارف (1/1/1)<br>• محاضرة<br>• مناقشة<br>• سؤال وجواب | • جهاز حاسوب<br>• جهاز عرض<br>• سبورة<br>• اوراق واقلام |

ملاحظة: للتدريسي حرية في تغيير الاساليب والانشطة والوسائل حسب ما يراه مناسبا

الوحدة الخامسة جلسة واحدة

المادة العلمية:

## Ion Measurements (pH meter)

**pH meter:** is the device used to determine the [H] concentration in the solution. The range of pH is between 1 to 14, the pH of water is 7 it is mean that water has o.oooooo1 moles of hydrogen ions per litre at 25 °C, as presented in Table (1).

Table (1): The pH coulom is a concentration in log format $(-\log[H])$

| H+ concentration (mole/liter) | OH- concentration (mole/liter) | pH |
|---|---|---|
| 1 | 0.00000000000001 | 0 |
| 0.1 | 0.0000000000001 | 1 |
| 0.01 | 0.000000000001 | 2 |
| 0.001 | 0.00000000001 | 3 |
| 0.0001 | 0.0000000001 | 4 |
| 0.00001 | 0.000000001 | 5 |
| 0.000001 | 0.00000001 | 6 |
| 0.0000001 | 0.0000001 | 7 |
| 0.00000001 | 0.000001 | 8 |
| 0.000000001 | 0.00001 | 9 |
| 0.0000000001 | 0.0001 | 10 |
| 0.00000000001 | 0.001 | 11 |
| 0.000000000001 | 0.01 | 12 |
| 0.0000000000001 | 0.1 | 13 |
| 0.00000000000001 | 1 | 14 |

The pH meter more commonly used in the clinical laboratory to measure the pH of blood and to check the pH of certain reagents such as that prepared in laboratory. It calculates the pH value by measure potential difference caused by variation in hydrogen ions after immersed in the solution.

pH: is the negative value of the logarithm to the base 10 of hydrogen ion concentration. Table (1) presents the normal ranges of some of essential body fluids.

$$pH = -\log[H]$$

Table (1): The normal ranges of some of essential body fluids.

| Substance | pH value |
|---|---|
| Blood | 7.35- 7.45 |
| Gastric juices | 1.6 – 1.8 |
| Bile | 7.8 – 8.6 |
| Urine | 5.5 – 7 |

**Buffer solution:** is a solution that resist pH change on the addition of acid or alkali usually contain a mixture of weak base and its salt or weak acid with its salt. Its pH is 7.

## Principle work of pH meter:

A pH meter measures essentially the electro-chemical potential between a known liquid inside the glass electrode (membrane) and an unknown liquid outside. Because the thin glass bulb allows mainly the agile and small hydrogen ions to interact with the glass, the glass electrode measures the electro-chemical potential of hydrogen ions or the potential of hydrogen. To complete the electrical circuit, also a reference electrode is needed. Note that the instrument does not measure a current but only an electrical voltage, yet a small

leakage of ions from the reference electrode is needed, forming a conducting bridge to the glass electrode. The pH meter measures the electrical potential (follow the drawing clock-wise from the meter) between the mercuric chloride of the reference electrode and its potassium chloride liquid, the unknown liquid, the solution inside the glass electrode, and the potential between that solution and the silver electrode. But only the potential between the unknown liquid and the solution inside the glass electrode change from sample to sample. So, all other potentials can be calibrated out of the equation. An acidic solution has far more positively charged hydrogen ions in it than an alkaline one, so it has greater potential to produce an electric current in a certain situation—in other words, it's a bit like a battery that can produce a greater voltage. A pH meter takes advantage of this and works like a voltmeter: it measures the voltage (electrical potential) produced by the solution whose acidity we're interested in, compares it with the voltage of a known solution, and uses the difference in voltage (the "potential difference") between them to deduce the difference in pH.

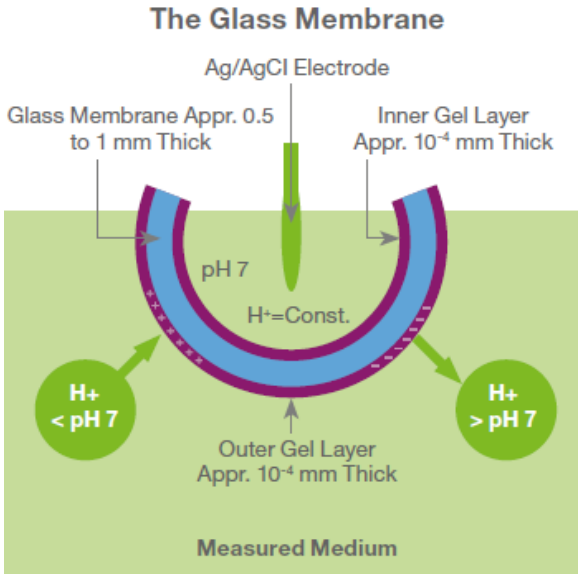



Figure: The glass membrane.

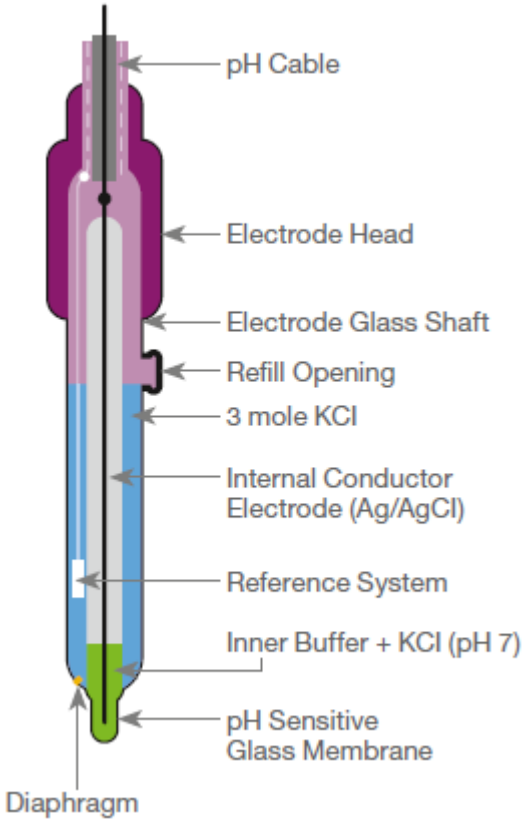



Figure: Construction of a modern Combination electrode.

## pH Probe Calibrations and Maintenance

### Probe Cleaning

When the reference junction becomes plugged the probe will become sluggish and unresponsive. In many cases the junction can be cleaned with aggressive alkaline cleaners (for oil plugging) or dilute acids (for salt deposits) or a combination of both. In most cases, for probes with large junction surface areas the junction material can be scraped away with a screw driver revealing a new surface. Aggressive procedures are sometimes necessary to bring life back to a dead probe. The glass pH sensing membrane may also require service in some applications. This membrane can become dehydrated or coated with a thin layer of deposits. The best procedure for cleaning or rehydrating the glass is to soak the probe in a pH buffer of 4.0 for several hours. If this does not work

then immersing the probe in hot buffer 4.0 solution will usually work.

**Probe calibration:**

Before use of pH meter must be calibrated, this is done by immersing the electrode in a buffer solution of known pH at particular temp. and the instrument with the calibration knob to the correct value. The buffer that is chosen for standardization should be close to the expected pH of the pH of the known sample, the second buffer with a different pH should be tested and the instrument adjusted accordingly to ensure that the pH meter is accurate over arrange of values.

The pH 7 or zero point of an electrode is the pH value at which the total output electrode voltage is equal to 0 mV. In theory, the zero point of a pH electrode happens at the pH value of 7.00. However, in practice, there is almost always a zero-point offset. For this reason, a zero-point calibration should always be performed prior to starting a pH measurement. To perform a zero-point adjustment, you need, for obvious reasons, a buffer solution of the pH-value of 7.00.

**Prob maintenance:**

The success or failure of pH measurement depends on the proper application of the probe and proper subsequent maintenance of the probe. The procedures described within apply to the most common pH probe in use today and that is the flat surface combination pH probe. The most common failure mode associated with pH probes is breakage. The pH electrode is a very thin glass membrane that is easily damaged. Foreign object damage within the installation or mechanical shock during calibration are often the culprits. The next most common cause of failure is a plugged reference junction. The reference junction consists of a porous material, usually ceramic or Teflon, that must remain open. The junction creates a fluid interface between the reference material which is a liquid and the process fluid. A flow, albeit infinitesimally low, must exist from the reference

electrode to the process fluid. In environments where there are high solids, oils or grease this junction can become plugged.

## Test Questions for Chapter 5

***Fill in the blank of the following statements:***

1. Gel electrode replacing of the reference solution in general, by soak in ----------.
2. pH value of urine is----------.
3. pH value of blood is ----------.
4. Calibration of pH meter is done by immersing the electrode in----------.

- What is the role of the following parts in pH measurement? (glass membrane, KCL, Ag/AgCL electrodes.

# الوحدة السادسة – المحاضرة الأولى - الزمن: 90 دقيقة

## أهداف المحاضرة:

**يتوقع في نهاية الجلسة أن يكون الطالب قادراً على:**

1. **معرفة أهمية قياس الأملاح في تشخيص العديد من الأمراض.**
2. **معرفة دور الأملاح الرئيسية في ارتفاع ضغط الدم.**
3. **معرفة وفهم آلية ضغط الدم في الجسم، وارتفاع الضغط والستويات الطبيعية والغير طبيعية لضغط الدم.**
4. **معرفة وتفريق بين ضغط الدم الإنقباضي والإنبساطي.**
5. **معرفة أهمية الألكترولايتات بالنسبة لجسم الإنسان، ومعرفة الأمراض التي تنتج عن تغير مستوياتهم الى خارج المدى الطبيعي.**
6. **مبادئ عمل أجهزة قياس الألكترولايتات.**

## موضوعات المحاضرة:

- **مقدمة عن الأملاح وقياسها.**
- **ضغط الدم.**
- **الإلكترولايتات.**
- **أجهزة قياس الألكترولايتات.**

## الأساليب والأنشطة والوسائل التعليمية

| م | الأساليب والأنشطة التدريبية | الوسائل التدريبية |
|---|---|---|
| 1 | • نشاط التعارف (1/1/1)<br>• محاضرة<br>• مناقشة<br>• سؤال وجواب | • جهاز حاسوب<br>• جهاز عرض<br>• سبورة<br>• اوراق واقلام |

ملاحظة: للتدريسي حرية في تغيير الاساليب والانشطة والوسائل حسب ما يراه مناسبا.

الوحدة السادسة جلسة واحدة

المادة العلمية:

# Salts measurements instrument and its uses

## Introduction:

Salt (sodium) is essential to our bodies. Normally the kidneys control the level of salt. If there is too much salt, the kidneys pass it into urine. But when our salt intake levels are very high, the kidneys cannot keep up and the salt ends up in our bloodstream. Salt attracts water. When there is too much salt in the blood, the salt draws more water into the blood. More water increases the volume of blood which raises blood pressure.

### Salt Sensitivity:

Some people are more sensitive to salt than others. In some people too much salt will cause their blood pressures to rise, in others there will not be as large a change. About half of people are salt sensitive. African-Americans, the elderly and people with diabetes are more often salt sensitive. If you have high blood pressure, you can always benefit from decreasing your salt intake.

**Note:** The terms salt and sodium are often used synonymously but on a weight basis, salt comprises 40% sodium and 60% chloride. To convert salt to sodium it is necessary to divide the salt figure by 2.5.

In addition to salt (sodium chloride, NaCl) there is a wide variety of other forms of sodium in our diet, many of which are used an additive in food processing, usually to add flavor, texture or others as shown in Table (1).

Table (1): Other format of salts rather than NaCl.

| Additive | Use |
|---|---|
| Sodium citrate | Flavoring, preservative |
| Sodium chloride | Flavoring, texture, preservative |
| Monosodium glutamate | Flavor enhancer |
| Sodium cyclamate | Artificial sweetener |
| Sodium bicarbonate | Yeast substitute |
| Sodium nitrate | Preservative, color |

Thus, total sodium intake is greater than that estimated from salt alone. However, overwhelmingly, salt is the major source of sodium in the diet (approximately 90%) and therefore any recommendation for a reduction in sodium will, in practical terms, translate into a reduction in salt. Nonetheless it is important that reductions in salt intake are not accompanied by increases in other forms of sodium. Sodium is an essential nutrient and an important component of the body water pool. There are complex physiological processes which regulate sodium concentration at the appropriate level, mostly by altering the amount of sodium excreted by the kidneys. However, over a prolonged period of time, a high dietary intake of sodium affects the ability of the kidneys to respond efficiently. Sodium excretion is impaired and this leads to an increase in blood pressure.

## Blood Pressure:

Blood pressure is the result of two opposing forces. Blood is pumped around the body by the left ventricle of the heart while the flow of blood is opposed by the resistance of the blood vessels. The pressure of blood flowing through the arteries varies at different times in the heart beat cycle. The peak, when the heart (left ventricle) contracts is known as the systolic pressure, and the minimum, when the heart relaxes, as diastolic pressure.

Blood pressure is measured in terms of the height (millimeters) of a column of mercury (Hg) which it can support and is conventionally recorded as systolic pressure/diastolic pressure e.g., 120/80 millimeters of mercury (mmHg).

*Raised blood pressure (hypertension)*

It is a major risk factor in the development of cardiovascular disease. In recent decades, a body of evidence has emerged from scientific research to suggest that a high dietary salt intake is an important causal factor in the development of hypertension.

Blood pressure must be controlled within relatively narrow limits to ensure adequate blood flow to the tissues, but without placing excess demands on the heart. Optimal blood pressure is defined as systolic pressure $< 120$ mmHg and diastolic pressure $< 80$ mmHg. High blood pressure (both systolic and diastolic) known as hypertension, is an important risk factor for cardiovascular disease. Table (2) presents the classification of blood pressure level. Figure (1) presents the normal mean systolic pressure.

Table (2): Classification of blood pressure levels

| Category | Systolic BP (mmHg) | Diastolic BP (mmHg) |
|---|---|---|
| Optimal blood pressure | <120 | <80 |
| Normal blood pressure | <130 | <85 |
| High-normal blood pressure | 130–139 | 85–89 |
| Grade 1 hypertension (mild) | 140–159 | 90–99 |
| Grade 3 hypertension (severe) | ≥180 | ≥110 |

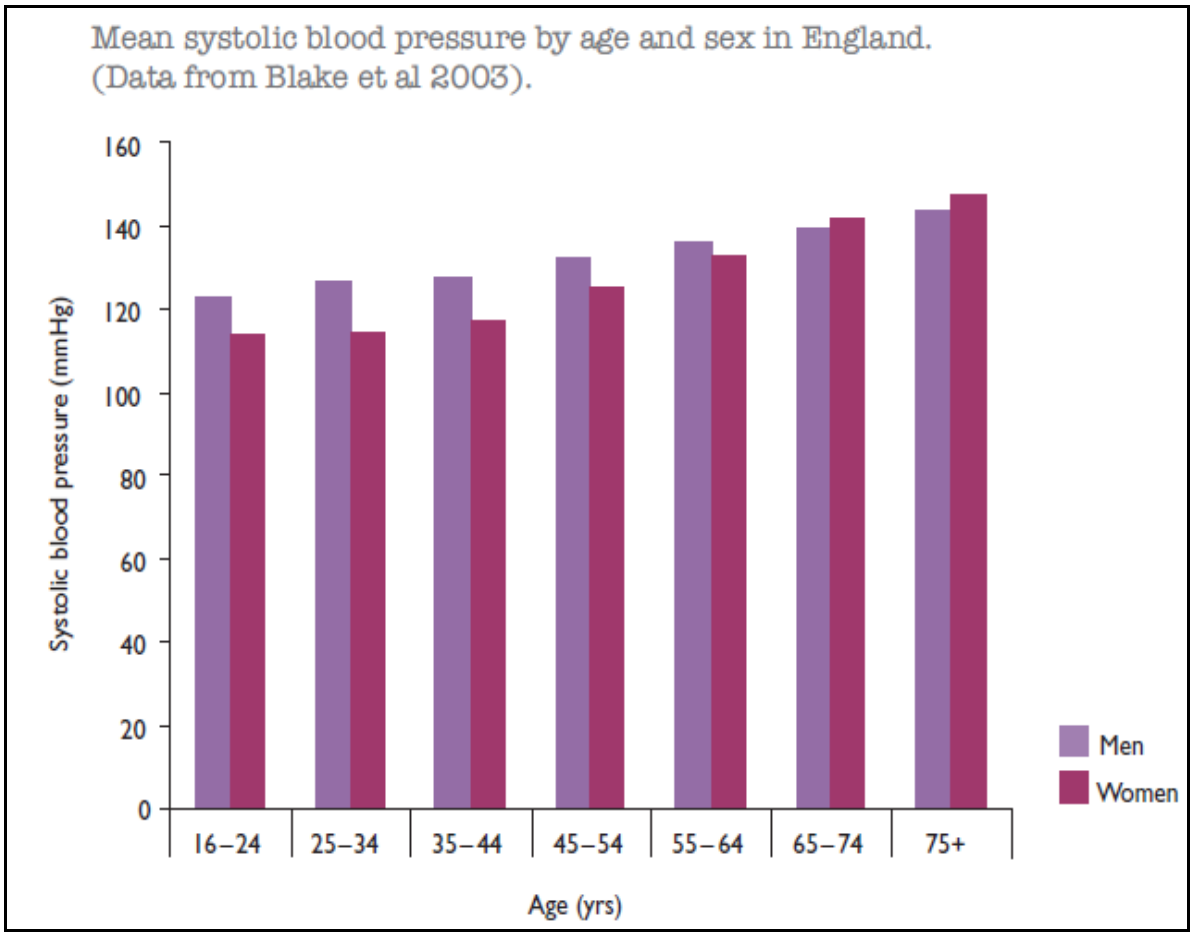



Figure (1): The mean systolic pressure.

Two techniques are used to measure the salt i.e., ion or electrolyte; Electrolyte analyzer and pH meter.

## Electrolytes

Electrolytes are minerals in your blood and other body fluids that carry an electric charge. Electrolytes affect how your body functions in many ways. Electrolytes are minerals in your body that have an electric charge. They are in the blood, urine, tissues, and other body fluids. Electrolytes are important because they help:

- Balance the amount of water in your body.
- Balance the body's acid/base (pH) level.
- Move nutrients into cells.
- Move wastes out of cells.
- Make sure that the nerves, muscles, the heart, and the brain work the way they should.

Electrolytes can be **acids**, **bases**, or **salts**. They can be measured by different blood tests. Each electrolyte can be measured separately, such as: **ionized calcium**, serum **calcium**, serum **chloride**, serum **magnesium**, serum **phosphorus**, serum **potassium**, serum **sodium**. Sodium, potassium, chloride, and calcium levels can also be measured as part of a **Basic Metabolic Panel (BMP)**. The basic metabolic panel is a group of blood tests that provides information about your body's metabolism, by testing the kidney function, blood acid/base balance, sodium and potassium levels, blood sugar levels, blood calcium level.

***EXTERNAL READING:***

An electrolyte panel, also known as a serum electrolyte test, is a blood test that measures levels of the body's main electrolytes:

**Sodium** → helps control the amount of fluid in the body. It also helps your nerves and muscles work properly.

**Chloride** → helps control the amount of fluid in the body. In addition, it helps maintain healthy blood volume and blood pressure.

**Potassium** → helps your heart and muscles work properly.

Bicarbonate → helps maintain the body's acid and base balance. It also plays an important role in moving carbon dioxide through the bloodstream.

*Abnormal levels of any of these electrolytes can be a sign of a serious health problem, including kidney disease, high blood pressure, and a life-threatening irregularity in heart rhythm.*

## Electrolyte analyzer

Electrolytes can be measured by a process known as potentiometry. This method measures the voltage that develops between the inner and outer surfaces of an ion selective electrode. The electrode (membrane) is made of a material that is selectively permeable to the ion being measured. For example, sodium electrodes are made from a special glass formula that selectively binds sodium ions. The inside of the electrode is filled with a fluid containing sodium ions, and the outside of the glass membrane is immersed in the sample. A potential difference develops across the glass membrane that is dependent upon the difference in sodium concentration (activity) on the inside and outside of the glass membrane. This potential is measured by comparing it to the potential of a reference electrode. Since the potential of the reference electrode is held constant, the difference in voltage between the two electrodes is attributed to the concentration of sodium in the sample. An example of industrial electrolyte analyzer is

Medica Corporation's EasyLyte® analyzer which is a completely automated, microprocessor-controlled electrolyte system that uses ISE (Ion Selective Electrode) technology to make electrolyte measurements. The EasyLyte product line measures combinations of Na+, K+, Cl–, Li+, Ca++, and pH in whole blood, serum, plasma, or urine. EasyLyte incorporates state-of-the-art electronics and an innovative ergonomic design that differentiates it significantly from competitors. The analyzer also stores quality-control data that is easily accessible. Patient histories are immediately retrievable for evaluation.

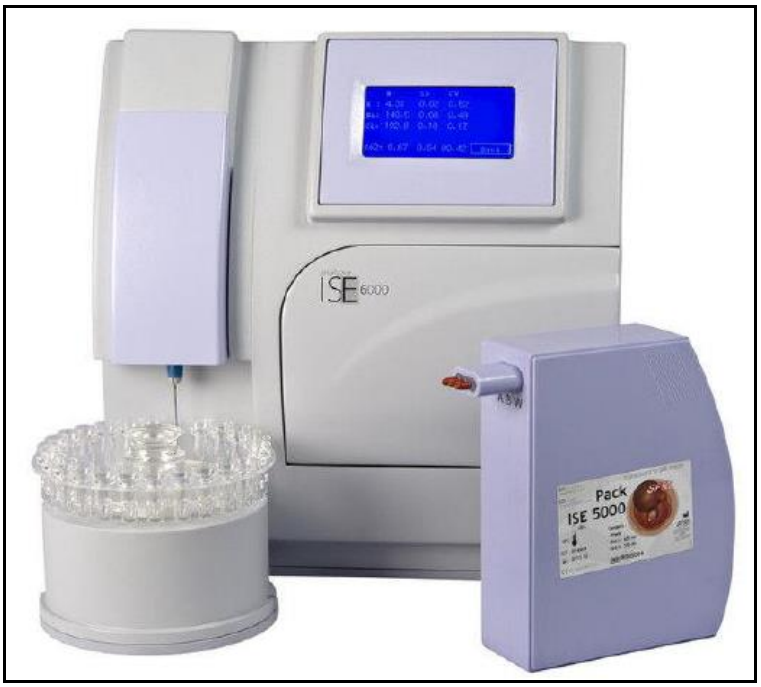



Figure 2: Medica Corporation's EasyLyte® analyzer.

## Questions for Chapter Six

**Answer true or false:**

1. In secondary hypertension (approximately 10% of all cases), a recognized by a risk of high salt.
2. Optimal blood pressure is defined as systolic pressure <120mmHg and diastolic pressure <80mmHg.
3. Blood pressure is measured in terms of the height (millimeters) of a column of silver Ag.
4. Mean systolic blood pressure for men age (65) is 140 mmHg.
5. Mean systolic blood pressure for women age (75) is 150 mmHg.

**Fill in the blank of the following statements:**

1. Primary hypertension is of unknown cause and is responsible for a least----------.
2. In secondary hypertension (approximately---------- a recognized medical condition such as kidney disease.
3. Optimal blood pressure is defined as systolic pressure ----------and diastolic pressure ----------.

**Choose the correct answer, from the following statements:**

1. The terms salt and sodium are often used synonymously but on a weight basis, salt Comprises:

   a. 30%sodium b. 50%sodium c. 40%sodium d. 70%sodium.

2. high salt intakes and blood pressure relates to:

   a. Calcium b. sodium c. chloride d. potassium.

4. Mean systolic blood pressure for men (75+age) is approximately:

   a. 120 mmHg b. 170mmHg c.130mmHg d. 145mmHg

# الوحدة السابعة – المحاضرة الأولى - الزمن: 90 دقيقة

## أهداف المحاضرة:

**يتوقع في نهاية الجلسة أن يكون الطالب قادراً على:**

1. **معرفة دور وأهمية الأنظمة الآلية في التحليلات الكيميائية السريرية.**
2. **الفرق بين نظامي الـ Modular والـ Integrated.**
3. **معرفة وتمييز الفرق بين نظامي Continous-flow processing ونظام الـ Discrete processing.**
4. **معرفة آلية عمل نظام التحليل الآلي لـ Continous-low system.**
5. **معرفة مساوئ نظام Continous-flow system.**
6. **معرفة آلية عمل نظام الـ Discrete Processing.**
7. **معرفة آلية عمل نظامي التحليل Centrifugal Analyzer، ونظام Random Access Analyzer.**

## موضوعات المحاضرة:

- **مقدمة.**
- **أهمية النظم الآلية (المؤتمتة) في تحليلات الكيمياء السريرية.**
- **نظام Contious-flow System.**
- **نظام Discrete processing.**
- **نظام Centrifugal analysis.**
- **نظام الـ Random Access Analyzer.**

## الأساليب والأنشطة والوسائل التعليمية

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ملاحظة: للتدريسي حرية في تغيير الاساليب والانشطة والوسائل حسب ما يراه مناسبا.

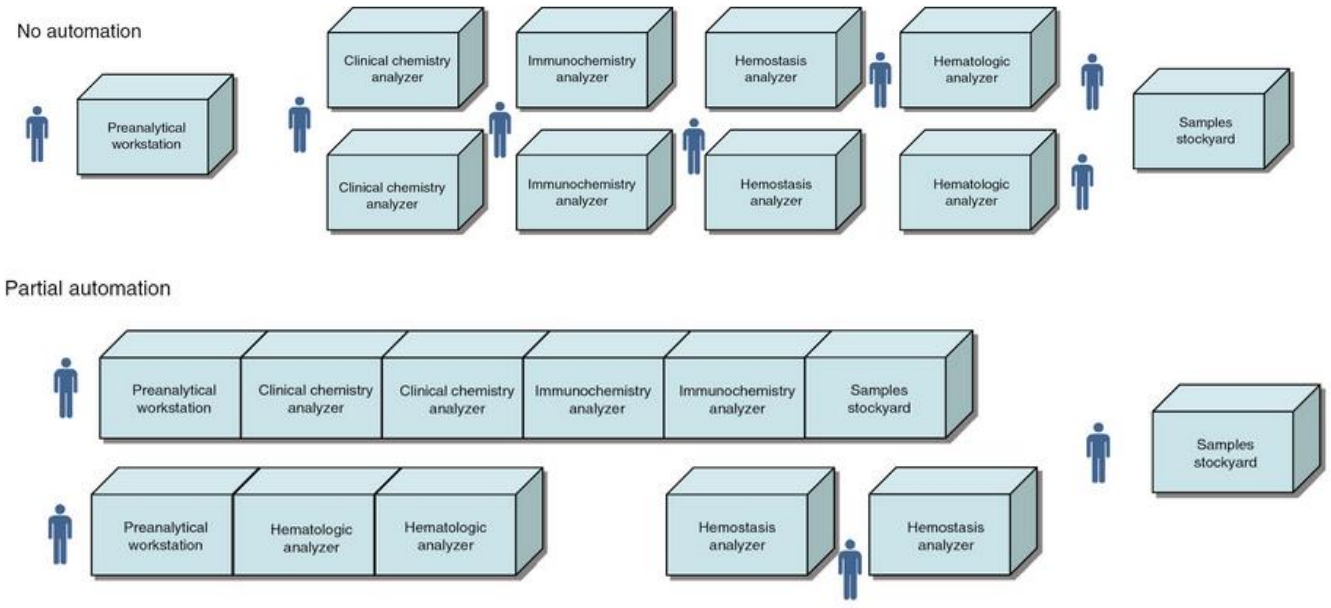
الوحدة السابعة جلسة واحدة

المادة العلمية:

# Auto – analysis instruments

## Introduction:-

The automation means getting work done by machines without our continuous monitoring. Automation refers to machines with intelligence and adaptability which reduces our workload and need for nonstop supervision. Clinical chemistry-based analysis tests can be achieved through three kinds of systems. Firstly, a conventional (no automated) system, where each category of tests required one technician to do. Secondly, it can also be achieved through partial automation, where more than one category of the tests are achived automatically. Lastly, is the fully automated systems, where a complete tests in many categories achieved using one system.



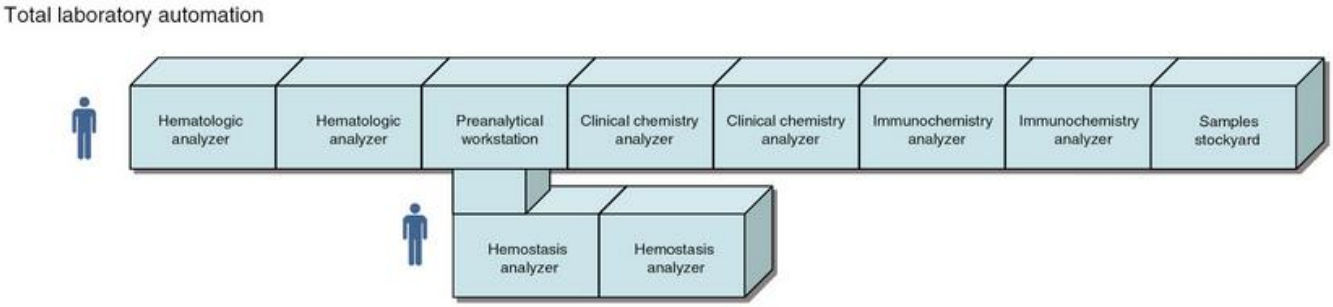



Figure (1): Different models of automated laboratory.

Auto analyzer were used mainly for routine repetitive medical laboratory analyses, they determine levels of albumin, alkaline phosphatase, aspartate transaminase (AST), blood urea nitrogen, bilirubin, calcium, cholesterol, creatinine, glucose, inorganic phosphorus, proteins, and uric acid in blood serum or other bodily samples. Auto analyzer automate repetitive sample analysis steps which would otherwise be done manually by a technician. An auto Analyzer can analyse hundreds of samples every day with one operating technician. Modern auto analyzer such as the SMAC tested for multiple analytes simultaneously in the samples.

## Importance Automation in Clinical Chemistry:

*Why the clinical chemistry automation is so important?*

1. To increase the number of tests performed by one laboratorian in each period.
2. To minimize the variation in results from one laboratorian to another.
3. It lowers the cost per test.
4. To increase the accuracy of measurements, where the accuracy is then not dependent on the skill or workload of a particular operator on a particular day.
5. Automation eliminates the potential errors of manual analyses such as volumetric pipetting steps, calculation of results, and transcription of results.
6. This allows better comparison of results from day to day and week to week.

7. It uses very small amounts of samples and reagents, this allows less blood to be drawn from each patient, and the use of small amounts of reagents decreases the cost of consumables.

- Different classification exist for auto analyzers:

The automated machines are designed to function as **modular system** or an **integrated system**. In modular system, the automated analyzer is composed of different modules, where each module is dedicated to do specfic clinical tests. Each module is created separately in such a way that they can fit into different system at any order, without affecting the entire machine. One example is: Roche Modular P auto analyzer as shown in Figure (2). The software is developed to enable the integration of any module in the future throught options in the GUI (graphical user interface) of the software.

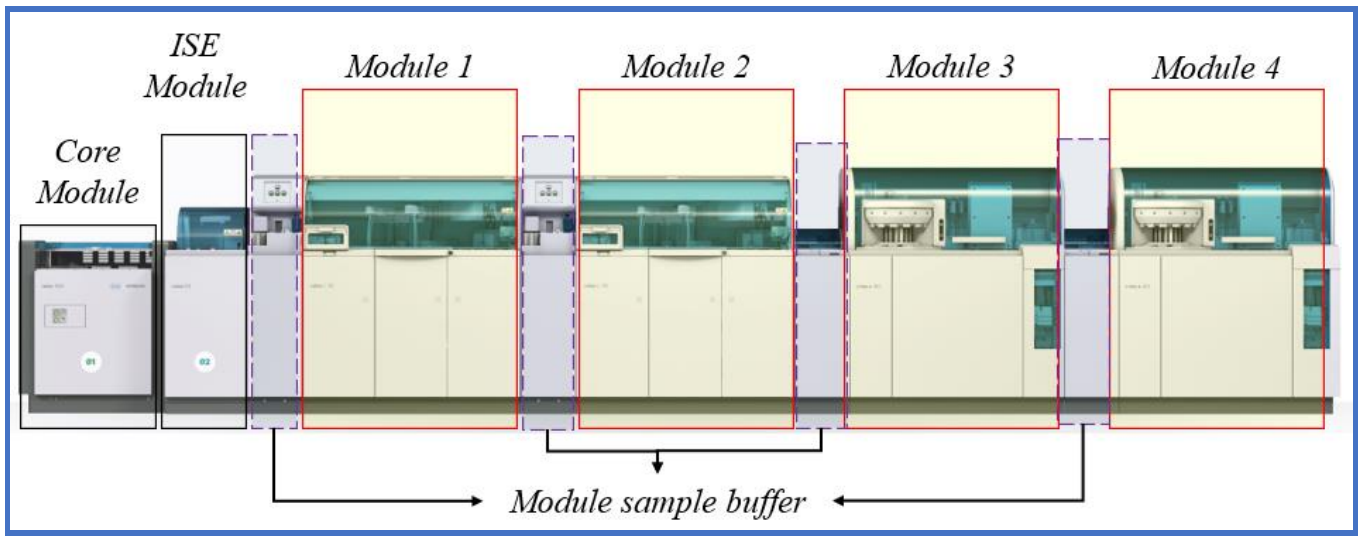



Figure (2): Example of modular system.

In contrast, in the integrated system, the entire equipment is designed in such a way that every part is an essential part of the machine. The software emerged the functionality of different software into one software solution.

Integrated system has supperior advantage such as improved communication and data

exchange between different softwares and machines. However, the modular system is easier to maintain. If there is a problem with any part, only that part is need to be maintained without disrupting the rest of the system parts. The maintanance of the integrated system could be more difficult and expesive, where the lab administration and technician rely on company engineers everytime even for a minor service.

- In terms of processing, auto-analyzers broadly fall into two categories; **continous-flow processing** and **discrete processing**.

**A. <u>Continuous flow analyzer (CFA)</u>**: The sample to be tested is subjected to turbulent-flow conditions that allow for complete sample dispersion (the sample passes through the pipes crossing to the whole parts of the analyzer – **carryover effect**, which leads to losses in its sample amounts due to friction with pipes and consequently required more cleaning and extensive cleaning and calibration process). It is made of different modules, such as sampler, pump, mixing coil, heater/incubator, sample treatment chamber (dialysis, distillation etc), signal detector, read out device (data generator). The main principle of continuous flow processing is the flowing carrier solution passes through small tubes continuously.

**The procedure technique of CFA:**

1. Sample collection from the patient.
2. Sample is injected into a flowing carrier solution then mixes withdiluents and reagent and it is sent through the tubing and mixing coils.
3. The machine prevents carry over effect between different samplesby injecting bubbles of air, which create separate space for differentreactions to take place inside the

tubing and mixing coils.

4. The tubing passes the samples from one apparatus to the other. Thereare different apparatus for different functions, such as ion exchange,heating ,incubation, and finally recording of the signal.
5. The flowconditions are regulated. When reaction is taking place, the optical density of the colour formed is read and results are obtained. So we do not have to wait till the reaction ends.

For example for better understanding. It is required to analyze for total protein, albumin, and creatinine for a patient with a nephrotic syndrome (متلازمة كلوية).

In case of continuous flow processing analyzer, the patient sample will be sucked by the instrument and injected into the tubing with reagents for protein, (and diluents if needed). Next **air bubbles** will be injected and patient sample will be sucked again. This time instrument will inject reagent for albumin. Mixing will be done inside the tubing and mixing coils. Again the process will be repeated for creatinine estimation. The 3 reactions will occur inside the same long tubing but they will remain separate due to air bubbles in between.

As the sample and standard are treated in the same manner, mixed in same condition, travel the same length of tubing, it removes the difference between the two. So the difference in reading for test-tube from that of standard gives the answer. Even though originally, CFA was designed to process only colorimetric reactions, later on CFA were designed to read reactions based on ion selective electrode, flame photometry, and others; depending on the need of laboratories.

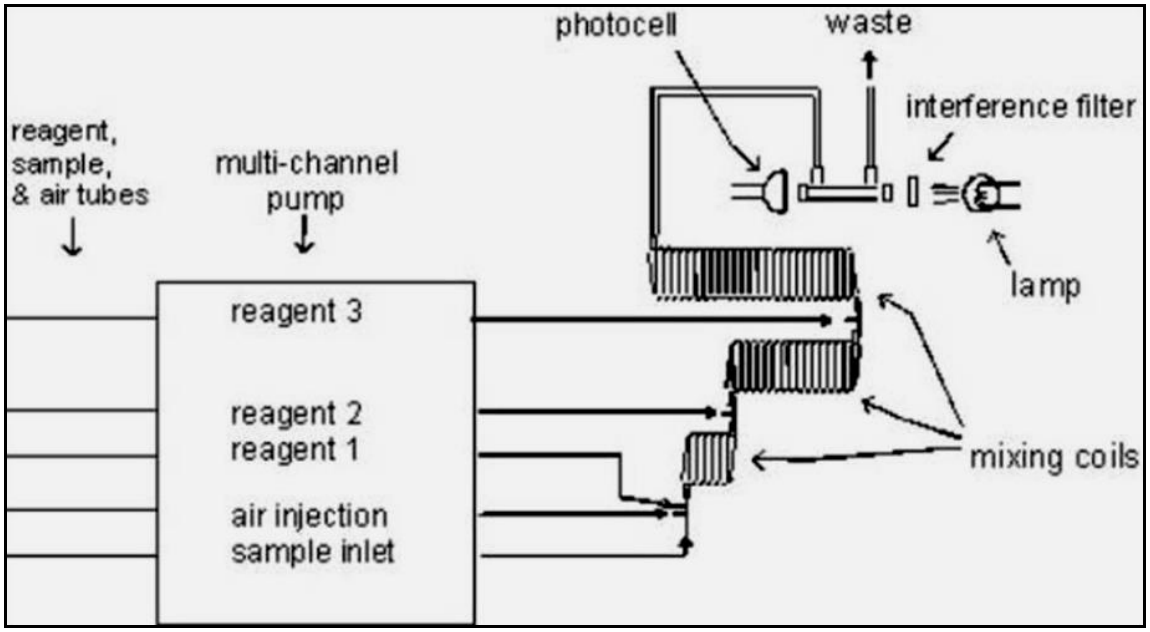



Figure (3): The illustration of a continous-flow auto analyzer.

## The disadvantage of CFA:

1. Even when there is no test to be done, reagents are drawn to maintain the flow. This adds to the cost per test.
2. Maintainance of instrument is required more frequently.
3. The probe and internal tubings must be free of clogs (foaling), when there is no sample the probe must be dipped in distilled water to avoid blockage or precipitation.
4. The machine itself occupies large space.

**B. Discrete processing:** The main concept of discrete analyzer that it keeps sample separate throughout the testing process, dispensing precise amounts when required. Rotating individual cuvettes through the instrument instead of releasing the sample in a continuous stream, which consequently cuts down on reagent waste, and can produce hundreds of results per hour.

Let us take the previous example of the nephrotic syndrome patient again. You If you want to analyze the same 3 parameters: total protein, albumin and creatinine. The procedure is:

1. The same patient sample will be sucked by the instrument and poured into 3 different cups.
2. Then reagents for protein, albumin and creatinine and diluents (if needed) will be added; mixing will be done.
3. Cups will be read at different times to give results.

Exact amount of sample and reagent is aspirated and mixed. So there is no loss of excess reagents used for flow as in continuous flow processing. As each analysis is done in different cups and read in different cuvetes, there is no carry over effect at all. So each analysis is discrete from each other. The prospect of cutting testing and consumable costs in descrete analysis, along with the ease of operation have prompted many laboratories to transfer methods from CFA to discrete analyzers.

*Based on this principle the auto analyzers developed into two different varieties such as* ***centrifugal analyzer*** *and* ***random access analyzer****.*

## Centrifugal Analyzer

Sample and reagents is pipette into different chambers on a rotor. The centrifugal force is used for transfer and mixing of sample and reagents. Rotor moves the final product upto the optical system for final reading. This is time saving for batch analysis because all cuvets can be read at a time. But its disadvantage is that only one test can be performed at a time.

Figure (5): An example of centrifugal analyzer.

## Random access analyzer:

Each sample can be analyzed for multiple tests, and multiple samples for one test also can be done by giving appropriate commands to computer software. It is the most versatile of all type analyzers. Let us say we have 3 different samples. First one needs renal profile, second one needs only glucose and urea and third one need triglyceride, albumin and calcium. So the technician has to simple take 3 different sample cups and loads 3 samples. Then he has to enter sample number, cup number and the tests required. And when he presses the start button tests will be done automatically.

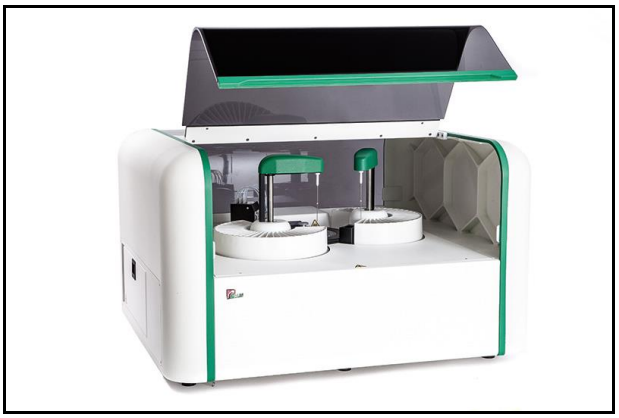


Figure (4): An example random access analyzer.

# Test Questions for Chapter 7

1. What is the main difference between centrifugal analyzer and random access analyzer?
2. What is the main difference between continuous-flow anlyzer and discrete processing analyzers?
3. An open system analyzer saves money by reducing .....
4. A modular system is flexible because its ..... can be replaced without affecting entire machine.
5. The main feature of CFA is that, a flow carrier solution runs through it .....
6. The main feature of discrete analyzer is that each reaction takes place discretely .....
7. Which analyzer is associated with minimum carry over effect? Choose between CFA and discrete analyzer.
8. One disadvantage of automation is ..... cost What have you learnt.
9. Discuss the disadvantages of CFA?
10. How is discrete analyzer better than CFA?
11. List the important uses for the auto analyzer over conventional ones?

# الوحدة الثامنة – المحاضرة الأولى - الزمن: 90 دقيقة

## أهداف المحاضرة:

**يتوقع في نهاية الجلسة أن يكون الطالب قادراً على:**

1. **معرفة أهمية كل معدن ووظيفته في جسم الأنسان.**
2. **التفريق بين فئتي أنواع المعادن: marominerals and microminirals**
3. **معرفة الكميات اليومية اللازمة للمعادن التي يحتاجها الجسم البشري.**
4. **معرفة تأثير التغير في مستويات الآيوداين والصوديوم والسيلينيوم والفسفور والنحاس والخارصين على عمل الجسم.**
5. **معرفة الأجهزة المستخدمة لقياس مستويات المعادن.**

## موضوعات المحاضرة:

- **التعريف بالمعادن وأنواعها وأهميتها.**
- **الكميات اليومية التي يحتاجها الجسم البشري.**
- **أجهزة قياس المعادن.**

## الأساليب والأنشطة والوسائل التعليمية

| م | الأساليب والأنشطة التدريبية | الوسائل التدريبية |
|---|---|---|
| 1 | • نشاط التعارف (1/1/1)<br>• محاضرة<br>• مناقشة<br>• سؤال وجواب | • جهاز حاسوب<br>• جهاز عرض<br>• سبورة<br>• اوراق واقلام |

ملاحظة: للتدريسي حرية في تغيير الاساليب والانشطة والوسائل حسب ما يراه مناسبا.

الوحدة الثامنة جلسة واحدة

المادة العلمية:

# Minirals Measurement Instrument

**Minerals:** are the chemical elements exist in all body tissues and fluids, their existance is necessary for maintaining certain physicochemical processes, essential for life.

**Minerals Nutrients:** are inorganic substances that must be ingested and absorbed in adequate amounts to satisfy a wide variety of essential metabolic and/or structural functions in the body.

- Minerals and electrolyte are important because the body cannot function without them. *All electrolyte are minerals but not all minerals are electrolyte*. Electrolyte are the minerals that carry an electrical charge.
- The body requires some raw materials, which include at least 30 vitamins, minerals, and dietary components that your body needs but cannot manufacture on its own in sufficient amounts.
- Vitamins and minerals are considered essential nutrients – because acting in concert, they perform hundreds of roles in the body. They help shore up bones, heal wounds, and bolster your immune system. They also convert food into energy, and repair cellular damage.

They are classified as major minerals (**macrominerals**) (body requires more than 100 mg/day) and trace minerals (**microminerals**) (body requires less than 100 mg/day), and Table (1) and (2) below list minerals, what they do in the body (their functions), and their sources in food.

Table (1): The major minirals (***macrominirals***) required by human body.

| Macro-mineral | Function | Sources |
|---|---|---|
| **Sodium** | Needed for proper fluid balance, nerve transmission, and muscle contraction. | Table salt, soy sauce; small amounts in milk, breads, vegetables. |
| **Chloride** | Needed for proper fluid balance, stomach acid, maintain the osmosis pressure in body cell. | Table salt, soy sauce; small amounts in milk, meats, breads, and vegetables |
| **Potassium** | Needed for proper fluid balance, nerve transmission, and muscle contraction. | Meats, milk, fresh fruits and vegetables, whole grains, legumes بقوليات |
| **Calcium** | Important for healthy bones and teeth; helps muscles relax and contract; important in nerve functioning, blood clotting, blood pressure regulation, immune system health. | Milk and milk products; canned fish with bones (salmon, sardines); greens (broccoli), legumes. |
| **Phosphorus** | Important for healthy bones and teeth; found in every cell; part of the system that maintains acid-base balance. | Meat, fish, poultry, eggs, milk, processed foods. |

| | | |
|---|---|---|
| **Magnesium** | Found in bones; needed for making protein, muscle contraction, nerve transmission, immune system health. | Nuts and seeds; legumes; leafy, green vegetables; seafood; chocolate. |

- Calcium, magnesium and phosphor are bulk mineral, while sodium, potassium, and chloride are electrolytes.

***Trace minerals (microminerals)*** The body needs trace minerals in very small amounts.

Table (2): The trace minirals (***microminirals***) required by human body.

| Micro-mineral | Function | Sources |
|---|---|---|
| **Iron** | Part of a molecule (hemoglobin) found in red blood cells that carries oxygen in the body; needed for energy metabolism. | Organ meats, red meats, fish, poultry, shellfish, egg yolks, legumes, dried fruits. |
| **Zinc** | Part of many enzymes; needed for making protein and genetic material; has a function in taste perception, wound healing, normal fetal development, immune system health. | Meats, fish, poultry, leavened whole grains, vegetables. |

| | | |
|---|---|---|
| **Iodine** | Found in thyroid hormone, which helps regulate growth, development, and metabolism. | Seafood, foods grown in iodine-rich soil, iodized salt, bread. |
| **Selenium** | Antioxidant | Meats, seafood, grains |
| **Copper** | Part of many enzymes; needed for iron metabolism | Legumes, nuts and seeds, organ meats, drinking water |
| **Fluoride** | Involved in formation of bones and teeth; helps prevent tooth decay. | Drinking water (either fluoridated or naturally containing fluoride), fish. |
| **Chromium** | Works closely with insulin to regulate blood sugar (glucose) levels. | Unrefined foods, especially liver, whole grains, nuts, cheeses. |

## Recommended daily requirements of minerals:

The daily requirements of minerals required by the body can be obtained from a well balanced diet. Like vitamins, excess minerals can produce toxic effects. The following table should cover the recommended daily requirements (**RDR** or **RDA**) of almost.

Table (3): The recommended daily intake of requirement for human body by both male and female.

| Mineral | Men | Women |
|---|---|---|
| Calcium | 1000 mg | 1200 mg |
| Sodium | 1100 mg | 3300 mg |
| Potassium | 2000 mg | 2000 mg |

| | | |
|---|---|---|
| Iron | 10 mg | 15 mg |
| Zinc | 15 mg | 12 mg |
| Magnesium | 350 mg | 280 mg |
| Phosphorus | 800 mg | 1200 mg |
| Chlorine | 700 mg | 700 mg |
| Fluorine | 1.5 mg | 4 mg |
| Copper | 2 mg | 2 mg |
| Selenium | 0.07 mg | 0.05 mg |

**Excess of minerals**: High concentrations of minerals in the body can have ill effects on your health. Symptoms of mineral toxicity vary as toxic levels depend on the type of mineral and how much of it your body takes in.

- High levels of **iodine** in the bloodstream can interfere with hormone functioning.
- Too much **sodium** can cause confusion, seizures, coma, and even death.
- **Selenium** is a mineral that is toxic in just small doses. Symptoms include black fingernails and the smell of garlic on your breath and skin.
- **Phosphorus** toxicity prevents the absorption of calcium and magnesium in the body. When ingested in amounts more than 1 g daily, phosphorus can cause diarrhea or lead to calcification تكلس of organs and soft tissues.
- **Copper** toxicity is also rare, however, excessive intake can cause vomiting, diarrhea, irritability تهيجات and dementia جنون.
- **Zinc** is generally considered to be non-toxic although extremely high doses of it can lead to symptoms such as nausea غثيان , vomiting and diarrhea.

## Mineral Measurement :

Measurement of minerals is a commonly performed diagnostic procedure, performed via blood testing.

1. Flame photometer or (Atomic absorption spectroscopy AAS) used to determine the concentration of minerals ions, such as(Ca, k and Na).
2. Auto analyzer (biochemistry analyzer) used to measure electrolyte most often are sodium and potassium, chloride, and bicarbonate or total $CO_2$.
3. Dual-energy X-ray absorptiometry (DXA): used to measure total body composition. The DXA scan is typically used to diagnose and follow osteoporosis, The bone density test is painless and quick. The X-rays measure how much calcium and minerals are in a part of your bone.

The amount of phosphate in the blood affects the level of calcium in the blood. Calcium and phosphate in the body react in opposite ways: as blood calcium levels rise, phosphate levels fall. A hormone called parathyroid hormone (PTH) regulates the levels of calcium and phosphorus in your blood. When the phosphorus level is measured, a vitamin D level, and sometimes a PTH level, is measured at the same time. Vitamin D is needed for your body to take in phosphate. The relation between calcium and phosphate may be disrupted by some diseases or infections. For this reason, phosphate and calcium levels are usually measured at the same time.

# الوحدة التاسعة – المحاضرة الأولى - الزمن: 90 دقيقة

## أهداف المحاضرة:

**يتوقع في نهاية الجلسة أن يكون الطالب قادراً على:**

1. **فهم آلية عمل الجهاز المناعي.**
2. **معرفة آلية حدوث antigen-antibody complex.**
3. **معرفة أهمية ودور الأختبارات المناعية في الكشف عن الأمراض.**
4. **معرفة آلية عمل جهاز الفحص المناعي Elisa**
5. **معرفة وفهم آلية عمل Indirect Elisa Test**
6. **معرفة وفهم آلية عمل Direct Elisa Test**
7. **معرفة وفهم آلية استنساخ الأجسام المضادة على الفأر المختبري وتكاثرها في الخلايا السرطانية.**
8. **معرفة آلية عمل الـ monoclonal antibody، للكشف عن الخلايا السرطانية.**

## موضوعات المحاضرة:

- **الجهاز المناعي.**
- **اختبار الـ Elisa.**
- **اختبار Indirect Elisa Test.**
- **اختبار Direct Elisa Test.**
- **مضادات الـ Monoclonal.**

## الأساليب والأنشطة والوسائل التعليمية

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ملاحظة: للتدريسي حرية في تغيير الاساليب والانشطة والوسائل حسب ما يراه مناسبا.

الوحدة التاسعة جلسة واحدة

المادة العلمية:

# Elisa Instrument and Its uses

## The immune system

The immune system helps to protect us against diseases caused by tiny invaders (called pathogens) such as viruses, bacteria, and parasites. The immune system is made up of specialized organs, cells, and tissues that all work together to destroy these invaders. Some of the main organs involved in the immune system include the spleen الطحال , lymph nodes العقد اللمفاوية, and bone marrow نخاع العظم . The immune system develops all kinds of cells that help to destroy disease causing microbes. Some of these cells are specifically designed for a certain kind of disease. All throughout the body, disease fighting cells are stored in the immune system waiting for the signal to go to battle.

When an antigen (Dot shapes) enters the body, the immune system produces antibodies (Y-shaped) against it. It is like a battle with the army (antibody) fighting off the invader (antigen). A type of white blood cell called a lymphocyte recognizes the antigen as being foreign and produces antibodies that are specific to that antigen. Each antibody has a unique binding site shape which locks onto the specific shape of the antigen. The antibodies destroy the antigen which is then engulfed and digested by macrophages.

Antibody (Ab): is gamma globulin Y-shape proteins, also called immunoglobulins that are manufactured by the body that help fight against foreign substances called antigens. It is used by the immune system to identify and neutralize foreign objects. When an antigen

enters the body, it stimulates the immune system to produce antibodies. The antibodies attach, or bind, themselves to the antigen and inactivate it. There are five classes of antibodies, each having a different function. They are Ig**G**, Ig**A**, Ig**M**, Ig**D**, and Ig**E**. Ig is the abbreviation for immunoglobulin, or antibody. Anti-forign body, while the forign body is antigen.

Antigen (Ag): is any substance that causes the body to make an immune response against that substance. Antigens include toxins, chemicals, bacteria, viruses, or other substances that come from outside the body. Body tissues and cells, including cancer cells, also have antigens on them that can cause an immune response. These antigens can also be used as markers in laboratory tests to identify those tissues or cells. It could be a proteins or polysaccarides located on the antigen cell wall. When the antibody binds to the invading antigen, the combining form called antigen-antibody complex, as shown in Figure (1).

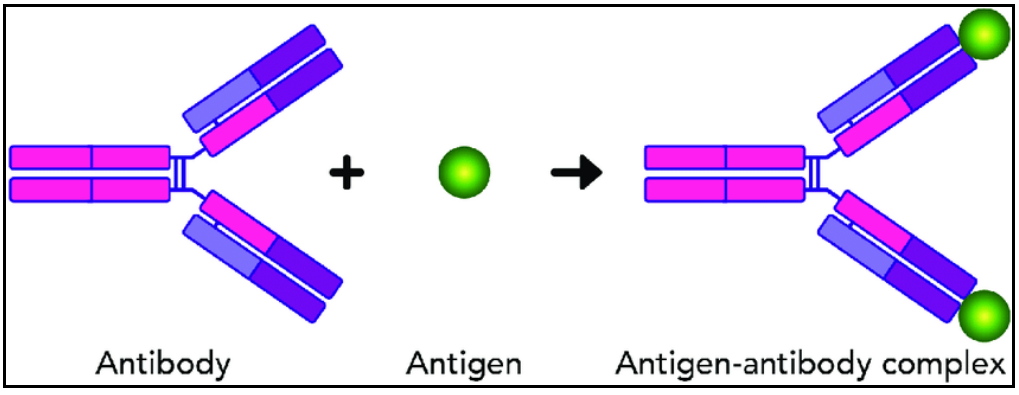



Figure (1): Antibody and antigen binding process.

**An immunoassay (IA)** is a biochemical test that measures the presence or concentration of a macromolecule or a small molecule in a solution through the use of an antibody

(usually) or an antigen (sometimes). The molecules in biological liquids such as serum or urine are frequently measured using immunoassays.

**ELIZA:** **E**nzyme-**L**inked **I**mmuno**s**orbent **A**ssay is a type of primary binding test used to detect and measure either antigen or antibody. The ELISA is a fundamental tool of clinical immunology, and is used as an initial screen for HIV (Human immunodeficiency virus) detection.

## ELIZA working principle:

The basic concept of elisa test, includes utilizing a specific synthesized antigen (Ag) coated in a well (0.2 mL tube) to detect or estimate the concentration of a spcific antibody (Ab) in the blood serum that match to the synthesized Ag. This process is called **indirect eliza** test. On the other hand, it also used to detect or estimate the existance or concentration of a specific antigen (Ag) molecules found in blood serum, by utilizing a specific synthesized antibody (Ab). This is called **direct eliza** test. When the antibody and antigen is combined in either method, forming an antigen-antibody complex (inside the well), an artificial enzyme linked antibody is added to the wells to enable detection of the captured protein. Finally, a substrate (substance) is added and converted by enzyme into a colored product. The rate of the colored information is proportional to the amount of spcific antibody. The final colored product is subjected to spectroscopy called elisa reader, to quatify the concentration of the Ab or Ab in the serum or urin sample. The process is repeated for the control samples with a predefined concentrations of that specific Ab or Ag to be assayed. Washing process is mandatory process; it has to be carried out after each step of the assay.

One of the key steps to focus on for optimizing ELISAs is washing. The washing steps are necessary to reduce background signal related to unbound, conjugated antibody and thereby increase the assay's signal-to-noise ratio. Washing between steps ensures that only specific (high-affinity) binding events are maintained, to cause signal at the final step. Insufficient washing can result in variation and high background, and thus poor results.

## The requirements for eliza assay:

1. Purified antigen.
2. Purified antibody.
3. Standard solution.
4. Well stip (microtiter dishes).
5. Wash fluid (buffer).
6. Enzyme labeled antibody and enzyme substrate.
7. Elisa reader (spectrophotometer)for quantities measurement.

**Indirect Elisa:** is a two-step ELISA which involves two binding process of primary antibody and labeled secondary antibody. It used to detect of antibody. The procedure of conducting indirect eliza test as follows:-

1. Prepare the well which coated with antigen.
2. Micro-well plates are incubated with antigens, washed up with buffer solution.
3. Samples with antibodies are added and washed.
4. Enzyme linked secondary antibody are added and washed.
5. A substrate for this enzyme is then added. Often, this substrate changes color upon reaction with the enzyme.

6. The color change indicates that the secondary antibody has bound to primary antibody, which strongly implies the donor has had an immune reaction to the test antigen.
7. The higher the concentration of the primary antibody present in the serum, the stronger the color change. Often, a spectrometer is used to give quantitative values for color strength.

## Direct Eliza Assay:

This technique is used to detect sample antigen, and sometimes is called "sandwich" elisa. The steps are as follows:-

1. Prepare a surface to which a known quantity of capture antibody is bound.
2. Block any nonspecific binding sites on the surface.
3. Apply the antigen-containing sample to the plate.
4. Wash the plate, so that unbound antigen is removed.
5. A specific antibody is added, and binds to antigen (hence the 'sandwich': the Ag is stuck between two antibodies).
6. Apply enzyme-linked secondary antibodies as detection antibodies that also bind specifically to the antibody's Wash the plate, so that the unbound antibody-enzyme conjugates are removed.
7. Apply a chemical that is converted by the enzyme into a color or fluorescent or electrochemical signal.
8. Measure the absorbency or fluorescence or electrochemical signal (e.g., current) of the plate wells to determine the presence and quantity of antigen.

The artificial antibodies are categorized into moloclonal or polyclonal antibodies, which are synthesized using inoculation inside animals such as mices or inside human.

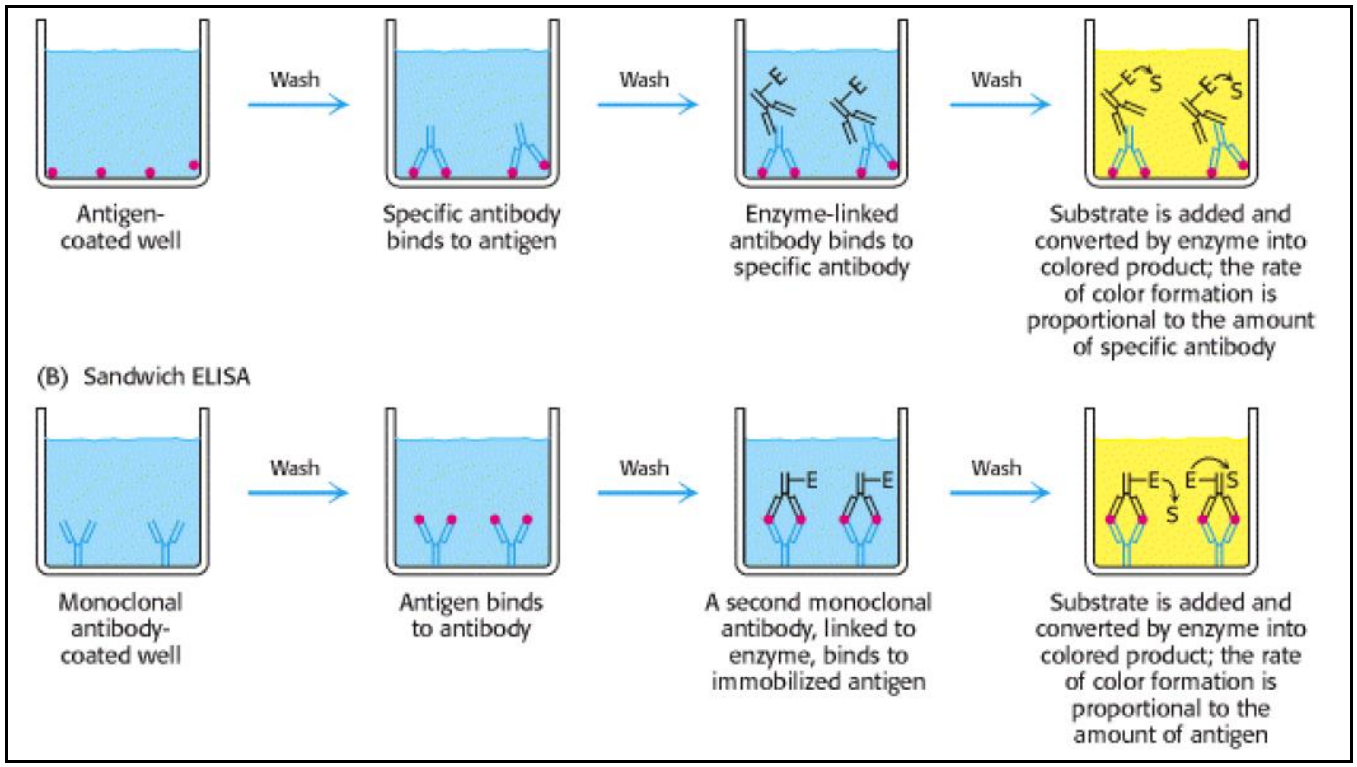



Figure (2): The illustrated steps for direct and indirect eliza test.

- لإنتاج الاجسام المضادة التي تستخدم في تحليلات الجهاز المناعي كالـ elisa، واختبار كشف الحمل أو لأغراض التشخيص لبعض الأمراض المستعصية ، يتم حقن الـ antigen المعين داخل جسم الفأر المختبري. يتم التعرف على الـ antigen من قبل خلايا الـ B-Cell والتي بدورها تبدأ بالانقسام وتكوين أجسام مضادة Antibody مخصصة فقط لهذا الـ antigen الذي تم حقنه مسبقا. ثم نأخذ خلايا الـ B-Cells ، المتخصصة خارج جسم الفأرة ليتم زراعتها في خلايا سرطانية والتي بدورها تعمل عمل المضيف للتكاثر (كونها سريعة الانقسام) ، حيث تضمن سرعة الانقسام والتكاثر، وبالتالي يتم الحصول على عدد كبير من خلايا الـ B-Cells المنتجة للأجسام المضادة. يتم أخذ هذه الخلايا ومن ثم تصفيتها Purified من الخلايا السرطانية وغيرها وخزنها كي تستخدم في تطبيقات كثيرة.

**Monoclonal antibodies:** اجسام مضادة مستنسخة are identical antibodies made by the many descendants (clones) of a single B cell (خلية لمفاوية تفرز كمية من الاجسام المضادة). Because of their unique specificity for different molecules, monoclonal antibodies are promising treatments for a range of diseases. Researchers make monoclonal antibodies by injecting a mouse with a target antigen and then fusing B cells from the mouse with another long-lived cell (Cancer cell). The resulting hybrid cell becomes a type of antibody factory, turning out identical copies of antibody molecules specific for the target antigen.

Mouse antibodies are "foreign" to people, however, and might trigger their own immune response when injected into a human. Therefore, researchers have begun to study "humanized" monoclonal antibodies.

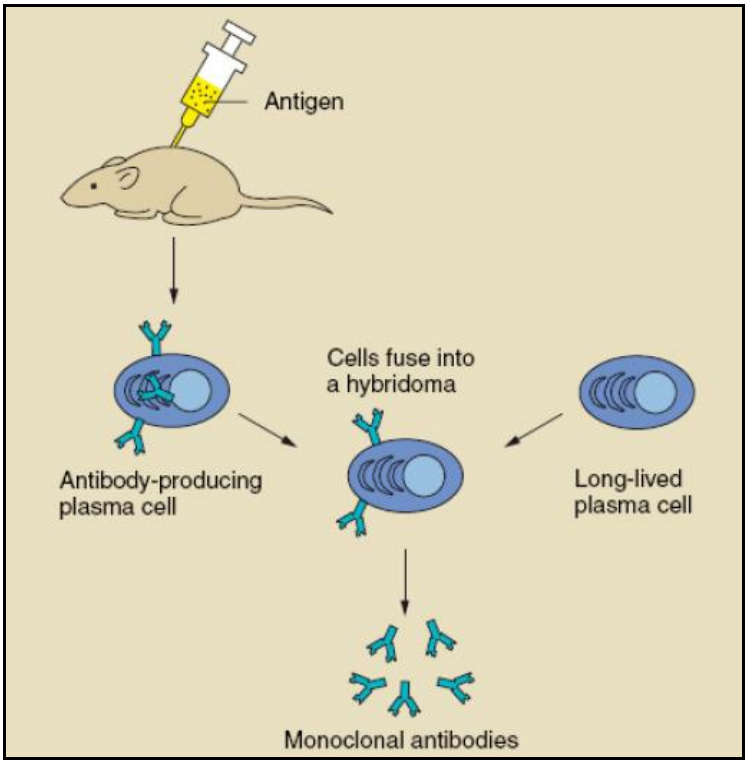



Figure (3): The process of monoclonal antibodies.

## How monoclonal antibodies work

Monoclonal antibodies are designed to recognise and find specific proteins on cancer cells. Each monoclonal antibody recognises one particular protein. Different types of cancer have different proteins. So different antibodies have to be made to target different types of cancer. Many different monoclonal antibodies are already available to treat cancer. Some are licensed to treat particular types of cancer. Some newer types are still in clinical trials. Different monoclonal antibodies cause different side effects. It can take a long time to develop this type of treatment because some monoclonal antibodies are very complicated.

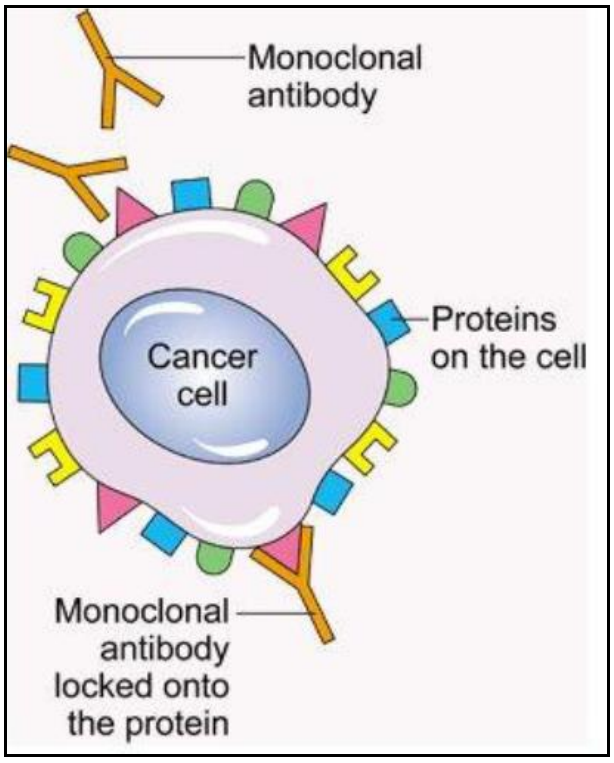



Figure (4): An illustration of a monochlonal antibody attached to a cancer cell.

# الوحدة العاشرة - المحاضرة الأولى - الزمن: 90 دقيقة

## أهداف المحاضرة الاولى:

**يتوقع في نهاية الجلسة أن يكون الطالب قادراً على:**

1. **تعريف التوصيل الكهربائي.**
2. **معرفة التوصيل الكهربائي في الجهاز العصبي لجسم الإنسان.**
3. **معرفة آلية عمل الخلية العصبية.**
4. **معرفة دور الخلايا العصبية في جسم الإنسان.**
5. **معرفة تقنية الـ EEG وآلية عملها في قياس النشاط الكهربائي للدماغ.**
6. **معرفة طريقة استخدام الـ EEG.**
7. **معرفة الإشارات الطبيعية للحالة الصحية للدماغ ومعرفة الأمراض التي يمكن تشخيصها بالاعتماد على قراءات الـ EEG.**
8. **معرفة قياسات الـ ECG وأهميتها في التحليل الكهربائي لعمل وأداء القلب.**
9. **فهم آلية الإنقباض والإنبساط في العضلات الهيكلية وكيفية قياسها باستخدام تقنية EMG.**
10. **معرفة مكونات جهاز الـ EMG.**

## موضوعات المحاضرة الاولى:

- **التوصيل الكهربائي في جسم الانسان.**
- **الخلية العصبية ومكوناتها وآلية عملها.**
- **تقنية الـ EEG لتحليل إشارات الدماغ.**
- **تقنية الـ ECG لتحليل إشارات الدماغ.**
- **تقنية الـ EMG لتحليل إشارات الدماغ.**

## الأساليب والأنشطة والوسائل التعليمية

| م | الأساليب والأنشطة التدريبية | الوسائل التدريبية |
|---|---|---|
| 1 | • نشاط التعارف (1/1/1)<br>• محاضرة<br>• مناقشة<br>• سؤال وجواب | • جهاز حاسوب<br>• جهاز عرض<br>• سبورة<br>• اوراق واقلام |

ملاحظة: للتدريسي حرية في تغيير الاساليب والانشطة والوسائل حسب ما يراه مناسبا

الوحدة العاشرة جلسة واحدة

المادة العلمية:

# Electrical Condution

Electrical conduction is the movement of electrically charged particles through a transmission medium (electrical conductor). The movement of charge constitutes an electric current.

## Electrical conduction in the human body:

The brain consists of about 100 billion cells. Most of these cells are called **neurons (Nerve Cells)**. All biological communication in the body is achieved by nerve cells. The brain can be divided into three separate areas that are the ***Cerebrum*** المخ, the ***Cerebellum*** المخيخ and the ***Brain Stem*** جذع الدماغ.

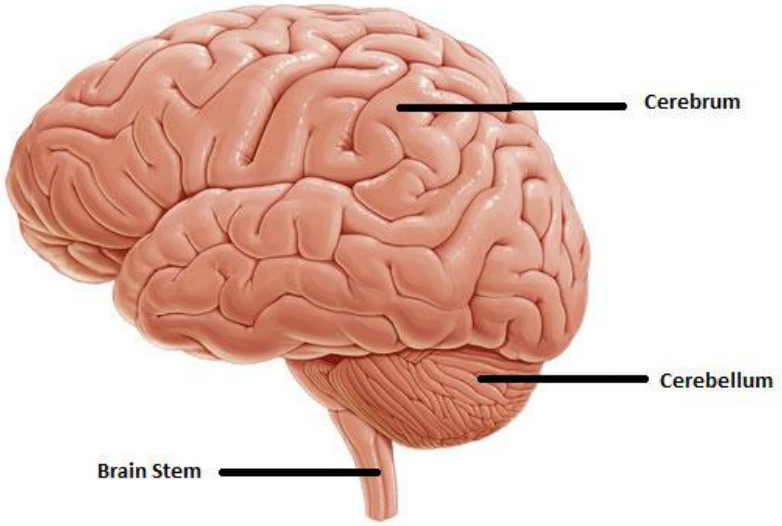



Figure (1): The areas of the human brain.

Neuron is the basic unit of communication in the nervous system. Table (1) presents the function of each part of the nerve cell structure.

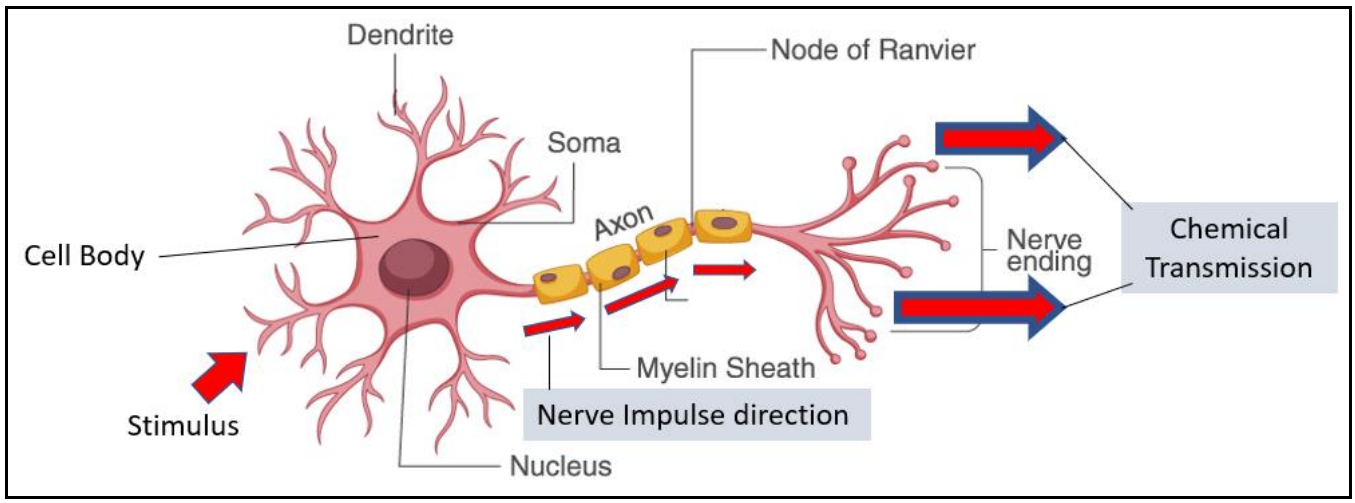



Figure (2): Nerve-cell structure.

Table (1): The nerve-cell compnents, associated with Figure (2), and their functions.

| Structure | Function |
|---|---|
| **Cell body** | It is the body of the nerve cell, where the cell's nucleus and most of the cell's organelles العضيات can be found. |
| **Nucleus** | The nucleus is the core of the cell, where the cell's DNA is located. |
| **Dendrites** | Dendrites are structures that extend from the cell body. They receive information from other cells and carry the information towards the cell body. |
| **Axon** | The axon is a long membrane covered structure that extends and transmits information away from the cell body in the form of electrical signals called action potentials. |

| | |
|---|---|
| **Myelin sheath** | The myelin sheath صفائح المايلين is a lipid layer that insulates the axon and helps to speed the transmission of information down the axon. |
| **Node of Ranvier** | Nodes of Ranvier are gaps between the myelin sheaths where K+/Na+ ion pumps are located. These pumps play an essential role in the transmission of action potentials down the axon. |
| **Axon Terminal** | The axon terminal المحورالعصبي is the point at which the axon ends and the location where neurotransmitters are released.<br>Neurotransmitters: the materials that are excerted from the axon terminal to targeted cell to achieve specific task. مواد تفرزها نهاية الخلايا العصبية الى أعضاء الجسم للقيام بمهامها. مثال على ذلك، تقوم نهايات الخلايا العصبية () بتحويل الاشارة الكهربائية الى مواد كيميائية تنفذ الى خلايا الأعضاء المستقبلة لتنفيذ مهام ما مثل تقليص العضلات بالنسبة لخلايا العضلات. |

There are two main types of nerves; ***Sensory nerves*** carry signals to your brain to help you touch, taste, smell and see; and ***Motor nerves*** carry signals to your muscles or glands to help you move and function.

**Nerve cell functions:**

- Sensory nerves, which carry the message to brain, which allows us to react to a stimulus.
- Motor nerves, which carry the signals (message) from brain and spinal cord to the muscles.

**Neuron** collects ***sensory information*** and convey it to the central nervous system – CNS (brain and spinal cord) for processing, then it carries ***motor commands*** from CNS to the appropriate target, such as muscle or a gland.

The dendrites serve as the stimulus receptors for the neuron, but they respond to a number of different types of stimuli. For example, the neurons in the optic nerve العصب البصري respond to electrical stimuli sent by the cells of the retina شبكية العين.

## EEG Techniques for brain signals measurement:

**EEG:** An electroencephalogram (EEG) is a test to measure the electrical activity of the brain. The Electroencephalograph does not record the activity of single neurons but records the gross electrical activity between two electrodes placed on the scalp فروة الراس of a participant.

### The EEG principle of work:

Flat metal disks called electrodes are placed all over your scalp. The disks are held in place with a sticky paste. The electrodes are connected by wires to a recording machine. The recording machine changes the electrical signals into patterns that can be seen on a computer. It looks like a bunch of wavy lines. Patient needs to lay down still during test with the eyes closed because movement can change the results. The patient may be asked to do certain things during the test, such as breathe fast and deeply for several minutes or look at a bright flashing light, which may induce abnormal electrical activity in the brain that can be seen as abnormal wave in the recording machine.

### How to Prepare for the Test:

Wash your hair (at the night before the test). The usage of any oils, sprays, or conditioner

is prohibited a night prior to the test because if may block the signal coupling. By having hair weaves, it is recommended to ask the doctor or nurse for special instructions. In addition, it is reuired to stop taking certain medications دواء before the test. Avoid all food and drinks containing caffeine for 8 hours before the test.

## What the pupose of the EEG test?

EEG is used to look at your brain activity. It can help diagnose seizures. It may also be used to diagnose or monitor the following health conditions:

- Abnormal changes in body chemistry that affect the brain.
- Brain diseases such as Alzheimer's disease.
- Confusion اضرابات.
- Head injuries
- Infections
- Tumors.
- Evaluate problems with sleep (sleep disorders).
- Monitor the brain during brain surgery.

*Normal Results*:

Brain electrical activity has a certain number of waves per second (frequencies) that are normal for different levels of alertness. For example, brain waves are faster when you are awake, and slower when you are sleeping. There are also normal patterns to these waves.

**(a)** Consciousness الوعي Calm الهدوء ,creative visualization التخيل الببداعي Deep relaxation الاسترخاء العميق Dreamless sleep النوم بل احلم


Figure (3): Typical brain waves frequencies.

## ECG Techniques for heart signals measurement:

### *Electrical in the heart:*

The heart's electrical signal is produced by a tiny structure known as **the sinus node**, which is located in the upper portion of the right atrium. From the sinus node, the electrical signal spreads across the right atrium and the left atrium, causing both atria to contract, and to push their load of blood into the right and left ventricles. The electrical signal then passes through the AV node to the ventricles, where it causes the ventricles to contract in turn.

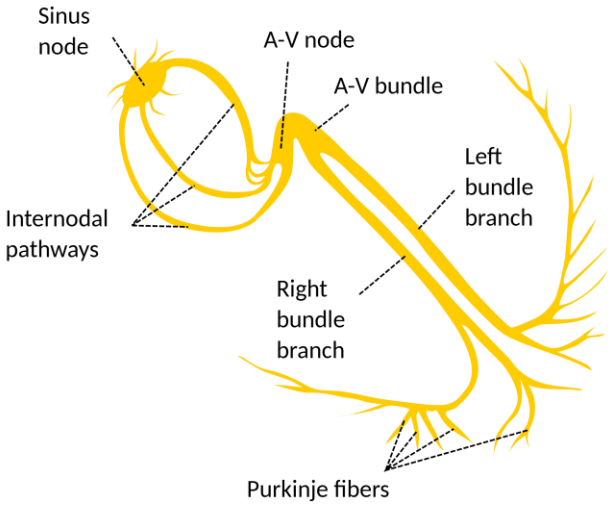



Figure (4): The electrical conduction of the heart.

## Depolarization and the ECG:

The different waves that comprise the ECG represent the sequence of depolarization and repolarization of the atria and ventricles. The ECG is recorded at a speed of 25 mm/sec (5 large squares/sec), and the voltages are calibrated so that 1 mV = 10 mm (2 large squares) in the vertical direction. Therefore, each small 1-mm square represents 0.04 sec (40 msec) in time and 0.10 mV in voltage. Because the recording speed is standardized, one can calculate the heart rate from the intervals between different waves.

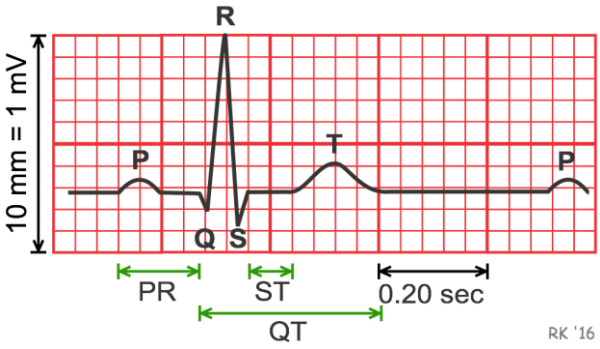



Figure (5): The The typical electrocardiogram signal.

*P – wave (atrial depolarization):* The P wave represents the wave of depolarization that spreads from the SA node throughout the atria, and is usually 0.08 to 0.10 seconds (80-100 ms) in duration.

*QRS complex (ventricular depolarization):* The QRS complex represents ventricular depolarization. Ventricular rate can be calculated by determining the time interval between QRS complexes.

*ST segment*: is the time at which both ventricles are completely depolarized. The ST segment is very important in the diagnosis of ventricular ischemia or hypoxia because under those conditions, the ST segment can become either depressed or elevated.

*The T wave:* is longer in duration than the QRS complex that represents depolarization. The longer duration occurs because conduction of the repolarization wave is slower than the wave of depolarization. Inverted T waves or prominent U waves indicates underlying pathology or conditions affecting repolarization.

*QT interval:* The QT interval represents the time for both ventricular depolarization and repolarization to occur. This interval can range from 0.20 to 0.40 seconds depending upon heart rate. At high heart rates, ventricular action potentials shorten in duration, which decreases the QT interval.

## EMG Techniques for muscle signals measurement:

### *The Electrical in skeletal muscles:*

Muscle is a soft tissue, Muscle cells contain protein filaments خيوط of actin and myosin that slide past one another, producing a contraction that changes both the length and the shape of the cell. Muscles function to produce force and motion. They are primarily responsible for maintaining and changing posture, locomotion, الوضع والتحرك as well as

movement of internal organs, such as the contraction of the heart and the movement of food through the digestive system.

A muscle is a bundle of many cells called fibers. You can think of muscle fibers as long cylinders, and compared to other cells in your body, muscle fibers are quite big. They are from about 1 to 40 microns long and 10 to 100 microns in diameter.

A muscle fiber contains many myofibrils الليفات العضلية , which are cylinders of muscle proteins. These proteins allow a muscle cell to contract. Myofibrils contain two types of filaments that run along the long axis of the fiber, and these filaments are arranged in hexagonal سداسي الاضلاع patterns. There are thick and thin filaments. Each thick filament is surrounded by six thin filaments.

The basic action of any muscle is contraction. For example, when you think about moving your arm using your biceps muscle عضلة ذات الراسين , your brain sends a signal down a nerve cell telling your biceps muscle to contract. The amount of force that the muscle creates varies -- the muscle can contract a little or a lot depending on the signal that the nerve sends.

## Muscle fiber contains:

- ***Myofibril:*** A cylindrical organelle عضية running the length of the muscle fibre, containing Actin and Myosin filaments.
- ***Sarcomere*** (القطعة العضلية) The functional unit of the Myofibril, divided into I, A and H bands.
- ***Actin:*** A thin, contractile protein filament, containing 'active' or 'binding' sites, which bind with Ca.

- ***Myosin:*** A thick, contractile protein filament, with protusions نتؤات known as Myosin Heads, which bind with Mg.
- ***Tropomyosin:*** An actin-binding protein which regulates muscle contraction.
- ***Troponin:*** A complex of three proteins, attached to Tropomyosin.

## Mechanism of Muscle Contraction:

During muscle contraction, the laterally projecting heads (cross bridges) of the thick myosin myofilaments come in contact with the thin actin myofilaments and rotate on them. This pulls the thin myofilaments towards the middle of the sarcomere past the thick myofilaments. The Z lines come closer together and the sarcomere becomes shorter. Length of the A band remains constant. Myofilaments stay the same length. Free end of actin myofilaments move closer to the centre of the sarcomere, bringing Z lines closer together. I bands shorten and H zone narrows. A similar action in all the sarcomeres results in shortening of the entire myofibril, and thereby of the whole fibre and the whole muscle. A contracted muscle becomes shorter and thicker and its volume remains the same.

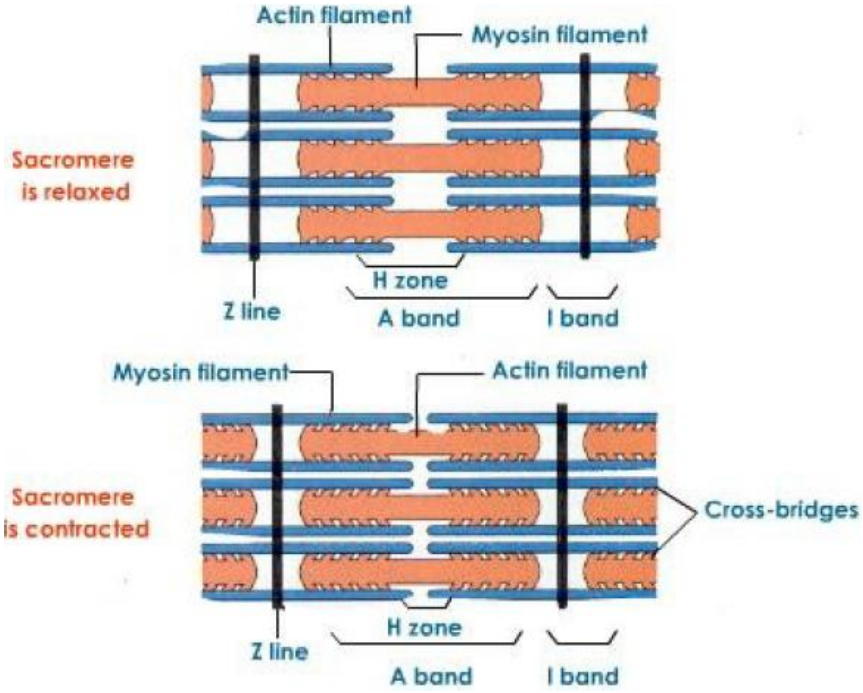



Figure (6): The mechanism of muscle contraction.

## The energy for the muscular contraction:

The energy for the muscular contraction is provided by the conversion of adenosine triphosphate (ATP) into adenosine diphosphate(ADP) and inorganic phosphate, releasing energy. A enzyme myosin ATPase catalyse the reaction in the presence of $Ca^{2+}$ and $Mg^{2+}$ ions.

**Electromyography (EMG)** is a technique for evaluating and recording the electrical activity produced by skeletal muscles. Electromyography is a test that measures and records the activity of contracting muscles in response to electrical stimulation. It checks the health of the muscles and the nerves that control the muscles.

When a muscle is contracted, a small electric potential is produced. Surface electrodes can sense this muscle activity potential when placed over the muscle. The signal detected by the electrodes is amplified and recorded with instrumentation, and is

known as the EMG.

## The pupose of EMG:

The EMG helps to distinguish between muscle conditions in which the problem begins in the muscle and muscle weakness due to nerve disorders. EMGs can also be used to isolate the level of nerve irritation تهيج عصبي.

## How is an intramuscular EMG done?

A needle is inserted through the skin into the muscle. The electrical activity is detected by this needle (which serves as an electrode). The activity is displayed visually on an oscilloscope. Since skeletal muscles are often large, several needle electrodes may need to be placed at various locations to obtain an informative EMG. After placement of the electrode(s), the patient may be asked to contract the muscle (for example, to bend the leg).

The presence, size, and shape of the wave form (the action potential) produced on the oscilloscope provide information about the ability of the muscle to respond to nervous stimulation. Each muscle fiber that contracts produces an action potential. The size of the muscle fiber affects the rate and the size (the amplitude) of the action potential.

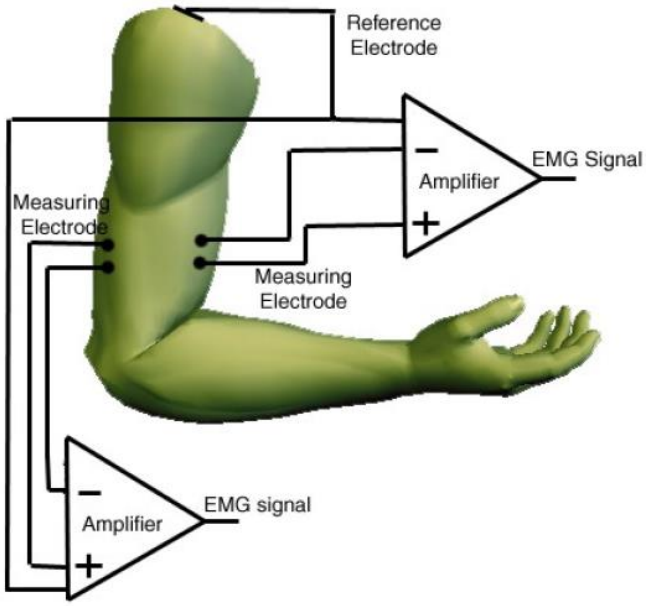
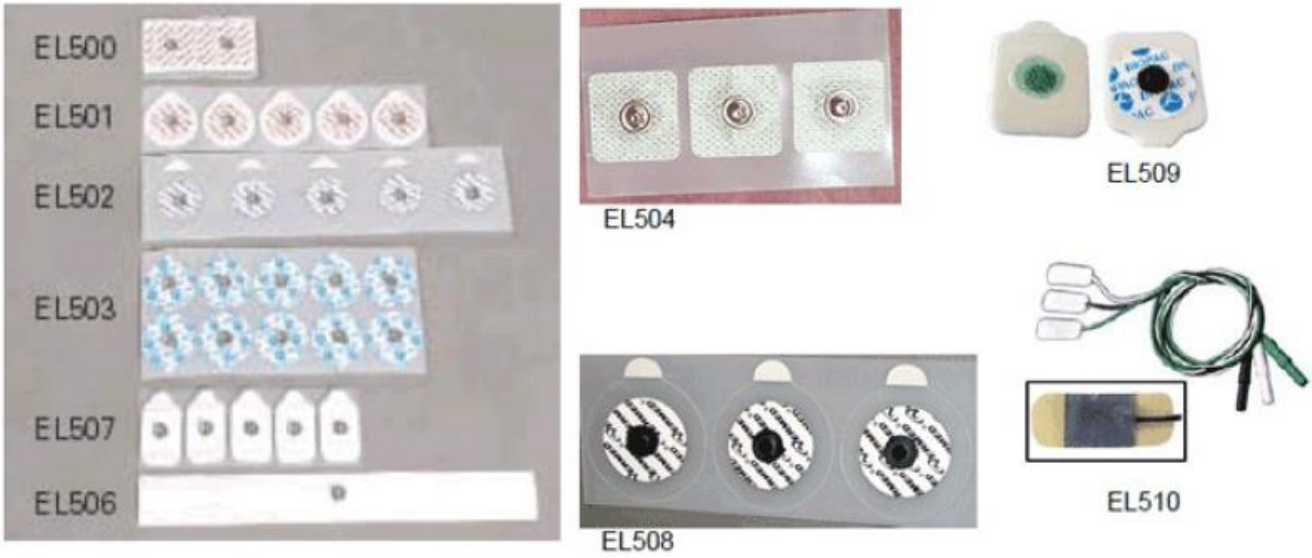



Figure (7): The block daigram of EMG system.



# الوحدة الحادية عشر - المحاضرة الأولى - الزمن: 90 دقيقة

## أهداف المحاضرة الاولى:

**يتوقع في نهاية الجلسة أن يكون الطالب قادراً على:**

1. **معرفة الضغط الإسموزي وأهميتة في تسيير عمل الكثير من الأنظمة الطبيعية لا سيما في جسم الإنسان.**
2. **معرفة حالات الضغط الإسموزي باستخدام خلايا الدم الحمر.**
3. **معرفة وضائف الكلية.**
4. **معرفة آلية عمل نظام الديلزة (Peritonial) و (Hemodialysis) والفرق بينهما.**

## موضوعات المحاضرة الاولى:

- **مقدمة عن التوصيل الإسموزي.**
- **وضائف الكبد وأنظمة الديلزة.**
- **نظام الديلزة Peritonial.**
- **نظام الديلزة Hemodialysis.**

## الأساليب والأنشطة والوسائل التعليمية

| م | الأساليب والأنشطة التدريبية | الوسائل التدريبية |
|---|---|---|
| 1 | • نشاط التعارف (1/1/1)<br>• محاضرة<br>• مناقشة<br>• سؤال وجواب | • جهاز حاسوب<br>• جهاز عرض<br>• سبورة<br>• اوراق واقلام |

ملاحظة: للتدريسي حرية في تغيير الاساليب والانشطة والوسائل حسب ما يراه مناسبا

الوحدة الحادية عشر جلسة واحدة

المادة العلمية:

# Osmetic Conduction

The term **osmosis** describes the movement of water molecules from solution with lower solute concentration (hypotonic solution) to the solution with higher solute concentration (hypertonic solution) through a selectively permeable membrane. The movement takes place due to the osmotic gradient created by difference in concentration of the solutions on both sides of the membrane and the end result is a state where ***osmotic equilibrium*** is reached wherein movement of the fluid ceases.

***Examples of osmosis:***

1. Absorption of water by plant roots.
2. Reabsorption of water by the proximal and distal convoluted tubules of the nephron.
3. Reabsorption of tissue fluid into the venule ends of the blood capillaries الشعيرا الدموية.
4. Absorption of water by the alimentary canal القناة الهضمية — stomach, small intestine and the colon.

***Osmosis examples in the body*:**

1. Salts and minerals associated with water are transferred due to osmosis pressure. Water flows through the plasma membrane of cells and due to osmosis concentration of water, glucose and salt is maintained inside the body. Thus, osmotic filtration is important in preventing cell damage.
2. Freshwater fish maintain fluid balance in their body through osmosis. Since the salt concentration in their body is higher than the surrounding water, they do not

need to drink water. This is because water is spontaneously absorbed by the salt present in their body.

3. Kidney dialysis is example of osmosis. It is for patients suffering from kidney diseases, the dialyzer removes waste products from a patient's blood through a dialyzing membrane, and passes them into the dialysis solution tank. Therefore, by the process of osmosis waste materials are continuously removed from the blood.

*Three types of environments that may exist outside the cells, which affect the internal environment, as follows:*

- **Isotonic** – concentration of solute is the same both in and out of cell, water movement is equal.
- **Hypertonic** – concentration of solute is greater outside the cell, watermoves to the outside of cell to balance out (possibly resulting in cell shriveling).
- **Hypotonic** – concentration of solute is lower outside the cell, watermoves into the cell to balance out (possibly resulting in cell explosion).

Figure (1), presents the three cases of osmosis of the red blood cells.

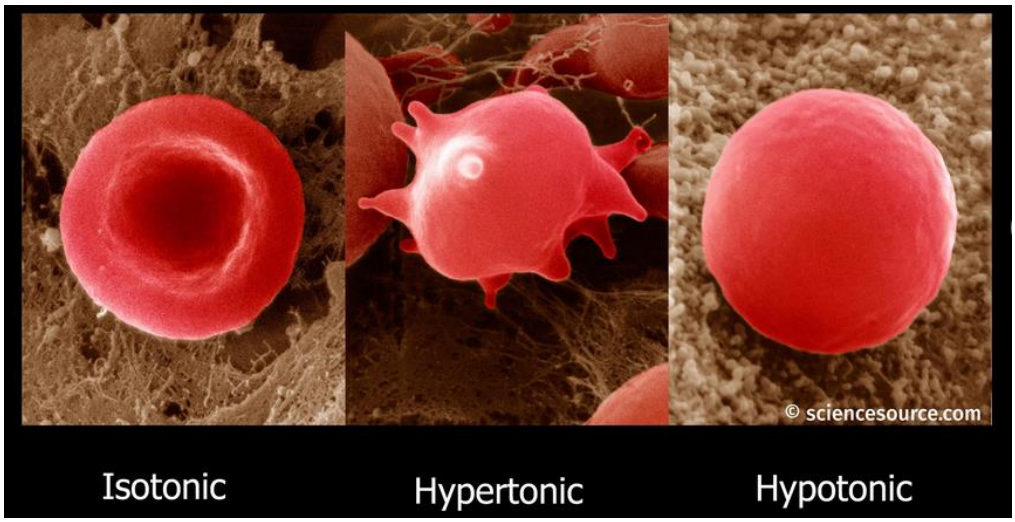



Figure (1): The photos of the isotonic, hypertonic, and hypotonic cases for the red blood cells.

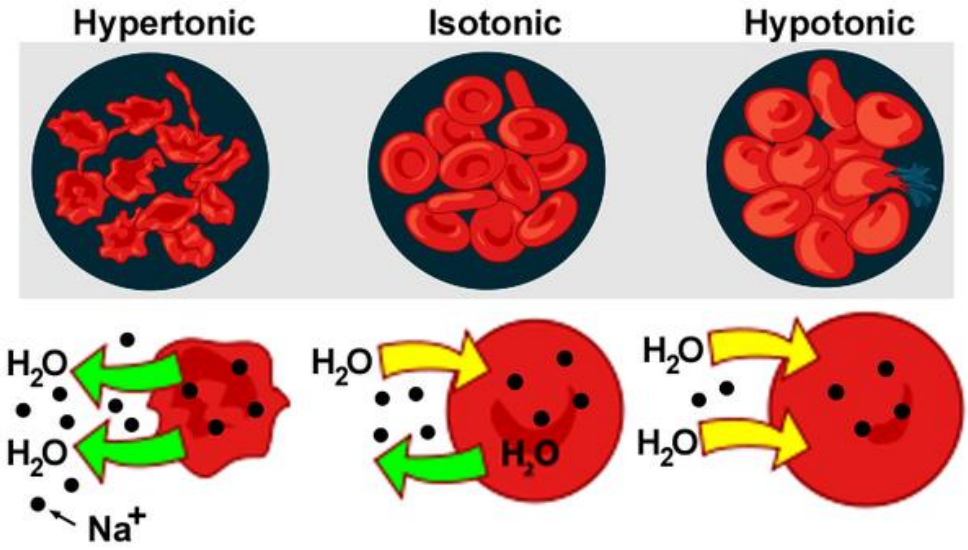



Figure (2): Illustration of the three osmosis conditions for the red blood cells.

## Kidney Functions

Blood contains particles of many different sizes, shapes, and polarity. Some of these particles (e.g., proteins) are essential for the body; some (e.g., urea) must be removed from the blood and the body; others (e.g., many ions) must be maintained at certain concentrations. The main function of the kidneys is to filter our blood and remove waste as urine. Both kidneys do the same job. Each kidney is made up of about a million filtering units called nephrons. Each nephron filters a small amount of blood. The nephron includes a filter, called the glomerulus, and a tubule The glomerulus lets fluid and waste products pass through it; however, it prevents blood cells and large molecules, mostly proteins, from passing. The filtered fluid then passes through the tubule, which sends needed minerals back to the bloodstream and removes wastes. The final product becomes urine. Blood is taken to the kidneys by the renal artery الشريان الكلوي and when it is cleaned, it is returned to the heart by the renal vein الوريد الكلوي. The urine is taken to the bladder المثانة by the ureter الحالب.

## Dialysis

In medicine "dialysis", meaning dissolution, "dia", meaning through, and "lysis", meaning loosening is primarily used to provide an artificial replacement for lost kidney function in people with renal failure الفشل الكلوي. Dialysis may be used for those with an (acute renal failure) الفشل الكلوي الحاد or for those with progressive but chronically worsening kidney function–a state known as chronic kidney disease مرض الكلية المزمن.

There are two types of dialysis: **Hemodialysis** and **Peritonial dialysis**.

## Hemodialysis

In hemodialysis, the patient's blood is pumped through the blood compartment of a dialyzer, exposing it to a partially permeable membrane. The dialyzer is composed of thousands of tiny synthetic hollow fibers. The fiber wall acts as the semi-permeable membrane. Blood flows through the fibers, dialysis solution flows around the outside the fibers, and water and wastes move between these two solutions. The cleansed blood is then returned via the circuit back to the body. Ultrafiltration occurs by increasing the hydrostatic pressure across the dialyzer membrane. This usually is done by applying a negative pressure to the dialysate compartment of the dialyzer. This pressure gradient causes water and dissolved solutes to move from blood to dialysate, and allows the removal of several litres of excess fluid during a typical 3 to 5 hour treatment. Figure (3) illustrates the basic principles of hemodialysis.

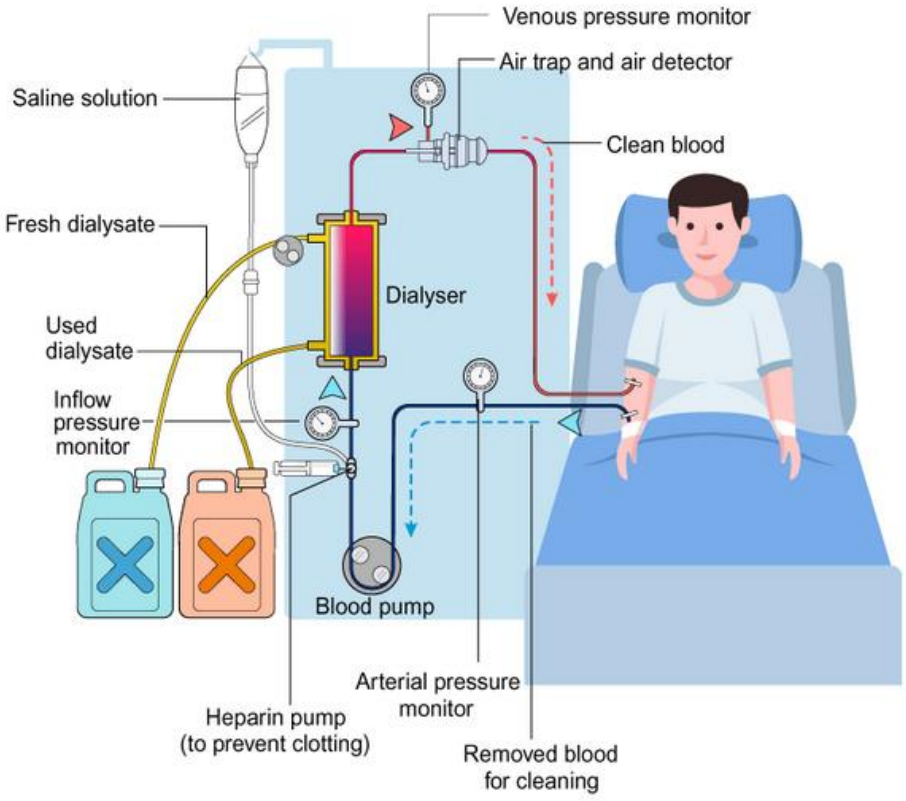



Figure (3): Illustration of hemodialysis operation.

## Peritonial dialysis:

In peritonial dialysis, a sterile solution containing glucose is run through a tube into the peritoneal cavity (the abdominal body cavity around the intestine), where the peritoneal membrane acts as a semi-permeable membrane. The peritoneal membrane or peritoneum is a layer of tissue containing blood vessels that lines and surrounds the peritoneal, or abdominal, cavity and internal abdominal organs (stomach, spleen الطحال, liver and intestines).

After the canula القسطرة, the dialysate محلول is leak to the abdominal body for 4-5 houres then because of concentrations different the waste products absorb from dialysate, and then it is drained out through the tube and discarded. This cycle or "exchange" is

normally repeated 4-5 times during the day, (sometimes more often overnight with an automated system). Each time the dialysate fills and empties from the abdomen is called one exchange. Peritoneal dialysis is less efficient than hemodialysis, but because it is carried out for a longer period of time the net effect in terms of removal of waste products and of salt and water are similar to hemodialysis. Peritoneal dialysis is carried out at home by the patient.

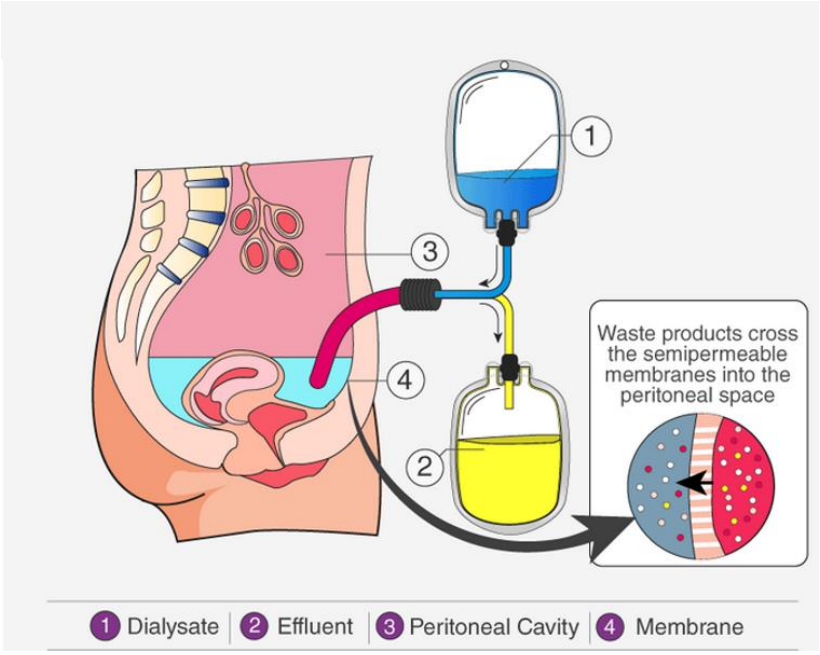



Figure (4): Ilustration the process of peritoneal dialysis.

# الوحدة الثانية عشر - المحاضرة الأولى - الزمن: 90 دقيقة

## أهداف المحاضرة الاولى:

**يتوقع في نهاية الجلسة أن يكون الطالب قادراً على:**

1. **تعريف الأنزيمات ودورها في تسيير عمل جسم الإنسان.**
2. **معرفة تركيب الأنزيمات ووضائفها.**
3. **تعداد أنواع الأنزيمات في جسم الإنسان.**
4. **معرفة قياس مجموعة من الانزيمات ومعرفة الأمراض المتسببة بالزيادة والنقصان عن المستويات الطبيعية للأنزيمات.**
5. **معرفة طرق قياس الأنزيمات بالإعتماد على UV-Vis. Spectrophotometers.**

## موضوعات المحاضرة الاولى:

- **الأنزيمات.**
- **تركيب الأنزيمات ووضائفها.**
- **أنواع الأنزيمات.**
- **الأمراض المتسببة في الزيادة والنقصان عن المستويات الطبيعية للأنزيمات.**
- **طريقة قياس الأنزيمات بالإعتماد على الـ UV-Vis Spectrophotometer.**

## الأساليب والأنشطة والوسائل التعليمية

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|---|---|---|
| 1 | • نشاط التعارف (1/1/1)<br>• محاضرة<br>• مناقشة<br>• سؤال وجواب | • جهاز حاسوب<br>• جهاز عرض<br>• سبورة<br>• اوراق واقلام |

ملاحظة: للتدريسي حرية في تغيير الاساليب والانشطة والوسائل حسب ما يراه مناسبا

الوحدة الثانية عشر جلسة واحدة

المادة العلمية:

# Enzymes and Their Measurements

**Enzymes** are large biomolecular that are responsible for many chemical reactions that take place within cells and necessary to sustain life. Enzyme significantly speed up the rate of virtually all of the chemical reactions .They serve a wide range important functions in the body, such as aiding in digestion and metabolism. Enzymes are produced in the body by certain organs like the salivary glands, stomach, pancreas, small intestine or from the food we eat.

## Enzymes Structure:

Enzymes are proteins, contain chains of amino acids linked together. The characteristic of an enzyme is determined by the sequence of amino acid arrangement as shown in Figure (1).

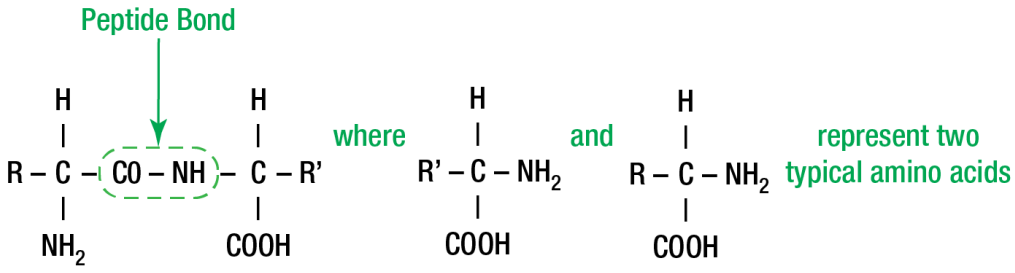


Figure (1): Typical Protein structur – two amino acids joined by a peptide bond.

## Enzymes functions

Enzyme in the body help carry out various chemical functions like digestion of food, assist in the process of providing cellular energy, support the brain functions, repairing and healing processes within the body, breaking down toxins, detoxification of blood, etc.

## Types of Enzymes in the Body:

There are basically three types of enzymes; **metabolic enzymes**, **digestive enzymes** and **food enzymes**.

- ***Metabolic enzymes***: This type of enzyme run our bodies, speed up the chemical reaction within the cells for detoxification and energy production. They enable us to see, hear, feel, move and think. Every organ, every tissue, and all 100 trillion cells in our body depend upon the reaction of metabolic enzymes and their energy factor. They are required for the growth of new cells and the repair and maintenance of all the body's organs and tissues. Metabolic enzymes take protein, fat, and carbohydrates and transform them into the proper balance of working cells and tissues. Two particularly important metabolic enzymes are superoxide dismutase (SOD) and its partner, catalase. SOD is an antioxidant that protects the cells by attacking from free radical (toxic oxygen metabolites), by converting superoxide to nto molecular oxygen and hydrogen peroxide via cyclic reduction and oxidation of an active site metal. Catalase breaks down hydrogen peroxide, a metabolic waste product, and liberates oxygen for the body to use.
- ***Digestive enzymes***: are secreted by the body that helps in digestion of food. They are classified to:

1. Amylase: is digestive enzyme produced by the salivary glands, pancreatic amylase

is secreted by the pancreas into the small intestine. This enzyme helps in breaking down carbohydrates to simple sugars, like glucose.

2. Proteases: It helps in digestion of proteins and break down complex proteins into much simpler amino acids. It is present in the stomach, pancreatic and intestinal juices.
3. Lipases: Lipases assist in digestion of fats and breaks down fats and other lipids, and converts them to fatty acids and glycerol. It is seen in the stomach, pancreatic juice and food fats.

- **Food enzymes:** are present in all raw foods like animal or plant products . Food Enzymes are introduced to the body through the raw foods we eat which naturally contain enzymes, providing a source of digestive enzymes when ingested. The cooking and processing of food destroys all of its enzymes. Since most of the foods we eat are cooked or processed in some way and since the raw foods we do eat contain only enough enzymes to process that particular food, our bodies must produce the majority of the digestive enzymes we require. For these reasons it is recommended that we supplement our diet with enzymes.

## Enzyme measurement:

Blood Enzymes test: Blood enzyme tests can be used to measure the levels and activity of certain enzymes. There are three types of blood enzyme can be assessed:

1. Pancreatic enzyme test (Amylase Enzyme Test): it measure the level of this enzyme in your blood. Normal Results: is 23 to 85 units per liter (U/L). The clinical signification of amylase enzyme is shown in Table (1) below.

Table (1): The clinical signification of amylase enzyme.

| Indication of **increased** amylase levels | Indication of **decreased** amylase levels |
|---|---|
| ▪ Acute pancreatitis.<br>▪ Cancer of the ovaries, or lungs.<br>▪ Infection of the salivary glands.<br>▪ Intestinal obstruction انسدادالامعاء الدقيقة<br>▪ Pancreatic or bile duct obstruction انسداد القناة الصفراء<br>▪ Perforated ulcer ثقوب القرحة<br>▪ Tubal pregnancy (may be ruptured). | ▪ Damage to the pancreas.<br>▪ Kidney disease.<br>▪ Pancreatic cancer.<br>▪ Toxemia of pregnancy تسمم الدم اثناء الحمل |

2. **Liver enzyme test:** The hepatic function panel evaluates:

- **Alkaline phosphatase (ALP):** This enzyme is found in the liver, bones, intestines, kidneys, and other organs. Kids and teens normally have higher levels of ALP than adults, even when they're healthy, due to bone growth. But ALP levels can also increase when kids have viral infections, liver diseases, or blocked bile ducts.  Acid phosphate (ACP): is found in liver, spleen, red blood cell and bone narrow and secreted with high concentration by the prostate gland into seminal fluid and is found in concentrations up to 400 times greater in semen than in other body fluids. The high level of this enzyme due to prostate disease, female breast cancer and bone cancer.
- **Alanine aminotransferase (ALT):** This enzyme, found in the liver, plays a role in metabolism, the process that converts food into energy. If the liver is injured, ALT is released into the bloodstream. Its levels are especially high with acute hepatitis.
- **Aspartate aminotransferase (AST):** This enzyme, which plays a role in processing

proteins, is found in the liver, heart, muscles, and kidneys. It is important to diagnose liver disease, heart diseases and muscular disease.

### 3. Cardiac Enzyme Test:

a. **Creatine kinase** is an enzyme which is produced by the majority of muscle cells. is found in the brain, heart and the skeletal muscle cells. The creatine kinase test is usually recommended for people who have had chest pain or weakness in the muscles. There are three forms of reatine kinase; these are: CK-MB: this is mostly found in the heart muscle cells, CK-BB: this is mostly found in the brain, CK-MM: this is mostly found in the heart and skeletal.

b. **Troponin** is a protein that helps the muscles to contract. Troponin is found in the cardiac and skeletal muscle cells. There are three types of troponins; these are: Troponin C (TnC), Troponin T (TnT) and Troponin I (TnI). The troponin test is usually preferred to the CK test for those who are suspected of having a heart attack; this is because the test is more specific in terms of assessing damage to the heart muscle.

## Spectrophotometric methods:

This is most method widely used to determine the enzyme activity; this assay is a classic enzyme test for the low cost. During a spectrophotometric assay, the operator follows the course of an enzyme reaction by measuring the changes in the intensity of the light absorbed or scattered by the reaction solution. Most tests use the UV/visible (UV/vis) spectroscopy as the detection method, which usually falls into the wavelength range of 100-1100 nm. If the light is in the visible region, meaning the wavelength of 400-700 nm or more broadly 360-900 nm, the color of the assay can be visibly captured by naked

eyes. Therefore, this type of tests is also called colorimetric assays.

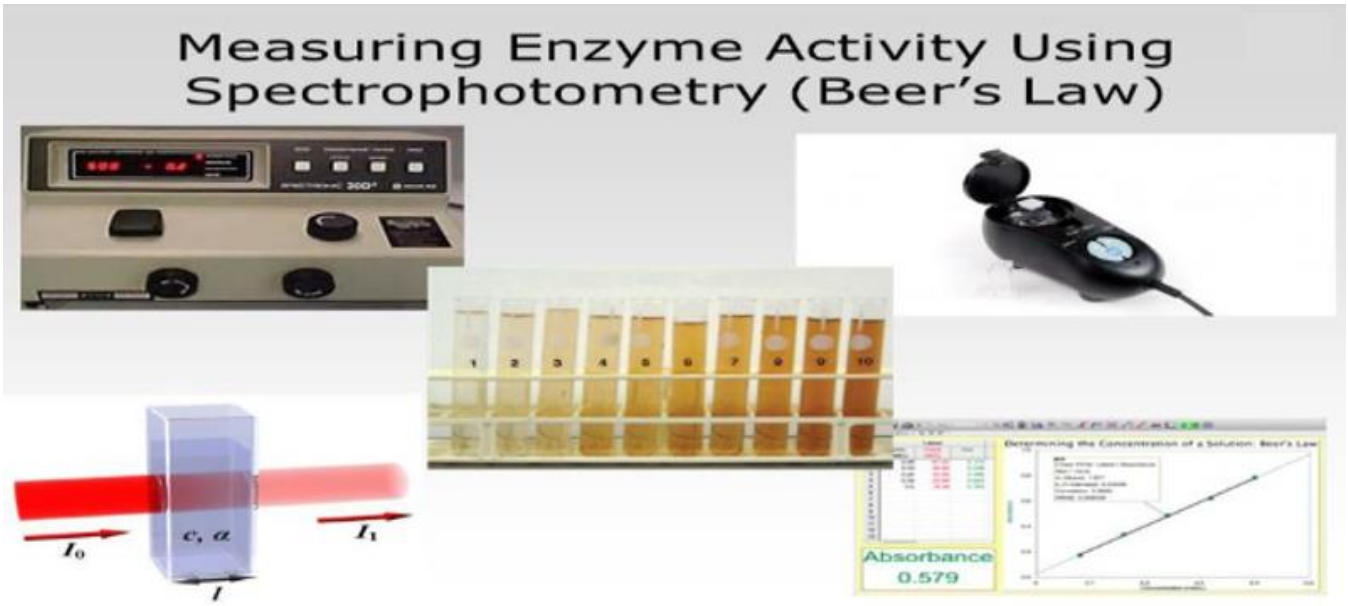


Figure (2): Measurement of enzyme using spectrophotmeter.

# الوحدة الثالثة عشر - المحاضرة الأولى - الزمن: 90 دقيقة

## أهداف المحاضرة الاولى:

**يتوقع في نهاية الجلسة أن يكون الطالب قادراً على:**

1. **معرفة البروتينات وتركيبها الكيميائي.**
2. **المعرفة الكمية لحاجات الجسم البشري اليومية للبروتينات.**
3. **معرفة أنواع البروتينات في جسم الإنسان ووضائفهم.**
4. **معرفة بعض الأمراض المتسببة في التغيرات الغير طبيعية للبروتينات.**
5. **معرفة طريقة فصل بروتينات الدم.**
6. **معرفة طريقة قياس البروتينات باستخدام تقنية STEP.**
7. **آلية عمل إختبار بتقنية STEP.**

## موضوعات المحاضرة الاولى:

- **البروتينات (تركيبها وأهميتها).**
- **أنواع البروتينات.**
- **فصل بروتينات الدم.**
- **إختبار الـ Electrophoresis (STEP) للبروتينات.**

## الأساليب والأنشطة والوسائل التعليمية

| م | الأساليب والأنشطة التدريبية | الوسائل التدريبية |
|---|---|---|
| 1 | • نشاط التعارف (1/1/1)<br>• محاضرة<br>• مناقشة<br>• سؤال وجواب | • جهاز حاسوب<br>• جهاز عرض<br>• سبورة<br>• اوراق واقلام |

ملاحظة: للتدريسي حرية في تغيير الاساليب والانشطة والوسائل حسب ما يراه مناسبا

الوحدة الثالثة عشر جلسة واحدة

المادة العلمية:

# Proteins and Importance

Proteins are large molecules composed of one or more chains of amino acids in a specific order determined by the base sequence of nucleotides in the DNA coding for the protein. Proteins are required for the structure, function, and regulation of the body's cells, tissues, and organs. Proteins perform a vast array of functions within organisms, including catalysing metabolic reactions, DNA replication, responding to stimuli, providing structure to cells, and organisms, and transporting molecules from one location to another.

## Protein synthesis

A gene is a segment of a DNA molecule that contains the instructions needed to make a new protein. All of our cells contain the same DNA molecules, but each cell uses a different combination of genes to build the particular proteins it needs to perform its specialized functions.

## The origin and occurrence:

Protein always are produced in nature by living matter and chiefly by plants. Animals may eat proteins, but transform them into other types of protein, but animals have limited powers to synthesis protein. Protein occur in living matter cell or are associated with living things, they constitute a large part of the solid matter of muscles, tendons (الأوتار), ligament (عضلات رابطة), cartilage (غضاريف), and 20% blood. About half of the solid matter involved in synthesis of the brain, nerve tissue and bone.

## Protein synthesis:

The two-peptide molecule represents a simple unit of protein synthesis, and the protein molecule has two acidic and basic sides. On this basis, a simple design of the protein molecule is shown in Figure (1), where changing in R gives different types of amino acids.

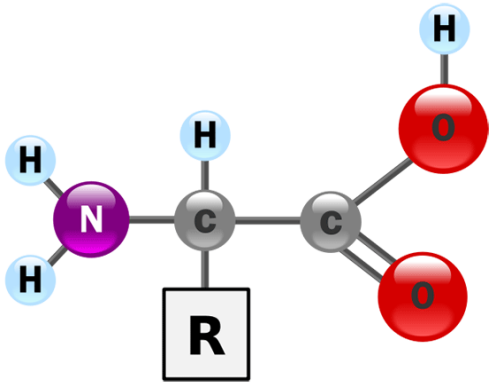


Figure (1): The basis of the protein molecule.

Proteins are found in the following foods, such meats, poultry, and fish, eggs, nuts and seeds, milk and milk products, some vegetables, and some fruits

.

***Recommended Dietary Allowance for Protein***

| The human ages | Grams of protein needed | Gram of proteins required each day |
|---|---|---|
| Children ages | 1 – 3 | 13 |
| | 4 – 8 | 19 |
| | 9 – 13 | 34 |
| Girls ages | 14 – 18 | 46 |
| Boys ages | 14 – 18 | 52 |

| | | |
|---|---|---|
| Women ages | 19 – 70+ | 46 |
| Men ages | 19 – 70+ | 56 |

## Types of proteins:

There are many types of proteins in our bodies, as follows:

1. **Enzymes:** are proteins accelerate metabolic processes in your cells liver functions, stomach digestion, blood clotting and converting glycogen to glucose, for example pepsin is a digestive enzyme in your stomach that helps to break down proteins in food, that your body can easily absorb.
2. **Hormones:** are protein-based chemicals secreted by the cells of the endocrine glands.it transported through the blood, hormones act as chemical messengers that transmit signals from one cell to another. An example of a hormonal protein is insulin, which is secreted by the pancreas to regulate the levels of blood sugar in your body.
3. **Structural proteins:** are necessary components of your body. They include collagen, keratin. Collagen It has important roles, including providing structure to your skin and helping your blood clot and form connective tissue of your muscles, bones, tendons, skin and cartilage. Keratin is the main structural component in hair, nails, teeth and skin.
4. **Defensive:** Antibodies, or immunoglobulin, are a core part of your immune system, keeping diseases at bay. Antibodies are formed in the white blood cells called ( B lymphocyte or a B cell) , and attack bacteria, viruses and other harmful microorganisms, rendering them inactive.
5. **Contractile proteins:** are involved in muscle contraction and movement, for

example, Actin, Myosin, Myoglobin, Ferritin Actin, Myosin, exist as filaments in muscles. When calcium ions are present the filaments slide over each other, causing the muscle to contract.

- **Myoglobin** is a red pigment in muscles that binds to oxygen. myoglobin absorbs oxygen from hemoglobin and then releases it to the muscles, when they need to produce energy. Ferritin is a protein in cells that stores iron and releases it when it's needed.
- **Ferritin** is found in the skeletal muscles and also in the liver, spleen, bone marrow, and other areas of the body.

6. **Storage proteins:** are mainly store mineral ions such as potassium in your body. Iron, for example, is an ion required for the formation of hemoglobin, the main structural component of red blood cells.
7. **Transport proteins** move molecules around our bodies, for example, hemoglobin which founded in red blood cell and transports oxygen through the blood to tissue cell. Fibrinogen founded in the plasma which is involved in the blood clotting process.

## The clinical significations:

| Hyperproteinamia cause:<br>ارتفاع نسبة البروتين بسبب | Hypoproteinemia cause:<br>انخفاض نسبة البروتين بسبب |
|---|---|
| 1. Dehydration.<br>2. Multiple myeloma (due to the formation of myloma protein). ( سرطان النخاع العظمي) | 1. Nephritic syndrome التهاب الكلية المزمن<br>2. Sever burns and extensive bleeding. |

**Blood proteins**, also termed plasma proteins, are proteins present in blood plasma. They

serve many different functions, including transport of lipids, hormones, vitamins and minerals in activity and functioning of the immune system. The three major fractions of plasma proteins are separated as follows: Albumin and Globulin. Globulin is larger in size than albumin. They are divided into three main groups: alpha, beta, and gamma.

**(a)** Alpha-1 globulin.

**(b)** Alpha-2 globulin.

**(c)** Beta globulin.

**(d)** Gamma globulin: is classified to: **IgA, IgD, IgM, IgE, IgG**.

## Techniques used for protein separation:

1. Salts or solvent fractionation: it is depend on change in solubility of protein so albumin soluble in sodium sulphite while globulin will precipitate.
2. Ultracentrifugation: depend on variation in molecular mass and molecular shape for proteins, when rotate with high velocity then will be separate each individually.
3. Chromatography: depend on the difference in size, shape, electric charge and the rate of flow protein through chromatography media.
4. Immunochemical analysis: is technique used for identification and analyze protein (antigen and antibody), it includes Eliza.
5. Electrophoresis: it is mostly used, depend on its diffusion velocity in the electrical field to the difference of electrical charge density on the protein surface.

## Measurement of protein:

**Electrophoresis:** Serum protein electrophoresis (SPEP) is a screening test that measures the major blood proteins by separating them into five distinct fractions: albumin, alpha1, alpha2, beta, and gamma proteins.

**Purpose:** Protein electrophoresis is used to diagnose a variety of diseases, such as cancer, intestinal or kidney protein-wasting syndromes متلازمه امراض الكليه, disorders of the immune system, liver dysfunction (الكبد ضعف).

***The normal values:***

Albumin = 4 – 5.5 g/100ml serum

Globulin = 2.2 – 2.7 g/100 ml serum

Total protein = 6.2 – 8.2 g/100 ml serum

**Electrophoresis components:**

1. Two plastic tanks for 500 ml of buffer solution with pH 8.6
2. Supporting medium (Poly acrylamide-gel).
3. Electrical electrode, micropipette and combs.
4. Power supply unit.
5. Staining solution.
6. Washing solution.
7. Scanner.

**The principle of electrophoresis test:**

Proteins carry a positive or a negative electrical charge, and they move in fluid when placed in an electrical field and applying power supply with 200 mv and 10-15 mA for 45 min. Serum protein electrophoresis uses an electrical field to separate the proteins in the blood serum into groups of similar size, shape, and charge.

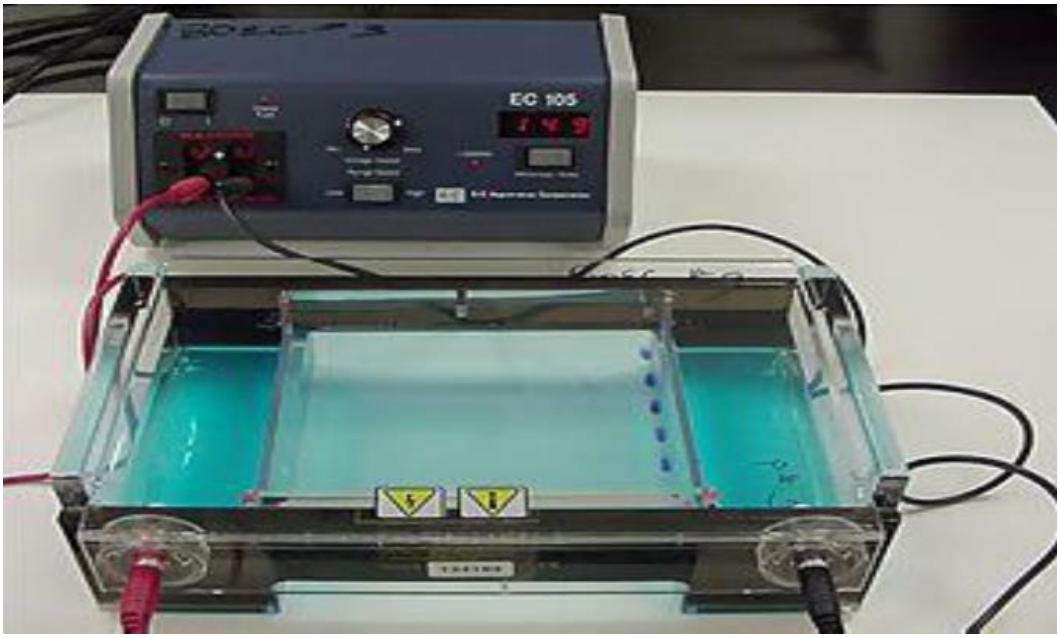


Figure (2): Electrophoresis test.

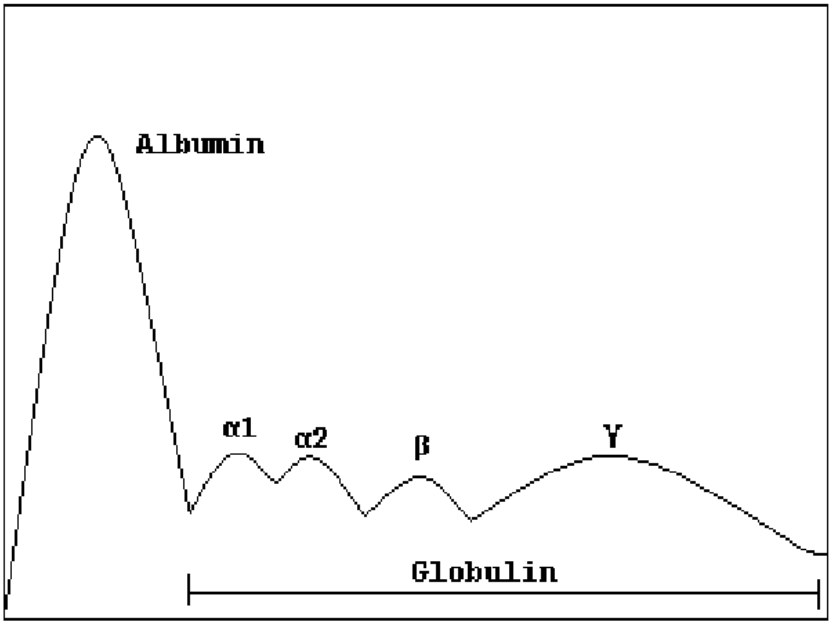


Figure (3): The normal value of protein separation.

# الوحدة الرابعة عشر - المحاضرة الأولى - الزمن: 90 دقيقة

## أهداف المحاضرة الاولى:

**يتوقع في نهاية الجلسة أن يكون الطالب قادراً على:**

1. معرفة أنواع الشحوم الموجودة في جسم الإنسان.
2. معرفة المستويات الطبيعية للكوليسترول والأمراض الناتجة عن زيادة ونقص نسبه.
3. معرفة نسب مصادر الطاقة في جسم الإنسان.
4. معرفة قياس نسبة الشحوم بالاعتماد على تقنية Hydro densitonety.
5. معرفة قياس نسبة الشحوم بالاعتماد على تقنية NIR.
6. معرفة قياس نسبة الشحوم بالاعتماد على تقنية BMI.
7. معرفة قياس نسبة الشحوم بالاعتماد على تقنية Skin fold caliper.
8. معرفة قياس نسبة الشحوم بالاعتماد على تقنية DEXA.

## موضوعات المحاضرة الاولى:

- الشحوم والتركيب الكيميائي لها.
- مستويات الشحوم في جسم الإنسان والأمراض الناتجة عنها.
- مكونات الجسم كمصادر طاقة.
- قياس نسبة الشحوم بالاعتماد على تقنية Hydro densitonety.
- قياس نسبة الشحوم بالاعتماد على تقنية NIR.
- قياس نسبة الشحوم بالاعتماد على تقنية BMI.
- قياس نسبة الشحوم بالاعتماد على تقنية Skin fold caliper.
- قياس نسبة الشحوم بالاعتماد على تقنية DEXA.

## الأساليب والأنشطة والوسائل التعليمية

| م | الأساليب والأنشطة التدريبية | الوسائل التدريبية |
|---|---|---|
| 1 | • نشاط التعارف (1/1/1)<br>• محاضرة<br>• مناقشة<br>• سؤال وجواب | • جهاز حاسوب<br>• جهاز عرض<br>• سبورة<br>• اوراق واقلام |

ملاحظة: للتدريسي حرية في تغيير الاساليب والانشطة والوسائل حسب ما يراه مناسبا

الوحدة الرابعة عشر جلسة واحدة

المادة العلمية:

## Fats and Importance

Fats are compound that do not dissolve in water. It includes saturated fatty acids, monosaturated fatty acids, polyunsaturated fatty acids (omega-3 fatty acids), trans fatty acids, triglycerides and cholesterol. The three basic kinds of fats: saturated, monosaturated and unsaturated. The level of fat intake recommended by experts is 35% or less of the total calories consumed daily. This mean that a person eating 2,000 calories a day should eat on more than 700 of those calories as fat which is equal to a bout 6.5 table spoon of fat.

### The chemical structure:

Fats and oils belong to a group of biological substances called lipids. Lipids are biological chemicals that do not dissolve in water. They serve a variety of functions in organisms, such as regulatory messengers (hormones), structural components of membranes, and as energy store houses.

**Cholesterol:**

Is a steroid compound containing a storied nucleus (the ring A,B,C,D). chole means "bile" and sterol means “solid alcohol”. The structural formula is shown in Figure (1).

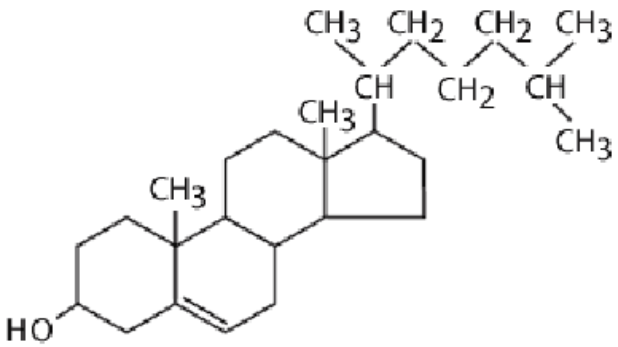


Figure (1): The structural formula of cholestrol.

Occurrence: The largest amount is present in most brain, nerve tissue, bile, human tissue, blood and liver. In blood the cholesterol is present in two forms:

**(a)** Free cholesterol which present 1/3 of the total fat.

**(b)** Cholesterol ester which present 2/3 of the total fat.

**Normal value: 140 – 280 mg/100m**

## Clinical signification:

*Increased cholesterol levels cause:*

- Bile canaclculi and duets obstruction (انسداد المرارة الصفراء) due to reduction of extraction into the intestine.
- Nephritic syndrome:(التهاب الكلية المزمن) due to rise of protein in the plasma and lipids.
- Diabetes mellitus السكري: due to malabsorption (سوء الامتصاص) of protein and lipids.
- Atherosclerosis (الشرايين تصلب): duo to cholesterol deposits in the athermatous lesions of the blood vessels. (افة تعصد الشرايين).
- Heart diseases: due to cholesterol deposits in blood vessels.

*Decreasing cholesterol levels cause:*

- Sever hepatitis (التهاب الكبدالشديد): due to low synthesis of cholesterol by the liver and in liver cirrhosis (تليف الكبد) duo to large area of damaged cells.

- Hyperthyroidism (افراز الغدة الدرقية): due to the inverse nature of thyroxin.

Table (1) presents the nutrition fact show the % daily values.

Table (1): The nutrition fact of the daily intake.

| Fat | Calories |
|---|---|
| Total fat | Less than 65g |
| Sat. fat | Less than 20g |
| Cholestrol | Less than 300mg |
| Total carbohydrate | 300 gm |

**Fat as an energy source:**

The body uses two main fuels for energy: **carbohydrates** and **fats**. The energy is obtained by changing carbohydrates to sugar (called blood sugar or glucose) and fats to fatty acids. However, fats can provide more than twice the energy of sugar.

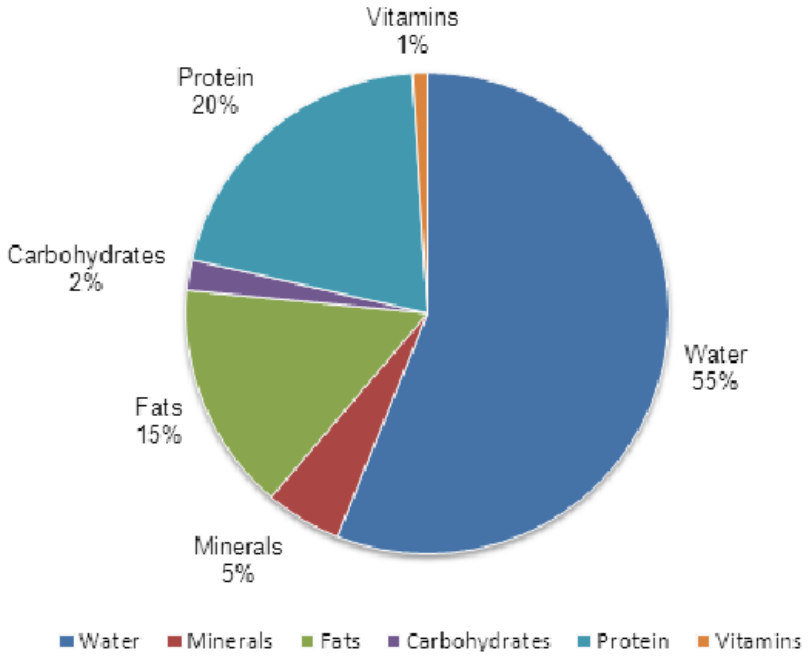


Figure (2): The composition of our body.

## Measurement of fats:

**Body fat percentage** is the total weight of person fat divided by the persons weight and consists of essential body fat. Essential body fat is necessary to maintenance life and reproduction functions. Essential fat is 3 – 5% in men and 8 – 12% in women.

**Measurement techniques of body fat percentage:** There are several techniques can be used to estimate fat percentage accurately:

1. **Hydro densitometry Weighing (Underwater Weighing):** This method measures whole body density by determining body volume. There is a variety of equipment available to do underwater weighing ranging in sophistication from the standard stainless-steel tank with a chair or cot mounted on underwater scales, to a chair and scale suspended from adiving board over a pool or hot tub. This technique first requires weighing a person outside the tank, then immersing them totally in water and weighing them again, the difference between these weighing in specific volume of water in liter will determine the density of person, $\rho$.

   The densities of bone and muscles are higher than water, and fat is less dense than water. So, a person with more bone and muscle will weight more in water than a person with less bone and muscle, meaning they have a higher body density and lower percentage of body fat. For example, athletes tend to have denser bones and muscles than non-athletes. The body fat percentage is calculated from body density using standard equations either Siri or Brozek, as in the following.

$$Brozek\ formula: BF = \left( \frac{4.57}{\rho} - 4.142 \right) \times 100$$

$$Siri\ formula: BF = \left( \frac{4.95}{\rho} - 4.50 \right) \times 100$$

2. **Near –infrared interaction (NIR):** The biceps (عضلات الذراع الاعلى) are the most often used single site for estimating body fat using the NIR method. A fiber optic probe is connected to a digital analyzer that indirectly measures the tissue composition (fat and water) at various sites on the body. The NIR light penetrates the tissues and is reflected off the bone back to the detector. The NIR data is entered into a prediction equation with the person's height, weight, and level of activity to estimate the percent body fat. This method has become popular outside of the laboratory because it is simple, fast, noninvasive, and the equipment is relatively inexpensive. However, the amount of pressure applied to the fiber optic probe during measurement may affect the values of optical densities, and skin color and hydration level may be potential sources of error. The validity of a single-site measurement at the biceps is questionable. Numerous sources report that more research is needed to substantiate the validity, ccuracy and applicability of this method.

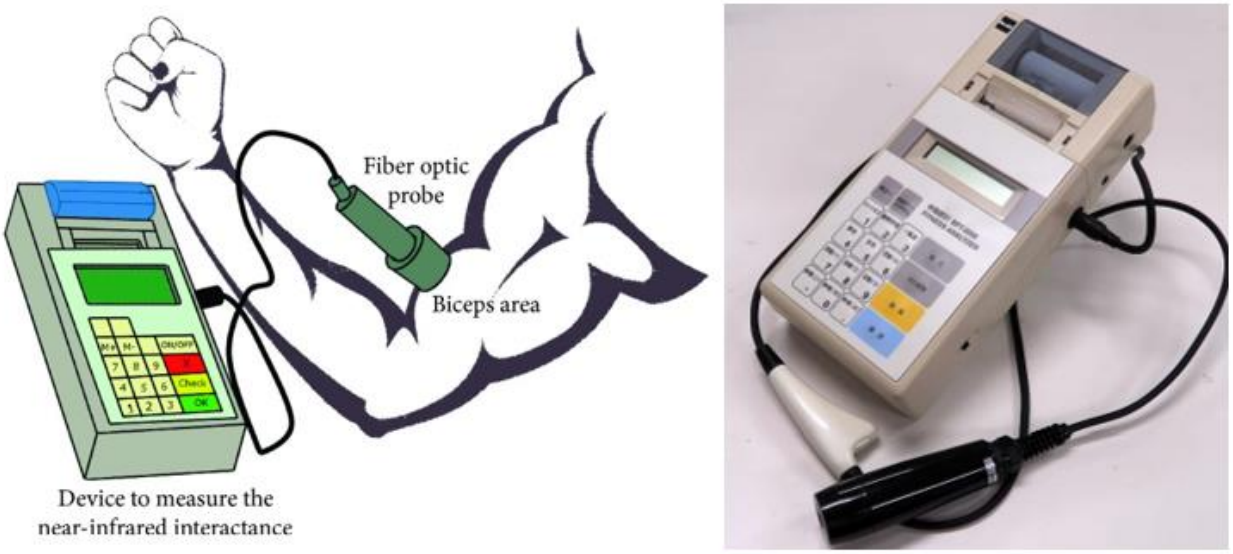


Figure (3): Near-IR spectroscopy for fat measuring.

## 3. Skin fold caliper:

The "skin fold" method measures your body fat percentage by pinching your fat with your fingers then measuring the thickness with a body fat caliper. The reading is given in millimeters, which you compare to a chart with age and gender to arrive at your body fat percentage.

Figure (4): The usage of skin fold caliper.

## 4. Dual energy X-ray absorptiometry (DEXA):

A relatively new technology that is very accurate. DEXA scan is fast becoming the "new" gold standard of body fat measurement because it's based on a three-compartment model that divides the body into total body mineral, fat-free soft (lean) mass, and fat tissue mass. Hydrostatic Weighing on the other hand only uses a 2-compartment model (fat free mass and fat mass).

In this technique the patient placed between two sources of x-ray and a detector. The tow sources of X-ray of different energy levels penetrate depending on body tissue i. e., denser tissue to pass through. The x-ray transmitted side are detected by an electronic calculates the density of entire between the x-ray source and the not allow to x-ray to out on the other detector which then tissue region detector. A scan takes between 10-20 minutes. This method is safe, although it is not as accurate in measuring the extremely obese and the cost of equipment is high.

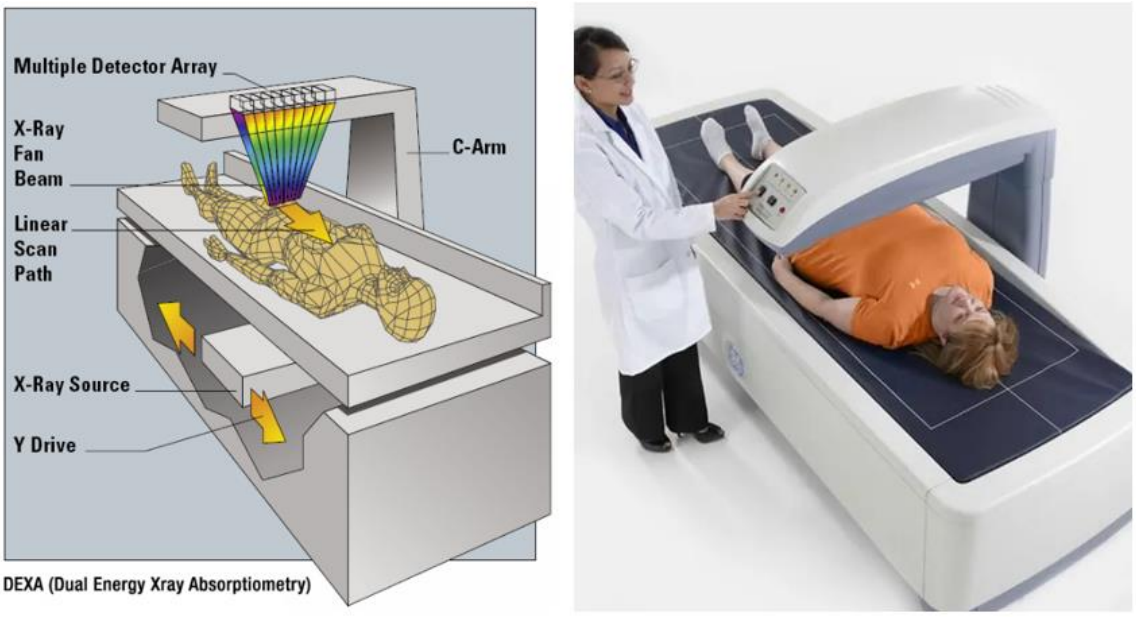


Figure (5): The DEXA absorptiometry.

## 5. Body mass impedance (BMI):

Bioelectrical impedance method is used to calculate the body fat percentage. The muscle, blood vessels and bones are body tissue having a high-water content that conduct electrically easily. but body fat is tissue has a little eclectic current conductivity. The body fat analyzer sends an extremely weak electrical current of 50 kHz and 500μA through your body to determine the amount of fat tissue. Then uses information on the person's weight, height, age, and sex, to calculate an approximate value for the person's body fat percentage. The calculation measures the total volume of water in the body (lean tissue and muscle contain a higher percentage of water than fat), and estimates the percentage of fat based on this information.


Figure (6): Industrial (BMI) equipments.

# الوحدة الخامسة عشر - المحاضرة الأولى - الزمن: 90 دقيقة

## أهداف المحاضرة الاولى:

**يتوقع في نهاية الجلسة أن يكون الطالب قادراً على:**

1. **تعريف الهيموكلوبين والمايوكلوبين والفرق بينهما.**
2. **تركيب الهيموكلوبين ووضائفه.**
3. **معرفة الدورة الطبيعية لتصنيع وتحلل الهيموكلوبين داخل جسم الإنسان.**
4. **معرفة المستويات الطبيعية للهيموكلوبين ومعرفة الأمراض المتسببة بزيادته ونقصه.**
5. **معرفة بعض الأمراض الوراثية الناتجة عن خلل في تصنيع الهيموكلوبين.**

## موضوعات المحاضرة الاولى:

- **مقدمة عن الهيموكلوبين والمايوكلوبين.**
- **تركيب الهيموكلوبين ووضائفه.**
- **تصنيع الهيموكلوبين.**
- **تحلل الهيموكلوبين.**
- **الأمراض المتسببة بزيادة ونقصان الهيموكلوبين.**
- **أمراض الهيموكلوبين الوراثية (Hemoglobinopathie).**

## الأساليب والأنشطة والوسائل التعليمية

| م | الأساليب والأنشطة التدريبية | الوسائل التدريبية |
|---|---|---|
| 1 | • نشاط التعارف (1/1/1)<br>• محاضرة<br>• مناقشة<br>• سؤال وجواب | • جهاز حاسوب<br>• جهاز عرض<br>• سبورة<br>• اوراق واقلام |

ملاحظة: للتدريسي حرية في تغيير الاساليب والانشطة والوسائل حسب ما يراه مناسبا

الوحدة الخامسة عشر جلسة واحدة

المادة العلمية:

# Maemoglobin

## Myoglobin and Hemoglobin:

Blood can be considered a liquid tissue consisting of water, proteins, and specialized cells. The most cells in the blood are classified as erythrocvtes (RBC), leukocytes {WBC) and thrombocytes (platelets).

- The ervthrocvtes transport oxygen to the tissues and contributes to buffering of the blood through the binding of protons by hemoglobin.
- The leukocvtes are nucleated cells present in blood that function involved defense against infection.
- The thrombocvtes contain cytoplasmic organelles but no nucleus, Qe involved in by contributing to normal thrombus (clot) formation within the lumen of the blood vessel.

All of the cells in the blood can be generated from hematopoietic stem cell in the bone marrow on demand.

## Myoglobin and Hemoglobin:

Myoglobin, is a simple protein containing one polypeptide chain and one heme group, normally present in Muscle. The polypeptide chain contains 153 amino acids, its molecular weight of approximately 17,000. Myoglobin receives oxygen from the red blood cells and transports it to the mitochondria of muscle cells, where oxygen is used in cellular respiration to produce energy. When muscle is damaged, myoglobin is released into the bloodstream. The kidneys help remove myoglobin from the body into the urine.

In large amounts myoglobin can damage the kidneys.

Blood myoglobin is a test that measures the amount of myoglobin in the blood. A normal negative result is 0 - 85 nanograms per milliliter (ng/mL.) Greater-than-normal levels are called a positive result. This may be rise due to:

(a) Mtsculardvstrophy (skeletal muscle, myocardial muscle cells are damaged).

(b) Malignant hyperthermia (very rare).

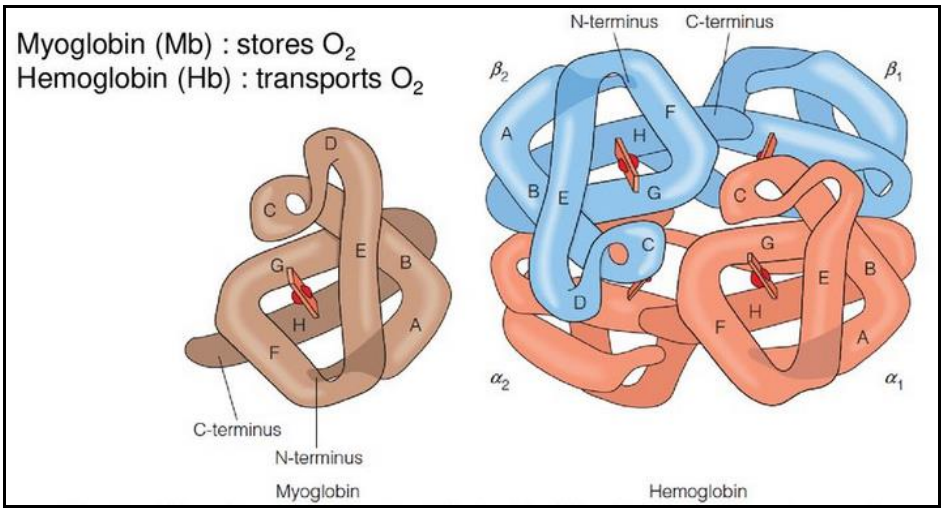


Figure (1): Myoglobin and Hemoglobin.

Hemoglobin is a large complex protein molecule in red blood cells with a molecular weight of approximately 68,000. The name hemoglobin comes from heme and globin.

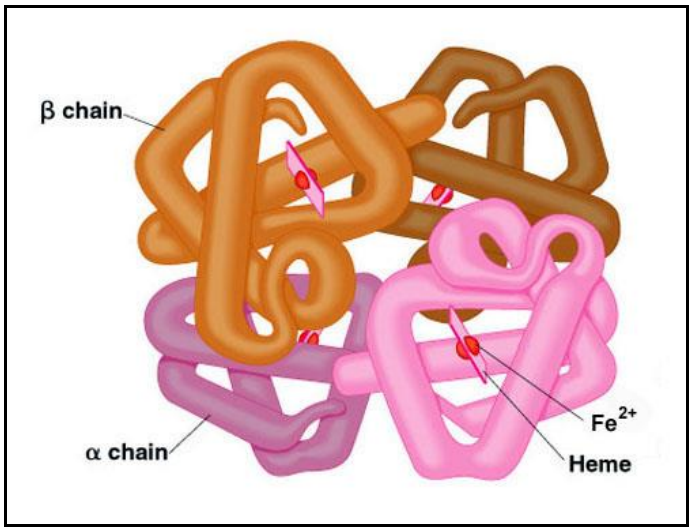

Figure (2): The Hemoglobin structure.

Its consisting of approximately 3.8% heme and 96.2% globin, Hemoglobin; frequently abbreviated as Hb.

**Structure of Hemoglobin:**

Fach hemoglobin protein structure (globin group) consists of four polypeptide chains-2 alpha and 2 beta chains with an embedded helne group contains an iron atom and pigment four pyrole rings which are held together by ionic bonds, hydrogen bonds, hydrophobic interactions, and Van der Waals forces, as well as four heme pigments, one in-each of the subunits.

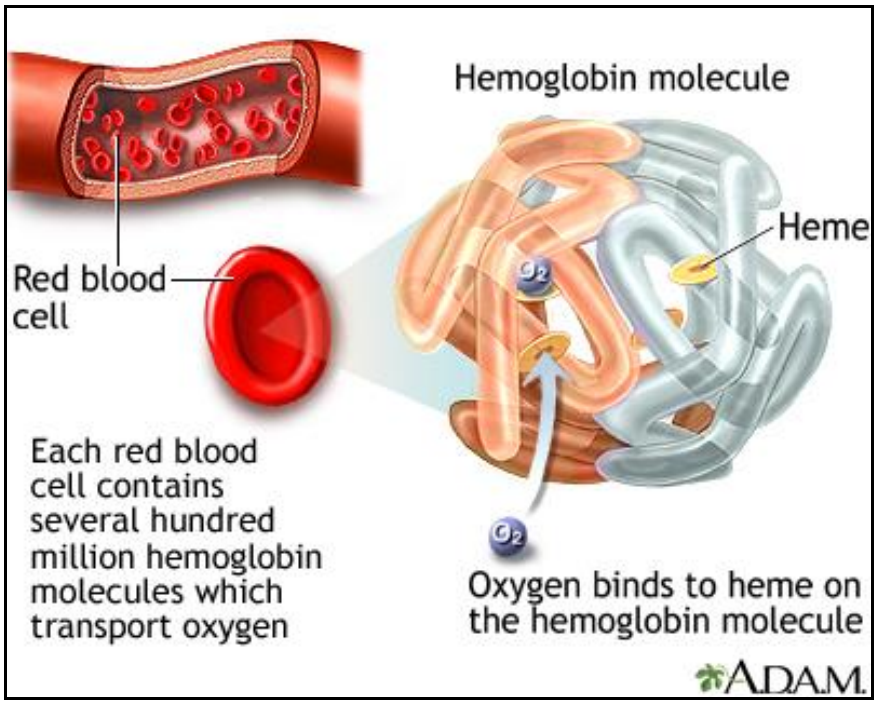


Figure (3): Illustration of hemoglobin.

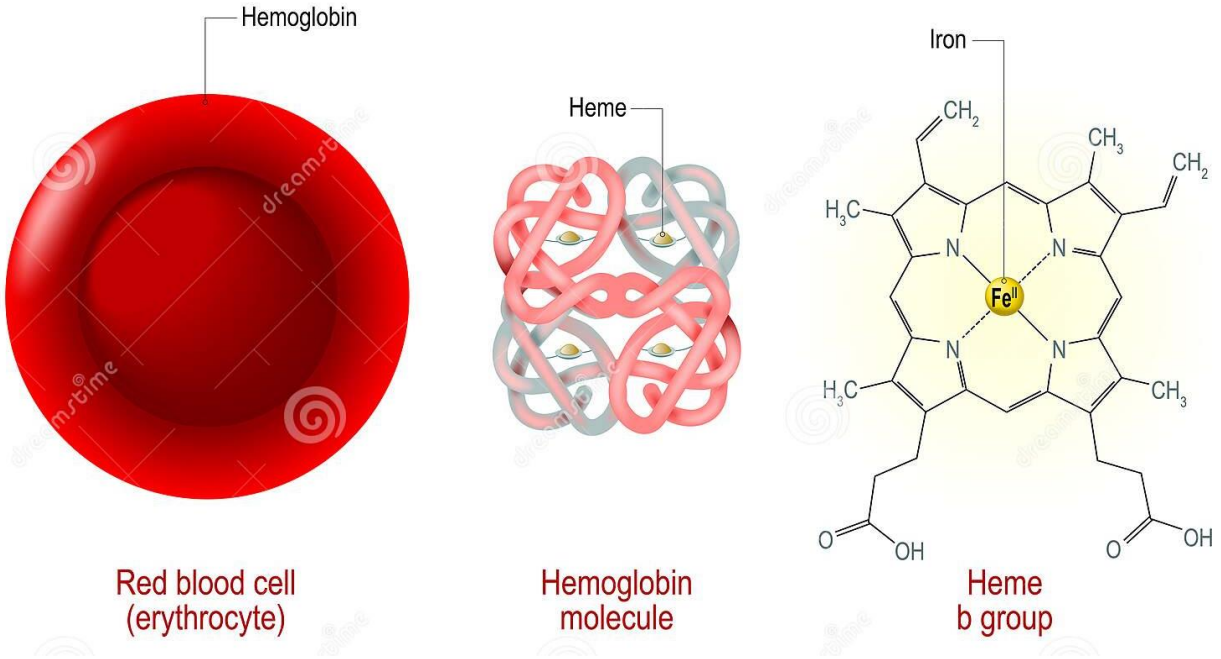


Figure (4): The chemical structure of the hemoglobin.

**Function of Hemoglobin:**

1. Hemoglobin has the ability to bind oxygen and carries oxygen from the lungs to the body's tissues.
2. It also facilitates the exchange of carbon dioxide between the lungs and the tissues.

These cells carry the oxygen, in a form called oxyhemoglobin, out to the tissues and cells of the body. The oxyhemoglobin releases the oxygen and- becomes hemoglobin. Again, the red blood cells, carrying hemoglobin (without oxygen), circulate back to the lungs to pick up more oxygen, and the process begins again.

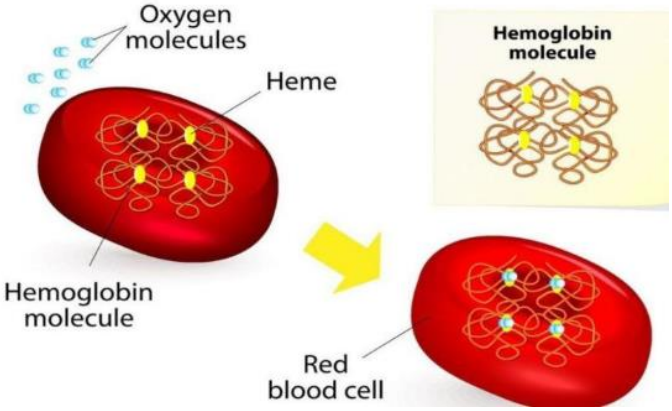


Figure (5): The function of hemoglubin.

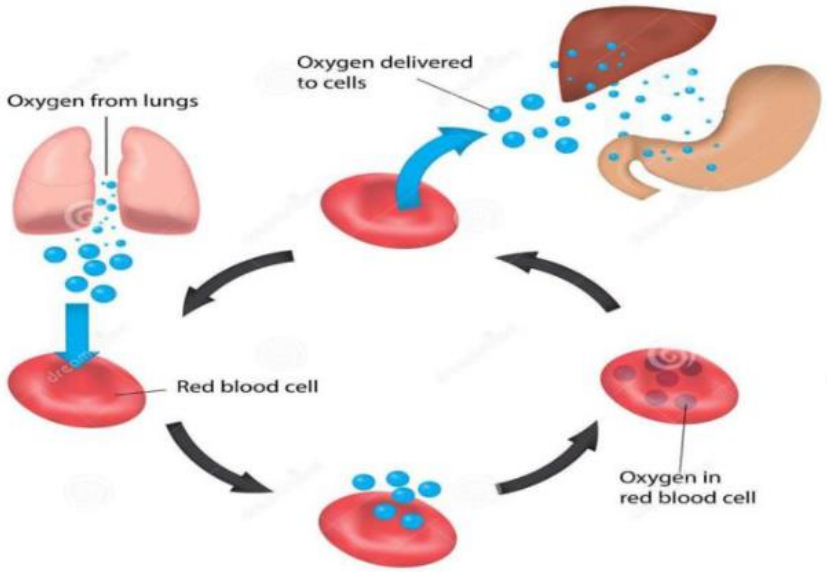


Figure (6): Overall hemoglobin function cycle.

## Hemoglobin Levels:

The concentration of Hb normally present varies according to a person's age and sex. Men have higher results than women do and newborn babies have higher values than adults (why)?

Men: 135 – 17.5 g/dL

Women: 12 – 15.5 g/dL

Newborn 14 – 24 g/dL

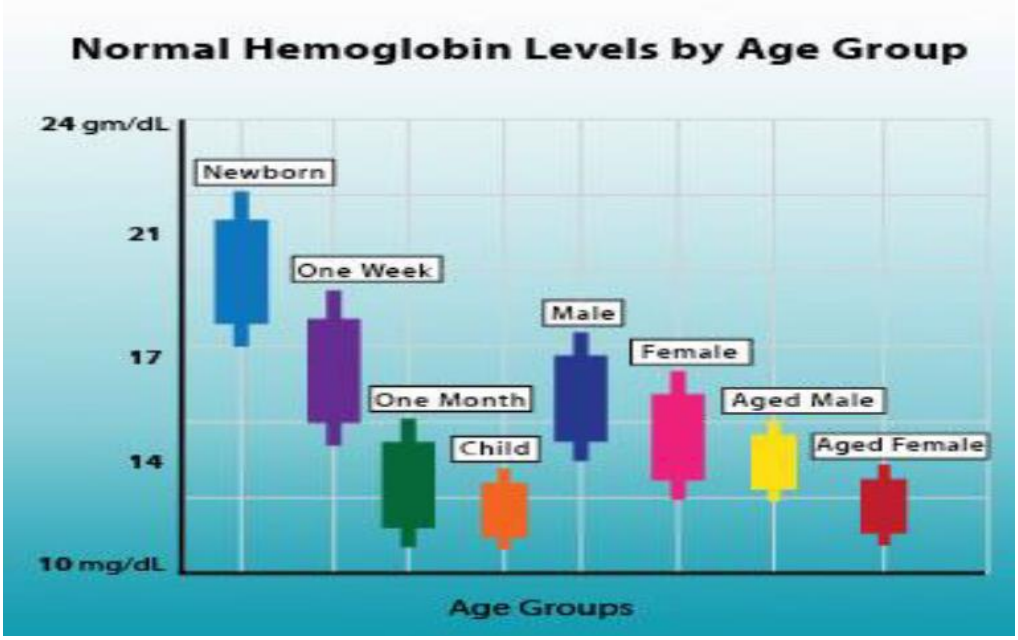


Figure (7): Normal hemoglobin levels by age group.

## Biosynthesis Hemoglobin: (anabolism Hb):

Hb is synthesized in a complex series of steps. The heme part is synthesized in a series of steps in the mitochondria and the cytosol of immature red blood cells, while the globin protein parts are synthesized by ribosomes in the cytosol.

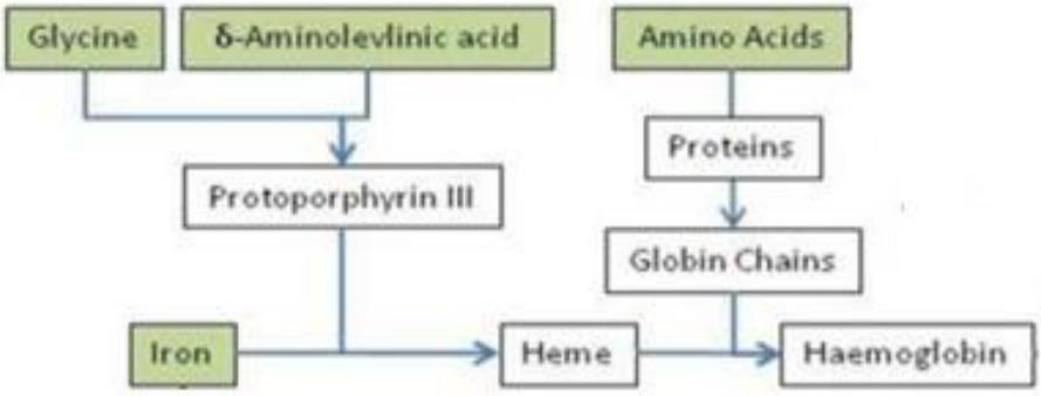

Figure (8)

## Breakdown of hemoglobin: (catabolism Hb)

RBCs reach the end of their life (life span in circulation =120 days) due to aging or defects, RBCs will rupture and released Hb, free hemoglobin are removed from the circulation by the phagocytic activity of macrophages in the spleen or the liver & bone marrow.

***Hb is broken in to its component:***

* Globin --- polypeptide --- amino acid {recycled or reused for synthesis protein}.
* Heme ----- iron {stored in liver and spleen or reused in synthesis RBCs in stem cells of bone marrow} ---- Porphyrin ring is converted to the bile pigment BILIRUBIN {secreted}.

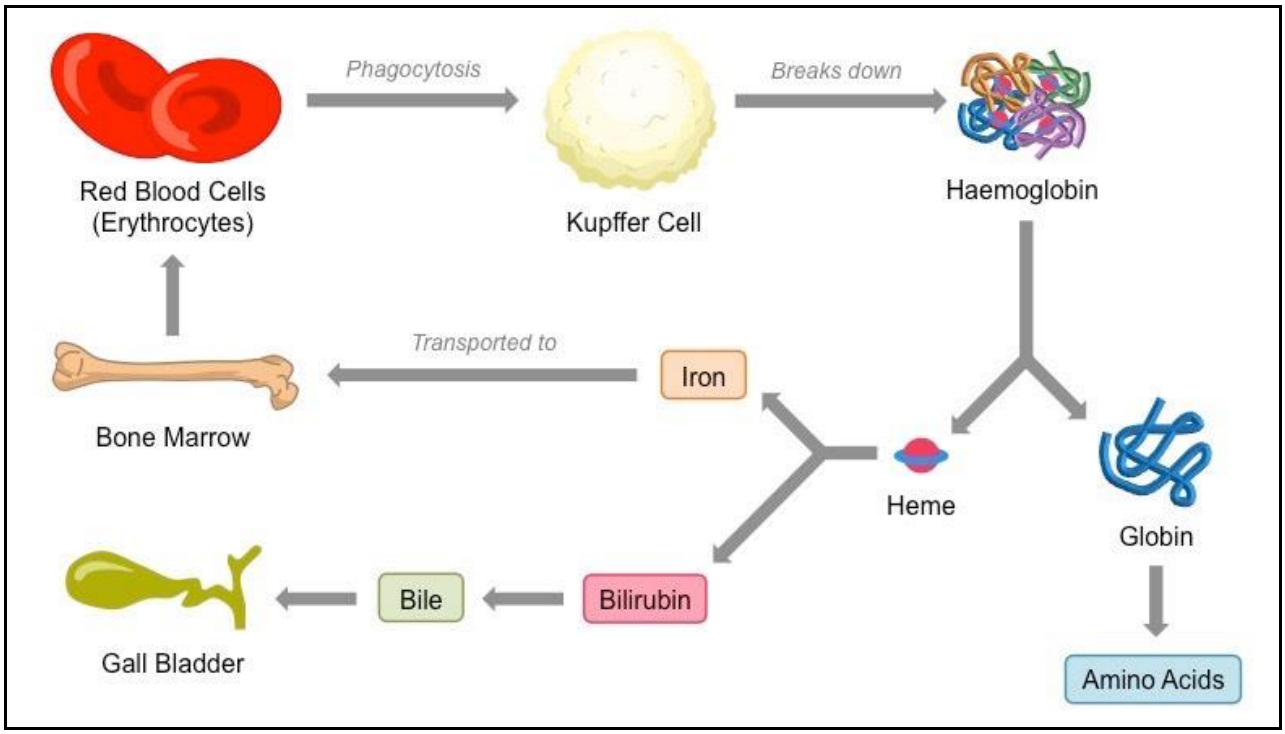


Figure (9): Breakdown of hemoglobin.

**Hemoglobin deficiency: (low amount of Hb)** → associated with diseases and conditions that can be caused a decreased amount of red blood cells.

*Diseases and conditions include:*

- Anemia [Aplastic, Vitamin deficiency, Iron deficiency].
- Cancer [Hodgkin's lymphoma, Leukemia, Multiple myeloma].
- Cirrhosis.
- Hypothyroidism (a thyroid disorder).
- Lead poisoning.
- Enlarged spleen.
- Hemoglobin defect (SickIe cell & Thalassemia).
- Bleeding from a wound.
- Bleeding in your digestive or urinary tract.
- Frequent blood donation.
- Heavy menstrual periods.
- Nosebleeds.

**High hemoglobin (Erythrocytosis)** → Specific disorders or other factors that may cause a high hemoglobin count include:

- Geographical factor: High altitude where oxygen levels are low thus stimulates your body to produce more red blood cells (which have the hemoglobin), Red blood cell production is governed by a hormone called erythropoietin that is secreted by the kidney.
- Polycythemia.
- Continual exposure to carbon monoxide (heavy smoking).
- Various diseases (heart, chronic lung disease, kidney disease).

- *Treated with frequent phlebotomy (draining blood from the body).*

## Hemoglobin qualitative defects :(Hemoglobinopathie)

Sickle cell disease is a genetic condition in which the quality of hemoglobin is defective. This condition can cause abnormal hemoglobin which, in turn, can result in abnormally shaped (sickled) red blood cells. These abnormal red blood cells cannot easily pass-through small blood vessels and, therefore, could deprive the body organs of adequate oxygen. This rapid turnover may-result in inadequate time to replace the red blood cells and may result in anemia.

# الوحدة السادسة عشر - المحاضرة الأولى - الزمن: 90 دقيقة

## أهداف المحاضرة الاولى:

**يتوقع في نهاية الجلسة أن يكون الطالب قادراً على:**

1. **معرفة أهمية كل معدن ووظيفته في جسم الأنسان.**
2. **معرفة الكميات اليومية اللازمة للمعادن التي يحتاجها الجسم البشري.**
3. **معرفة تأثير التغير في مستويات بعض المعادن على عمل الجسم.**
4. **معرفة الأجهزة المستخدمة لقياس مستويات المعادن.**

## موضوعات المحاضرة:

- **المعادن وأنواعها وأهميتها.**
- **الكميات اليومية التي يحتاجها الجسم البشري.**
- **أجهزة قياس المعادن.**

## الأساليب والأنشطة والوسائل التعليمية

| م | الأساليب والأنشطة التدريبية | الوسائل التدريبية |
|---|---|---|
| 1 | • نشاط التعارف (1/1/1)<br>• محاضرة<br>• مناقشة<br>• سؤال وجواب | • جهاز حاسوب<br>• جهاز عرض<br>• سبورة<br>• اوراق واقلام |

ملاحظة: للتدريسي حرية في تغيير الاساليب والانشطة والوسائل حسب ما يراه مناسبا

الوحدة السادسة عشر جلسة واحدة

المادة العلمية:

# Minerals and Nutrition

**Minerals:** are the chemical elements exist in all body tissues and fluids, their existance is necessary for maintaining certain physicochemical processes, essential for life.

**Minerals Nutrients:** are inorganic substances that must be ingested and absorbed in adequate amounts to satisfy a wide variety of essential metabolic and/or structural functions in the body.

- Minerals and electrolyte are important because the body cannot function without them. *All electrolyte are minerals but not all minerals are electrolyte*. Electrolyte are the minerals that carry an electrical charge.
- The body requires some raw materials, which include at least 30 vitamins, minerals, and dietary components that your body needs but cannot manufacture on its own in sufficient amounts.
- Vitamins and minerals are considered essential nutrients – because acting in concert, they perform hundreds of roles in the body. They help shore up bones, heal wounds, and bolster your immune system. They also convert food into energy, and repair cellular damage.

They are classified as major minerals (**macrominerals**) (body requires more than 100 mg/day) and trace minerals (**microminerals**) (body requires less than 100 mg/day), and Table (1) and (2) below list minerals, what they do in the body (their functions), and their sources in food.

Table (1): The major minirals (***macrominirals***) required by human body.

| Macro-mineral | Function | Sources |
|---|---|---|
| **Sodium** | Needed for proper fluid balance, nerve transmission, and muscle contraction. | Table salt, soy sauce; small amounts in milk, breads, vegetables. |
| **Chloride** | Needed for proper fluid balance, stomach acid, maintain the osmosis pressure in body cell. | Table salt, soy sauce; small amounts in milk, meats, breads, and vegetables |
| **Potassium** | Needed for proper fluid balance, nerve transmission, and muscle contraction. | Meats, milk, fresh fruits and vegetables, whole grains, legumes بقوليات |
| **Calcium** | Important for healthy bones and teeth; helps muscles relax and contract; important in nerve functioning, blood clotting, blood pressure regulation, immune system health. | Milk and milk products; canned fish with bones (salmon, sardines); greens (broccoli), legumes. |
| **Phosphorus** | Important for healthy bones and teeth; found in every cell; part of the system that maintains acid-base balance. | Meat, fish, poultry, eggs, milk, processed foods. |

| | | |
|---|---|---|
| **Magnesium** | Found in bones; needed for making protein, muscle contraction, nerve transmission, immune system health. | Nuts and seeds; legumes; leafy, green vegetables; seafood; chocolate. |

- Calcium, magnesium, and phosphor are bulk mineral, while sodium, potassium, and chloride are electrolytes.

***Trace minerals (microminerals)*** The body needs trace minerals in very small amounts.

Table (2): The trace minirals (***microminirals***) required by human body.

| Micro-mineral | Function | Sources |
|---|---|---|
| **Iron** | Part of a molecule (hemoglobin) found in red blood cells that carries oxygen in the body; needed for energy metabolism. | Organ meats, red meats, fish, poultry, shellfish, egg yolks, legumes, dried fruits. |
| **Zinc** | Part of many enzymes; needed for making protein and genetic material; has a function in taste perception, wound healing, normal fetal development, immune system health. | Meats, fish, poultry, leavened whole grains, vegetables. |

| | | |
|---|---|---|
| **Iodine** | Found in thyroid hormone, which helps regulate growth, development, and metabolism. | Seafood, foods grown in iodine-rich soil, iodized salt, bread. |
| **Selenium** | Antioxidant | Meats, seafood, grains |
| **Copper** | Part of many enzymes; needed for iron metabolism | Legumes, nuts and seeds, organ meats, drinking water |
| **Fluoride** | Involved in formation of bones and teeth; helps prevent tooth decay. | Drinking water (either fluoridated or naturally containing fluoride), fish. |
| **Chromium** | Works closely with insulin to regulate blood sugar (glucose) levels. | Unrefined foods, especially liver, whole grains, nuts, cheeses. |

## Recommended daily requirements of minerals:

The daily requirements of minerals required by the body can be obtained from a well-balanced diet. Like vitamins, excess minerals can produce toxic effects. The following table should cover the recommended daily requirements (**RDR** or **RDA**) of almost.

Table (3): The recommended daily intake of requirement for human body by both male and female.

| Mineral | Men | Women |
|---|---|---|
| Calcium | 1000 mg | 1200 mg |
| Sodium | 1100 mg | 3300 mg |
| Potassium | 2000 mg | 2000 mg |

| | | |
|---|---|---|
| Iron | 10 mg | 15 mg |
| Zinc | 15 mg | 12 mg |
| Magnesium | 350 mg | 280 mg |
| Phosphorus | 800 mg | 1200 mg |
| Chlorine | 700 mg | 700 mg |
| Fluorine | 1.5 mg | 4 mg |
| Copper | 2 mg | 2 mg |
| Selenium | 0.07 mg | 0.05 mg |

**Excess of minerals**: High concentrations of minerals in the body can have ill effects on your health. Symptoms of mineral toxicity vary as toxic levels depend on the type of mineral and how much of it your body takes in.

- High levels of **iodine** in the bloodstream can interfere with hormone functioning.
- Too much **sodium** can cause confusion, seizures, coma, and even death.
- **Selenium** is a mineral that is toxic in just small doses. Symptoms include black fingernails and the smell of garlic on your breath and skin.
- **Phosphorus** toxicity prevents the absorption of calcium and magnesium in the body. When ingested in amounts more than 1 g daily, phosphorus can cause diarrhea or lead to calcification تكلس of organs and soft tissues.
- **Copper** toxicity is also rare, however, excessive intake can cause vomiting, diarrhea, irritability تهيجات and dementia جنون.
- **Zinc** is generally considered to be non-toxic although extremely high doses of it can lead to symptoms such as nausea غثيان , vomiting and diarrhea.

## Mineral Measurement :

Measurement of minerals is a commonly performed diagnostic procedure, performed via blood testing.

4. Flame photometer or (Atomic absorption spectroscopy AAS) used to determine the concentration of minerals ions, such as (Ca, k and Na).
5. Auto analyzer (biochemistry analyzer) used to measure electrolyte most often are sodium and potassium, chloride, and bicarbonate or total $CO_2$.
6. Dual-energy X-ray absorptiometry (DXA): used to measure total body composition. The DXA scan is typically used to diagnose and follow osteoporosis, The bone density test is painless and quick. The X-rays measure how much calcium and minerals are in a part of your bone.

The amount of phosphate in the blood affects the level of calcium in the blood. Calcium and phosphate in the body react in opposite ways: as blood calcium levels rise, phosphate levels fall. A hormone called parathyroid hormone (PTH) regulates the levels of calcium and phosphorus in your blood. When the phosphorus level is measured, a vitamin D level, and sometimes a PTH level, is measured at the same time. Vitamin D is needed for your body to take in phosphate. The relation between calcium and phosphate may be disrupted by some diseases or infections. For this reason, phosphate and calcium levels are usually measured at the same time.

# الوحدة السابعة عشر - المحاضرة الأولى - الزمن: 90 دقيقة

## أهداف المحاضرة الاولى:

**يتوقع في نهاية الجلسة أن يكون الطالب قادراً على:**

1. **تعريف المناعة والفرق بين Immunology والـ classic immunology.**
2. **معرفة مكونات الجهاز المناعي في جسم الإنسان.**
3. **معرفة بعض الأمراض المتسببة في خلل في الجهاز المناعي.**
4. **معرفة الـ Immunotherapy واستخدامه في علاج الأمراض المناعية.**

## موضوعات المحاضرة الاولى:

- **مقدمة عن الجهاز المناعي.**
- **مكونات الجهاز المناعي لجسم الإنسان.**
- **الأمراض المناعية.**
- **الـ Immunotherapy.**

## الأساليب والأنشطة والوسائل التعليمية

| م | الأساليب والأنشطة التدريبية | الوسائل التدريبية |
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ملاحظة: للتدريسي حرية في تغيير الاساليب والانشطة والوسائل حسب ما يراه مناسبا

الوحدة السابعة عشر جلسة واحدة

المادة العلمية:

# Immunological Chemistry

The immune system is a complex and highly developed system, yet its mission is simple: to seek and kill invaders. If a person is born with a severely defective immune system, death from infection by a virus, bacterium, fungus or parasite will occur.

Immunology is a broad branch of biomedical science that covers the study of all aspects of the immune system in all organisms. It deals with the physiological functioning of the immune system in states of both health and disease; malfunctions of the immune system in immunological disorders (autoimmune diseases, hypersensitivities, immune deficiency, transplant rejection); the physical, chemical and physiological characteristics of the components of the immune system in vitro, in situ, and in vivo.

**Clinical immunology** is the study of diseases caused by disorders of the immune system (failure, aberrant action, and malignant growth of the cellular elements of the system). It also involves diseases of other systems, where immune reactions play a part in the pathology and clinical features.

The diseases caused by disorders of the immune system fall into two broad categories: immunodeficiency, in which parts of the immune system fail to provide an adequate response (examples include chronic granulomatous disease), and autoimmunity, in which the immune system attacks its own host's body (examples include systemic lupus erythematosus, rheumatoid arthritis, Hashimoto's disease and myasthenia gravis). Other immune system disorders include different hypersensitivities, in which the system responds inappropriately to harmless compounds (asthma and other allergies) or responds too intensely.

**Immunotherapy:**

The use of immune system components to treat a disease or disorder is known as immunotherapy. Immunotherapy is most commonly used in the context of the treatment of cancers together with chemotherapy (drugs) and radiotherapy (radiation). However, immunotherapy is also often used in the immunosuppressed (such as HIV patients) and people suffering from other immune deficiencies or autoimmune diseases

**Classical immunology:**

**Classical immunology** ties in with the fields of epidemiology and medicine. It studies the relationship between the body systems, pathogens, and immunity. The earliest written mention of immunity can be traced back to the plague of Athens in 430 BCE. Thucydides noted that people who had recovered from a previous bout of the disease could nurse the sick without contracting the illness a second time. Many other ancient societies have references to this phenomenon, but it was not until the 19th and 20th centuries before the concept developed into scientific theory.

The study of the molecular and cellular components that comprise the immune system, including their function and interaction, is the central science of immunology. The immune system has been divided into a more primitive innate immune system, and acquired or adaptive immune system of vertebrates, the latter of which is further divided into humeral and cellular components. The humeral (antibody) response is defined as the interaction between antibodies and antigens. Antibodies are specific proteins released from a certain class of immune cells (B lymphocytes). Antigens are defined as anything that elicits generation of antibodies; hence they are Antibody Generators. Immunology itself rests on an understanding of the properties of these two biological entities. However, equally important is the cellular response, which can not only kill infected cells in its own right, but is also crucial in controlling the antibody response. Put simply, both

systems are highly interdependent.

**Diseases of the Immune System:**

The immune system is a complex and highly developed system, yet its mission is simple: to seek and kill invaders. If a person is born with a severely defective immune system, death from infection by a virus, bacterium, fungus or parasite will occur. In severe combined immunodeficiency, lack of an enzyme means that toxic waste builds up inside immune system cells, killing them and thus devastating the immune system. A lack of immune system cells is also the basis for DiGeorge syndrome: improper development of the thymus gland means that T cell production is diminished.

**Asthma:**

Asthma affects more than 5% of the population of the US, including children. It is a chronic inflammatory disorder of the airways characterized by coughing, shortness of breath, and chest tightness. A variety of "triggers" may initiate or worsen an asthma attack, including viral respiratory infections, exercise, and exposure to irritants such as tobacco smoke. The physiological symptoms of asthma are a narrowing of the airways caused by edema (fluid in the intracellular tissue space) and the influx of inflammatory cells into the walls of the airways.

**Autoimmune polyglandular syndrome:**

The endocrine system is responsible for the release of hormones into the blood or lymph. Deficiencies in the endocrine system can be caused by infection, infarction, or a tumor destroying all or a large part of the gland. However, the activity of an endocrine organ is most often depressed as a result of an autoimmune reaction that ultimately results in partial or complete destruction of the gland. Autoimmune disease affecting one organ is frequently followed by the impairment of other glands, resulting in multiple endocrine

failure.

**Diabetes type 1:**

Diabetes is a chronic metabolic disorder that adversely affects the body's ability to manufacture and use insulin, a hormone necessary for the conversion of food into energy. The disease greatly increases the risk of blindness, heart disease, kidney failure, neurological disease, and other conditions for the approximately 16 million Americans who are affected by it. Type 1, or juvenile onset diabetes, is the more severe form of the illness.

**DiGeorge syndrome**: is a rare congenital (i.e. present at birth) disease whose symptoms vary greatly between individuals but commonly include a history of recurrent infection, heart defects, and characteristic facial features. DiGeorge syndrome is caused by a large deletion from chromosome 22, produced by an error in recombination at meiosis (the process that creates germ cells and ensures genetic variation in the offspring). This deletion means that several genes from this region are not present in DiGeorge syndrome patients. It appears that the variation in the symptoms of the disease is related to the amount of genetic material lost in the chromosomal deletion.

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