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Study of Uranium, Radon and Trace Elements Concentration in Biological Samples of Cancer Patients

A Thesis

Submitted to the Council of the College of Science, University of Kerbala, in Partial Fulfillment of the Requirements for the Ph.D. Degree in Physics

By

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Dedication

To all the hands that are raised to pray to reach my goal

To all the hearts that rejoiced to my success

To all the pure souls who supported and helped me

my

mother

father

husband

children

brothers

sisters

and friends

Present the results of my studies

HAURA

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Abstract

Investigating the effects of radioactive and toxic pollution, as well as the high rates of cancer patients worldwide and in Iraq in particular, have become vital, especially given the situation in which Iraq has been and remains vulnerable to the pollution consequences of conflicts and wars. The study dealt with human biological samples from whole blood and tissues from five types of cancers (breast, cervix, kidney, colon, and prostate) to evaluate radioactive and toxic pollution levels in Karbala governorate. It included two groups, one for cancer patients and the other for healthy subjects. The nitrogenous bases present in human DNA, Adenine (A), Cytosine (C), Guanine (G), and Thymine (T), were measured for their effects on damage or alteration using a laser source Raman spectra and compared with healthy samples.

The solid nuclear track detector (CR-39) with TASL*Image*™ Systems was applied to detect the alpha emitters concentrations in the samples: radon concentrations (C_{Rn}), radon concentration inner sample ($C_{Rn}^{s,ac}$) radium concentration ($C_{Ra}^{s,ac}$), annual effective dose (E), and uranium (U) concentrations in(*ppm*) units. The values of alpha emitters represented by radon and uranium were compared for healthy and patient groups, blood and tissue samples, and then compared with the change of gender, age, smoking, location of rural or urban residence, as well as the type of cancer. The concentration of radon and uranium in the blood samples of cancer patients was 7.631 ± 1.238 (*Bq/Kg*) and 0.615 ± 0.099 (*ppm)* respectively, while in the tissue samples, it was 7.385±0.838 (*Bq/Kg*) and 0.595± 0.211 (*ppm*) respectively. Statistical comparisons showed significant differences taken into account between cancer patients and healthy subjects in the concentrations of both radon and uranium for both blood and tissue samples, as well as ,the values of radon and uranium being similar between blood and tissue for patient samples, with a very slight increase in blood. Based on the studied radon and uranium concentrations under

the influence of gender in the blood and tissue samples, the values were slightly higher for males, which was consistent with these higher percentages of smokers in blood samples and resident areas with tissue samples. The age factor was not a statistical change that was taken into account, although the highest concentrations in the blood and tissues were within the range of 51-60 years. For cancers affecting both genders, there was an increase in radon and uranium concentrations of kidney cancer in blood and tissue samples.

Concentrations of the toxic elements Lead (Pb), Cadmium (Cd), Arsenic (As), and the body's essential elements Manganese (Mn), Nickel (Ni), and Zinc (Zn) were calculated using an inductively coupled plasma mass spectrometry (ICP-MS), compared for healthy and patient groups, blood and tissue samples, and then compared with the change in gender, age, smoking, and location of rural or urban residence. The concentration of toxic trace elements Leads (Pb), Cadmium (Cd), and Arsenic (As) in blood samples was 5.699± 1.410, 0.314± 0.043, and 0.309± 0.042 (*ppm*). In tissue samples, these concentrations were found to be 3.199±1.291, 0.121±0.007, and 0.1871±0.027 (*ppm*) respectively. All values of these elements were higher than the global permissible. While the concentration of essential trace elements Manganese (Mn), Nickel (Ni), and Zinc (Zn) in blood samples was as follows 4.964±1.245, 0.798±0.158, and 155.281±20.537 (*ppm*) and in tissue samples, as follows 0.182±0.037, 0.141±0.009 and 4.318±0.764 (*ppm*). Regarding toxic trace elements, the concentrations of Lead were higher than that of Arsenic and Cadmium in blood and tissue samples. On the other hand, Zinc concentration occupied a higher value concerning the Manganese and Nickel in patients and healthy people in blood and tissue samples.The concentrations of Arsenic in the blood samples were higher in men, while Lead and Cadmium were higher in females. The values of Lead and Arsenic were higher among smokers, while the concentration of Lead and Cadmium increased among city residents. In terms of the essential elements, men had higher levels of Manganese, whereas women had higher levels of Zinc and Nickel. Smoking had no impact on altering the concentrations of essential elements, even after taking into account that tissue patients who reside on the city side have higher levels of Manganese and Zinc. In contrast, rural people's cancerous tissue contained higher levels of Nickel. In general the proportions of toxic elements of Arsenic, Lead and Cadmium were higher than the universally permissible in both blood and tissue samples, also the tissue samples gave preference when detecting the concentrations of the toxic elements Lead, Arsenic and Cadmium compared to using blood samples while the use of whole blood samples was better than tissue when detecting the concentrations of the basic elements in the body, Manganese, Nickel and Zinc.

Examination of the (DNA) nitrogenous bases using Raman spectroscopy of the chemical bond sites showed a change in the positions of all bonds in Adenine (A), Cytosine (C), and Guanine (G), but in Thymine (T) the bonds at site 642 (cm^{-1}) remained the same. However, sites 1239 (cm^{-1}) and 1208 (cm^{-1}) were almost unaffected in most of the samples.

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List of Symble and Abbrivations	
Symble and Abbrivations	**Meaning**
DNA	Deoxyribonucleic acid
A	Adenine
C	Cytosine
G	Guanine
T	Thiamine
C_{Rn}	Radon concentrations
$C_{Rn}^{s,ac}$	Radon concentration inner samples
$C_{Ra}^{s,ac}$	Radium concentration inner samples
E	Annual effective dose
U	Uranium
Pb	Lead
Cd	Cadmium
As	Arsenic
Mn	Manganese
Ni	Nickel
Zn	Zinc
(ICP-MS)	Inductively coupled plasma mass spectrometry
IARC	International Agency for Research on Cancer
(^{234}U),(^{235}U), and (^{238}U),	Uranium isotopes
^{222}Rn	Radon
^{226}Ra	Radium
SSNTDs	Solid-state nuclear track detectors
US	United States
UK	United Kingdom
WHO	World Health Organization
DU	Depleted Uranium

RBCs	Red blood cells
WBCs	White blood cells
UNEP	United Nations Environment Programme
RS	Ramab Spectroscopy
PAS	Prostate-specific antigen
^{14}C	Carbon
^{40}k	Potassium
^{210}Po	Polonium
A	Angstrom
^{232}Th	Thorium
HM	Heavy metal
RNA	Ribonucleic acid
Fe	Iron
MS	Mass Spectroscopy
Ppb	Part per billion
(m/z)	Mass-to-charge
v	Frequency
v_0	Frequency of incident photon
v_s	Frequency of scattered photon
λ_0	Wavelength of incident photon
λ_s	Wavelength of scattered photon
H	Plank constant
(S/N)	Signal to noise ratio
CCD	Charge-coupled device
NIR	Near-infrared radiation
RR	Resonance Raman
$\boldsymbol{\alpha}$	Dipol moment
Q	Equilibrium position

μ	Dipole moment in a small field
Cu	Copper
ICP-OES	Inductivity-coupled plasma optical emission spectroscopy
Cr	Cribton
Al	Aluminum
Sn	Slinum
B	Boron
Mg	Magnisum
FAAS	Flame atomic absorbtion spectroscopy
P	Track density
K	Diffusion constant
T	Exposure time
R	Radius of the container
r_a	Alpha range
θ_c	Critical angle
C_{Rn}^{s}	Radon within the sample
λ_{Rn}	Radon decay constant
H	Distant between detector and the samples
L	Thickness of the samples
A^S	Surface area
M^S	Mass of the samples
V^S	Volume of the samples
A_{Rn}^{s}	Radon activity
O	The average indoor occupancy time per person
DCF	Dose conversion factor
N_U^S	Number of uranium atomic
λ_U	Constant decay of uranium

M_U^S	Uranium weight in gram
C_U^S	Uranium concentration in ppm
(MnSOD)	Manganese superoxide dismutase

Chapter One

General Introduction

Chapter One

General Introduction

1.1 Introduction

Cancer is one of the deadliest diseases of the human race. which is defined as an abnormality in the shape and function of a living cell represented by many pathological symptoms that affect the normal course of human life, It is a major cause of death around the world for the year 2020, with nearly 10 million deaths worldwide, and a rate of 1 out of every 6 deaths [1]. There are three possible causes of cancer, according to the International Agency for Research on Cancer (IARC), which are biological causes that are related to many genetic and hereditary diseases, some bacterial and viral infections. The second reason is related to radioactive activities such as radon gas, uranium and cosmic radiation while the third reason was the effect of poisoning resulting from toxic and trace elements [2].

The problem of environmental pollution, both radioactive and chemical, afflicts the human race and threatens its existence, especially since the causes of these pollutants have become one of the main components of the Earth's environment. The increases in the environmental radiation levels spurred over by human activity are referred to as radioactive pollution, which means the emission of matter in the form of a substance or radiation, such as alpha, beta or gamma rays, and the elements become new and more stable elements [3]. Positively charged alpha particles, negatively charged beta particles or uncharged gamma rays are all possible emissions of this radiation, however, the radioisotopes that produce them gradually lose their radioactivity. The four radioactive series that emits gamma and alpha radiation are represented by the elements uranium, actinium, thorium, and neptunium [4,5]. Depending on the source, radiation is categorized into natural and industrial types. Our earth's surroundings, cosmic rays, and living things themselves are all seen as natural sources, whereas industrial sources are seen as man-made [6,7]. According to how it interacts with matter, radiation can be ionizing or non-ionizing. Visible light, heat, radar, microwaves, and radio waves are all examples of non-ionizing radiation. Non-ionizing radiation is less energetic than ionizing radiation, which includes cosmic rays and x-rays. As a result, when ionizing radiation travels through the substance, it leaves behind enough energy to dissolve molecular bonds and extract electrons from atoms. This electron displacement generates two electrically charged particles (ions), which may result in alterations in the living cells of people, animals, and plants [5,7].

The emission of charged Alpha particles is the result of the natural radioactivity of naturally available elements such as uranium and industrial elements such as plutonium. Alpha particle has a weak ability to penetrate materials, although their progeny are harmful to live tissues that collide with them, due to their high charge compared to other particles [5]. Uranium is a hazardous heavy metal that emits alpha radiation naturally. The three isotopes of uranium that are found in nature are (^{234}U),(^{235}U), and (^{238}U), all of which decay mostly through alpha emission with some beta and gamma emission [8]. Both (^{226}Ra) and (^{222}Rn) are produced by uranium decay [9]. As an average consequence of the food chain, the human body has (90 μg) of uranium, of which 66 percent is contained in the skeleton, 16 percent in the liver, 8 percent in the kidneys, and 10 percent in other tissues. Adults are thought to consume on average (of 460 μg) and breathe on average (of 0.59 μg) of uranium every year [10]. Whereas the radioactive and poisonous by-product of the uranium enrichment process is depleted uranium. For the first time in history, it was deployed as ammunition by US and UK soldiers on Iraqi civilians and military targets in the year 1991 [11]. According to estimates, up to 70% of the depleted uranium (DU) in a projectile becomes aerosolized and then gaseous upon impact [12]. Radon has been linked to cancer, either directly or indirectly, according to the World Health Organization (WHO) [5].

Radon (^{222}Rn)is a radioactive noble gas that arises in the decay chain of the (^{238}U) series and has a half-life of 3.82 days. Nearly half of the normal background radiation dosage that humans receive comes from the gas and its offspring [13]. (DU) aerosols have been shown to travel up to 26 miles [14], and some investigations have claimed considerably greater distances. In a single day, one milligram of (^{238}U) produces 1,007,000 alpha particles. Over 4.17 million electron volts (*MeV*) of energy are released by each alpha particle [15]. This much energy will strike up to six neighboring cells in the affected tissue or organ if Depleted Uranium Oxides aerosols are ingested or breathed. To split the nuclear (DNA) strand in a human cell, only 6–10 electron volts (*eV*) of energy are required [11]. Cities and towns with high populations, such as Baghdad, Basra, Najaf, Amarah, Samawa, Tikrit, Karbala, Falluja, and Baaquba, have been subjected to higher levels of radioactive contamination during and after the military occupation of Iraq in 2003 [12]. Following the events of the Gulf Wars, the prevalence of cancer diseases has considerably grown in Iraq, when the total population of Iraq was 39, 127, 889 people for the year 2019, and the total number of cancer cases was 35,864 with 10,957 deaths, 1,291 of the cases were in Karbala governorate, which numbered with 1,283,484 people [16].

In recent years, chemical contamination has also become a significant issue in both Iraq and the rest of the world. Due to the continuation of industrial operations, which resulted in the discharge and detection of contaminants in the air, water, food, soil, and many other natural and man-made samples [17]. In recent years, many studies have emerged linking toxic and trace elements with cancer [18]. The danger of these elements is represented by the delay and difficulty of detecting them [19]. Trace elements like (Pb, As, Cd, Mn, Ni, and

Zn) can attack amino acid bonds that inhibit enzymatic activity in the body for their ability to deceive the human body and replace its essential elements as Lead does, displacing calcium in bones [20]. Besides trace elements may be involved in the metabolism of ketones, thus affecting the percentage or preventing the body from absorbing the important elements in the metabolism [21]. On the other hand, trace elements and their concentrations in the human body play important roles due to their relationship to the speed of (DNA) formation and the formation of enzymes and immune indicators, however, the effect of these elements may include changing the structure of cell organisms and the permeability of their membranes, which affects the absorption of the main elements to maintain life normally and cause diseases such as cancer [22,23]. Many studies have drawn attention to the relationship of trace elements to human health in general and cancer in particular [18,24].

Despite the great scientific progress in the medical field, the early diagnosis of the disease is still ineffective, in addition to the fact that the knowledge of the main causes of the disease is still not fully understood [25]. The calculating concentrations of radioactive elements and measurement of the change in the concentrations of trace elements and their effect on human health with several techniques have emerged to calculate the differences in the bodies of people with cancer from healthy people, using biomarkers, which are defined as biochemical, cellular, molecular, or physiological changes in cells and body fluids such as whole blood, serum, human tears, tissue, and any fluids or parts of the human body [26–28].

Blood is an essential body fluid that performs a variety of biological tasks. Red blood cells (RBCs, also known as erythrocytes), white blood cells (WBCs, also known as leucocytes), and platelets (also known as thrombocytes) are suspended in a yellow liquid medium called plasma. In a brief, platelets are necessary for blood clotting and healing, WBCs fight infection and disease as a component of the immune system, and RBCs transfer oxygen and carbon dioxide between cells and the lungs. Various proteins, electrolytes, and clotting factors are also transported by extracellular plasma, and changes in blood chemistry can be utilized to determine a patient's health status [29].

Tissue is a collection of cells with similar structures and functions. The intercellular matrix, a nonliving substance, fills the spaces between the cells. A particular tissue may have special components in its intercellular matrix, but not always much in others, such as fibers and salts, that are specific to that tissue and give it specialized properties. The body is made up of four different types of tissue: epithelial, connective, muscular, and nervous. Each has a purpose for which it was created [30].

Cancer diagnosis remains one of the biggest challenges in medicine. The development of new noninvasive strategies repeatable or the improvements of existing ones makes Raman Spectroscopy (RS) fundamental for early diagnosing need minimal sample preparation and is non-destructive. These techniques also give information at the molecular level (in vivo and in vitro), enabling the investigation of functional groups, bonding types, and molecular conformations [31,32]. Solid-state nuclear track detectors (SSNTDs) are one of the effective, less expensive, and similarly, precise ways to measure the amounts of uranium in biological samples beside these biological matrices can be accurately and widely analyzed with high accuracy and sensitivity for trace elements using inductively coupled plasma mass spectrometry (ICP-MS) [13,33,34]. This thesis was written in four chapters:

Chapter one reviews the general introduction, which included the key points pertaining to the research, its choice, its goal and the scope of the study.

Chapter two gives an explanation of the theoretical aspect related to the study and also displays the literature and previous studies.

Chapter three shows the practical side, including the method of all samples, their preparation, methods of measurement, the area under study, and information about samples.

Chapter four reviews the results of the research, statistical analysis, and results discussed and compared. Conclusion, future study and recommendations have been added to this chapter.

1.2 Aim of the study

The aim of this research includes an attempt to obtain a preliminary diagnosis of cancer and link it to the possible causes through:

1- The use of Raman spectra to compare the changes in the blood of patients with cancer and healthy ones.

2- Measuring the concentration of radon gas in blood and tissue samples of cancer patients and healthy people in Karbala Governorate, then finding the values of uranium concentrations.

3- Measurement of concentration in samples of some trace elements in the blood and tissue of cancer patients and healthy people in Karbala governorate.

4- Comparison of the values of radon, uranium and trace elements in the blood and tissues of cancer patients with those of healthy controls.

5- Studying the relationship between cancer patient samples and healthy samples under smoking habits, age, residential area and gender factors.

6- Comparing the results with global values and other studies and determining within the normal range or not.

7- Putting the information we obtain during the study as a reference to the Karbala governorate and its suburbs.

1.3 Scope of the Study

This study examined various radioactive and toxic environmental pollutants in the rural and urban areas of the Karbala Governorate, taking into account the radioactive pollution from the 1991 Gulf War and advancements in industry and agriculture that released their pollutants into the environment of Iraq. Utilizing nuclear track detectors and induced mass spectrometry technologies, this effect was examined by utilizing laser beams to compare biological samples.

Chapter Two

Review of the Related Literature

This chapter gives an explanation of the theoretical aspect related to the study and also displays the literature and previous studies.

2.1 Cancer

Cancer is a complicated condition that affects a variety of temporal abnormalities in cell physiology that eventually result in cancerous growth [35]. Several factors supported the role of genetic modification in the cell, was no single genetic change responsible for all types of cancers that resulted in the development of cancer. Cell physiology involves six crucial changes to become a cancerous cell as shown in figure (2.1) [36].

1- Self-sufficiency in growth signals.

2- Incapability towards using growth inhibitors (anti-growth).

3- The ability to evade programmed cell death (apoptosis).

4- Unlimited capacity for replication.

5- Long-term vascularity.

6- Invasion and metastasis of tissue (angiogenesis).

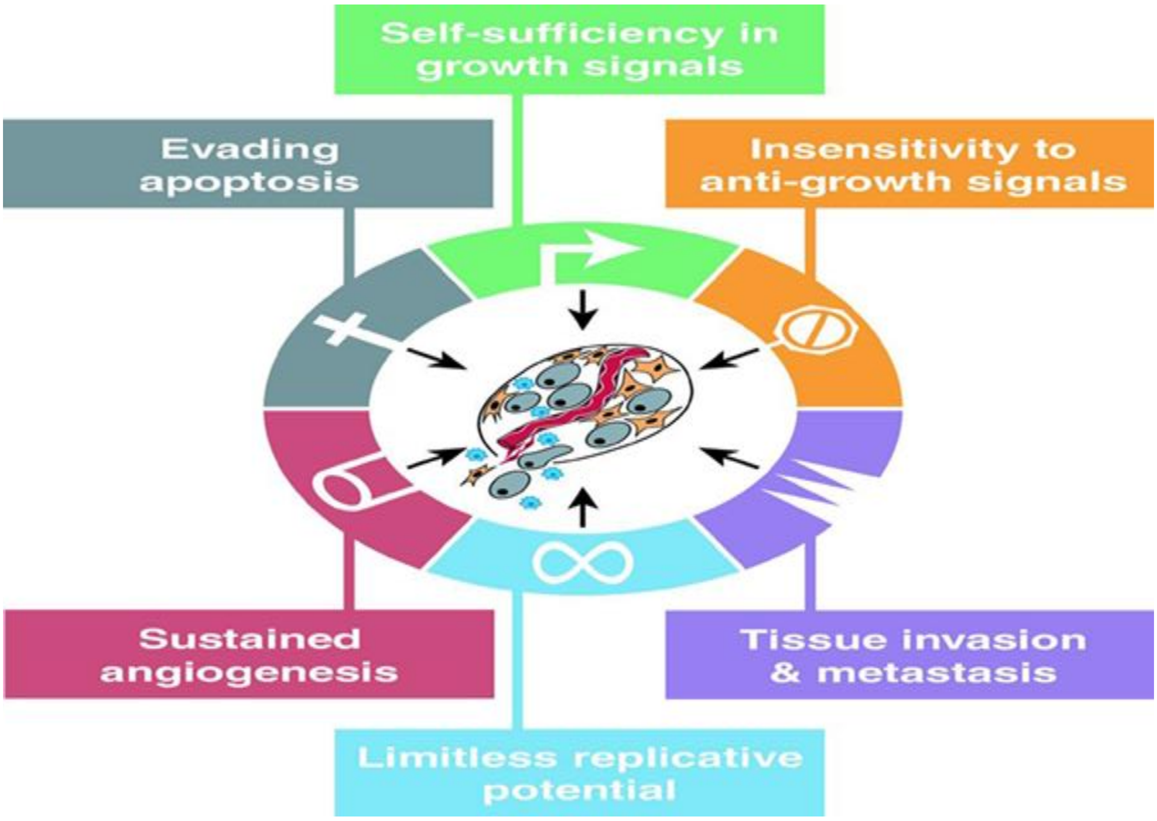


Figure 2.1: Shows how cancer can be acquired [36]

2.1.1 Breast Cancer

Breast cells regularly grow and divide as they should in order to age or become change when breast cancer develops, but cancer cells continue to divide uncontrollably and spread the infection to other cells, which causes them to clump together to create a tumor. The cells of the ducts (the ducts that transport milk from the glands to the nipple) or the lobules are where breast cancer typically starts (groups of glands that secrete milk), breast cancer that starts in the lobules is known as lobular carcinoma, whereas breast cancer that starts in the ducts is known as ductal carcinoma [37]. That number of casualties 685 000 women die from breast cancer worldwide in 2020. Breast cancer is the most common cancer in the world, with 2.3 million new cases and 7.8 million women alive as of the end of 2020 who had received a diagnosis in the previous five years [1].

2.1.2 Prostate Cancer

Male prostate cancer occurs when the prostate gland is abnormally divided, the part of the male genital system that lies above the bladder and surrounds the first part of the urethra and increases in size with age in men. Prostate-specific antigen is a protein generated by the prostate gland (PSA). Its specific level will be the measurement by a blood test [38]. With an expected 1,414,000 new cancer diseases and 375,304 deaths in 2020, prostate cancer is the second most often diagnosed cancer and the fifth Leading cause of cancer death among men globally. In 112 nations around the world in 2020, prostate cancer will be cancer that is most commonly diagnosed [39,40].

2.1.3 Cervix Cancer

Cervix cancer is one of the most hazardous malignancies for women has an impact on the lower portion of the female reproductive system, and because the majority of its components are skin tissue, it swiftly spreads throughout the rest of the body. The ectocervix is a layer of skin-like cells that covers the cervix exterior also there are glandular cells that create mucus inside the cervix. It is the most typical form of cervix cancer. Abnormal cells of the cervix can develop as a result of the glandular tissue of the endocervix developing cancer [38]. According to statistics, there were 604 000 illness cases and 342 000 deaths from cervical cancer in women worldwide in 2020. About 90% of disease cases and deaths worldwide occurred in low- and middle-income countries in 2020 [41].

2.1.4 Colon Cancer

Colorectal cancer is another name for bowel cancer. The larger stool, which consists of the colon and rectum, is affected, when unwanted cells begin to divide and expand in an uncontrolled manner, cancer results. The cells may spread to other parts of the body and develop into the tissues or organs around their part of the digestive system including the bowel. The small and big bowels make up this division [38]. The big bowel starts with the colon, which has four pieces and is around five feet long any of these can develop cancer [38]. The third most prevalent cancer in the world is colorectal cancer. It ranks second among cancers in women and third among cancers in males, In 2020, there were about 1.9 million brand-new diseases of colorectal cancer [42].

2.1.5 Kidney Cancer

Renal cancer arises when abnormal cells begin to divide and expand in an uncontrolled manner in either of the kidneys. The cells may spread to different parts of the body and develop into the tissues or organs around them kidney is a portion of the human urinary system, this system creates urine and filters waste from the blood [34]. The 14th most probable cancer in the world is renal cell adenocarcinoma, normally recognized as kidney cancer. It rates as the ninth most frequent cancer in males and the fourteenth most frequent in women. In 2020, there were approximately 430,000 new diseases of kidney cancer [41].

2.2 Radiation Definition and Classifications

Radiation from an unstable substance is defined as the release of rays or small particles to be stable [44], it is surrounded humankind in all directions, and some amounts of radioactive substances like carbon ($^{14}_{6}C$), potassium ($^{40}_{19}K$) and polonium($^{21}_{84}$Po) are contained naturally in human bodies. As a result of the type of source, it can be divided into natural and artificial radiation [45]. Natural radiation is classified as follows:

1. Cosmic radiation (the earliest source, thought to have begun around 13-14 billion years ago at the beginning of the universe).

2. Terrestrial radiation (the creation of primordial radioactive elements during the earth's formation), roughly 4.5 billion years ago; concentrations or amounts of naturally occurring radioactive material.

3. Internal radiation (cosmogenic radioactivity occurs naturally as cosmic radiation interacts with the atmosphere to form radionuclides).

Moreover, cosmic radiation consists of abnormal energetic particles (up to 10^{18} *eV*), the majority of which are protons (87%) and also some greater particles (alpha radiation 13%). It can cause the most harm to humans, while medical and commercial products, nuclear weapons, and nuclear power industries contribute less than 0.3 percent to the radiation exposure of our population, such as X-rays that include man-made radiation [3,46,47]. According to the ability of ionization radiation is also dived into ionized and non-ionized. Electromagnetic radiation having a wavelength A of at least 10 *nm* is considered nonionizing radiation. Radio waves, microwaves, visible light (λ ≈770–390 *nm*), and ultraviolet light (λ ≈390–10 *nm*) are all included in that region of the electromagnetic spectrum. The remainder of the electromagnetic spectrum (X-rays, λ ≈0.01–10 *nm*) and γ-rays, which have a shorter wavelength than X-rays, are also considered to be ionizing radiation. All of the atomic and subatomic particles, such as electrons, positrons, protons, alpha particles, neutrons, heavy ions, and mesons, are also included in this classification [46].

2.3 General information and Sources about Alpha particles

Alpha particles are one form of ionizing radiation that is the least penetrating of the radiations released by unstable heavy metals [48]. Because it has more large and highly charged than other types of ionizing radiation, these particles are more dangerous to living tissues [49]. The powerful alpha particles from radioactive materials can only travel a few centimeters through the air, whereas the range of alpha particles in bodily tissue is exceedingly small, measuring only 0.03 mm [50]. The Uranium (^{238}U), Actinium (^{235}U) and Thorium (^{232}Th) series are three naturally occurring radioactive series released as a radioactive source released alpha particles. Figures (2.2),(2.3) and (2.4) show the nuclear chains of each of these radioactive decays respectively.

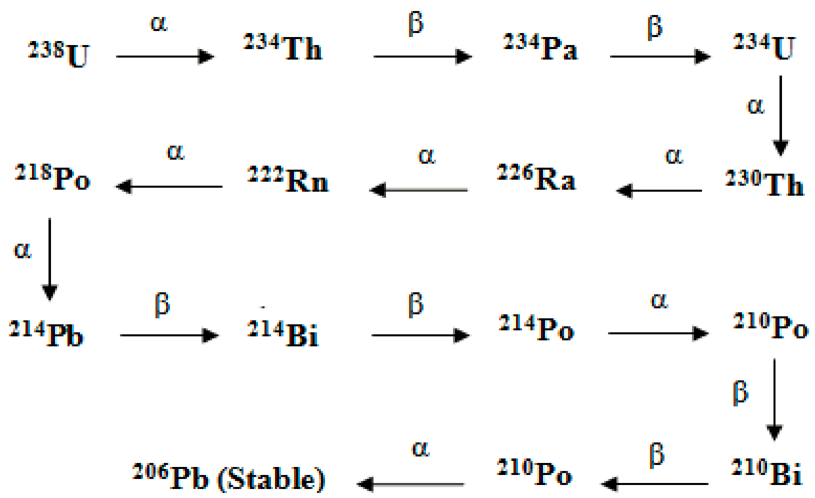


Figure 2.2: The radioactive decay of ^{238}U [51].

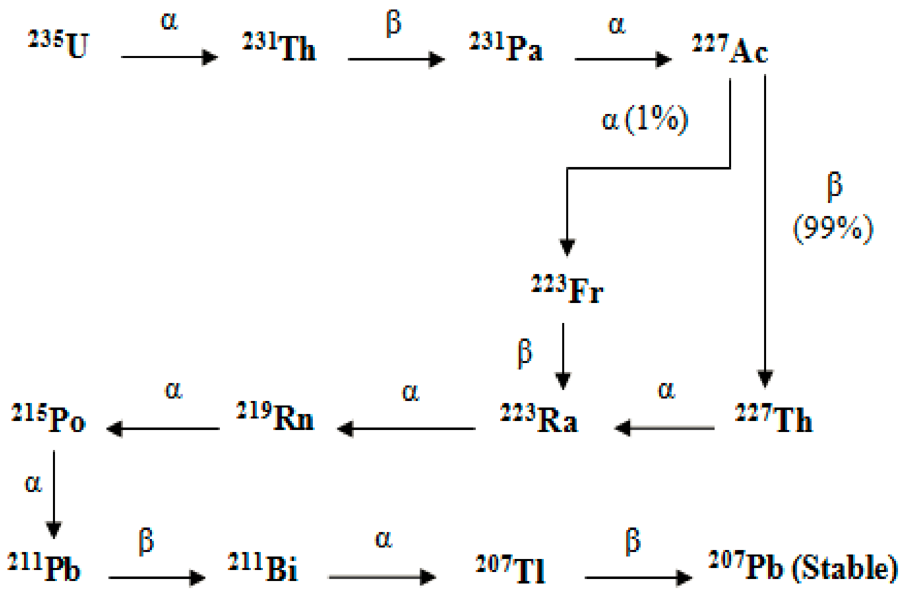


Figure 2.3: The radioactive decay of ^{235}U [51].

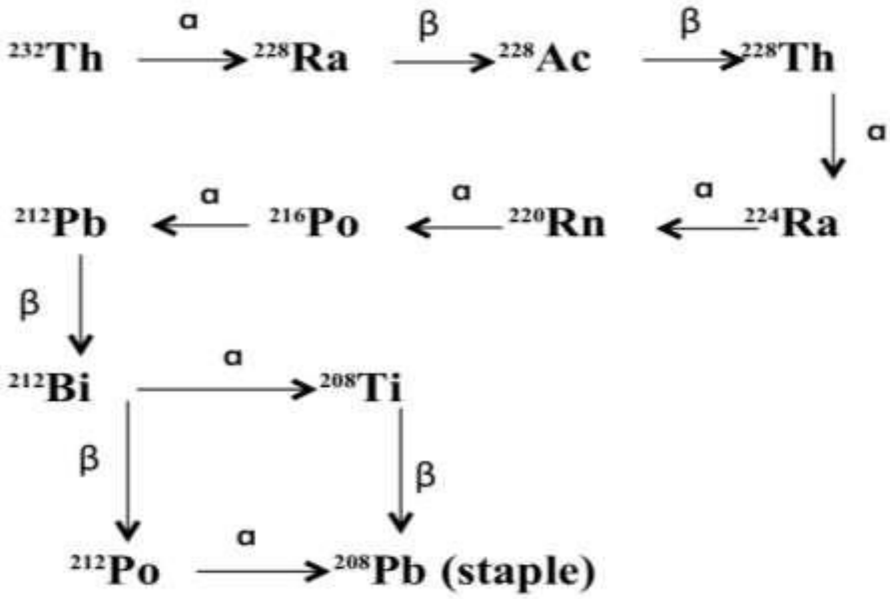


Figure 2.4 ^{232}Th decay chain [51].

2.4 Radioactive Equilibrium

The decay series develops when all radionuclides decay uniformly and are in equilibrium. Depending on whether the parent's half-life is longer or shorter than the daughter's half-life, there are three forms of equilibrium: secular equilibrium, nonequilibrium, and transitory equipoise [52].

1- Secular Equilibrium

When a radionuclide in a series has a significantly longer half-life than the others in the series, a secular equilibrium is typically reached where daughter activity equals parent activity.

2- Transient Equilibrium

It happens when the half-life of the parent of the radionuclide is longer than the daughter's half-life.

3- NoN Equilibrium

Nonequilibrium In case the daughter's half-life is shorter than the parent's. There will be nonequilibrium as the daughter's activity increases and the parent's activity decreases.

2.5 Natural and Depleted Uranium

Uranium is a naturally radioactive and poisonous (heavy metal) substance. It is include a variety of radioactive isotopes including ^{238}U, ^{235}U, and ^{234}U [53,54]. The usual percentages of ^{238}U, ^{235}U, and ^{234}U are 99.27%, 0.72%, and 0.007% respectively [55]. The majority of these isotopes present in both natural (U) and Depleted Uranium (DU) emit alpha particles through erosion caused by wind and water as well as uranium volcanic eruptions, uranium can be released into the environment during industries mines and mills [54]. Natural uranium dividing into two types by the industrial process of enrichment: enriched uranium (with a higher percentage of ^{235}U), and depleted uranium (DU) is a radioactive, poisonous, and man-made heavy metal that is derived from uranium with a decreased percentage of (^{235}U) .Depleted uranium is less radioactive because of its decreased percentage of (^{234}U), which grows during the refining process and increases radioactivity, depleted uranium is less radioactive. When enhancing uranium used in commercial nuclear energy, it has an activity-based (^{235}U) content of roughly 3%. Also, uranium can be filtered to be used in nuclear bombs or other applications and can have a (^{235}U) content as high as 97.3 percent and specific activity as high as (50 *Ci/g*). The byproduct of the enrichment procedure is depleted uranium. The specific activities of depleted uranium are even lower (0.33 *Ci/g*) than that of natural uranium [11,54]. Up to 70% of the (DU) in a projectile is thought to be aerosolized (converting to a gaseous form) [12]. The most hazardous route for (DU) aerosols to enter the civilian population present on and near the battlefield is by the wind, where they remain airborne for an extended period of time. (DU) aerosols have been shown to travel up to 26 miles [11], and some investigations have claimed considerably greater distances. The digestive system, skin, and wounds, as well as inhalation and trans-transfer to the bloodstream, are the three main pathways for internal uranium exposure [56]. The main ways that uranium can enter the human body are either by breathing particles in the air or ingesting food and liquids [57,58]. The expected daily intake of uranium is (1.5 μg) in water and (1-2 μg) in food. In persons who do not subject to radiation, the quantity of uranium in their bodies is roughly (56 μg) [59]. Biokinetics describes how a chemical behaves in the human body (including absorption, distribution, elimination, and retention) [60].

2.6 Radon

The decay of the (^{238}U) series leads to the formation of radioactive noble gas (^{222}Rn). Considering the half-life of the (^{222}Rn) nucleus (3.83 days), some of the radon gas created as a consequence of soil decay may travel over large distances before reaching the earth's surface and the atmosphere. Numerous domains, including dosimetry and geophysics, employ the knowledge of radon and its daughter concentrations [61]. Due to its presence in soil, groundwater, and air, radon gas is the most significant gas worldwide in studies on natural radiation. It makes up around 50% of the natural radiation in our environment [62]. Three isotopes (^{222}Rn), (^{220}Rn), and (^{219}Rn) were produced as a result of the decay of (^{238}U), (^{232}Th), and (^{235}U), respectively. Compared to other rare atmospheric gases, such as (^{220}Rn), and (^{219}Rn), which have incredibly short half-lives of (55.65 seconds) and (3.69 seconds), respectively [63].

2.7 Physiology of the Human Body

Understanding the physiology of the human body is crucial to understanding how radioactive elements are transferred inside the body, while Biokinetics describes how a chemical behaves in the human body (including absorption, distribution, elimination, and retention) [60]. The human body is composed of a wide range of organs and systems. Each of them has a distinct purpose. Understanding how radioactive materials are transmitted throughout the human body depends on three mechanisms. The digestive system is in charge of breaking down and absorbing food; the respiratory system, which supplies oxygen to the body; and the circulatory system the one which distributes blood to the body [64,65].

2.7.1 Blood

Blood, a type of connective tissue that circulates through the heart and blood vessels and is composed of cells and fragments of cells encased in a liquid matrix, is a form of connective tissue [66]. White blood cells and platelets make up your blood's solid component. Human organs and tissue receive oxygen from the lungs through red blood cells (RBC). White blood cells (WBC), Which are a part of the human immune system, fight infection. When the human body has a cut or wound, platelets assist blood in clotting. Human bones are spongy inside, called bone marrow, where the production of new blood cells originates. The body constantly generates new cells of blood to replace those that perish. Platelets have a lifetime of six days, compared to 120 days for red blood cells. White blood cells can live for less than a day in some cases but much longer in others [67]. Total blood in female (4-5) and male (5-6) litters contains cells and cell fragments. All blood cells develop from stem or precursor cells, which are primarily produced in the bone marrow, and make up roughly 45 percent of blood compared to plasma's about 55 percent [68]. The composition of human blood is shown in figure (2.5) [69].

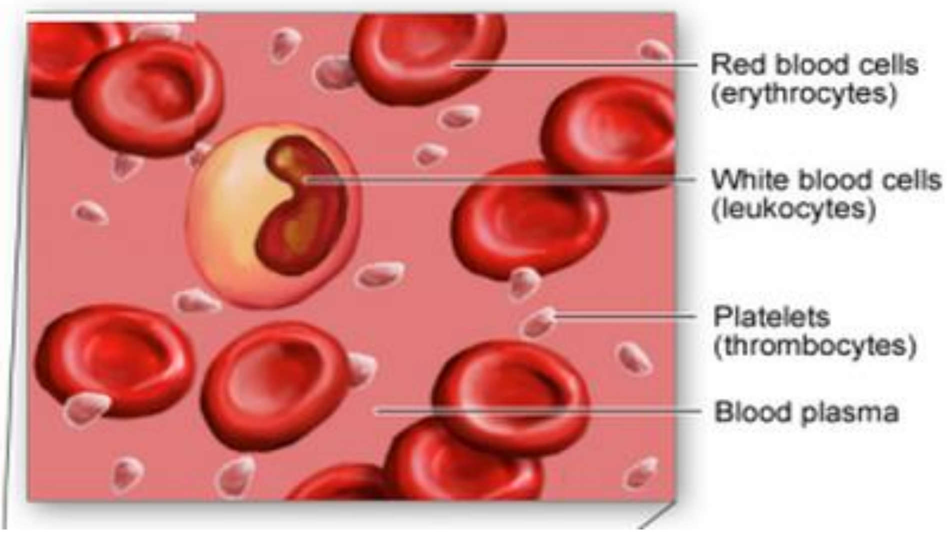


Figure 2.5: The composition of human blood [69].

2.7.2 Tissues

A tissue is a grouping of associated cells that perform the same function for an organism [70]. Tissues devoid of single-celled organisms even the simplest multicellular creatures, such as sponges, lack or have weakly differentiated tissues. High-level multicellular animals and plants, however, contain specialized tissues that may organize and regulate an organism's reaction to its environment[71]. The four fundamental types of tissue are connective, epithelial, muscular, and nervous. Other tissues are supported by and bound together by connective tissue (bone, blood, and lymph tissues). Smooth muscle, like the muscles that surround the stomach, is a type of muscle tissue in addition to the striated (sometimes referred to as voluntary) muscles that move the skeleton. Neurons, the building blocks of nerve tissue, are responsible for carrying "messages" between different bodily areas [67]. Water makes up a large portion of human tissue, accounting for typically more than half of the body's weight, along with lipids and proteins. Figure (2.6) shows the four types of human tissues Connective, b Epithelial, c Muscle and d Nervous tissues [71].

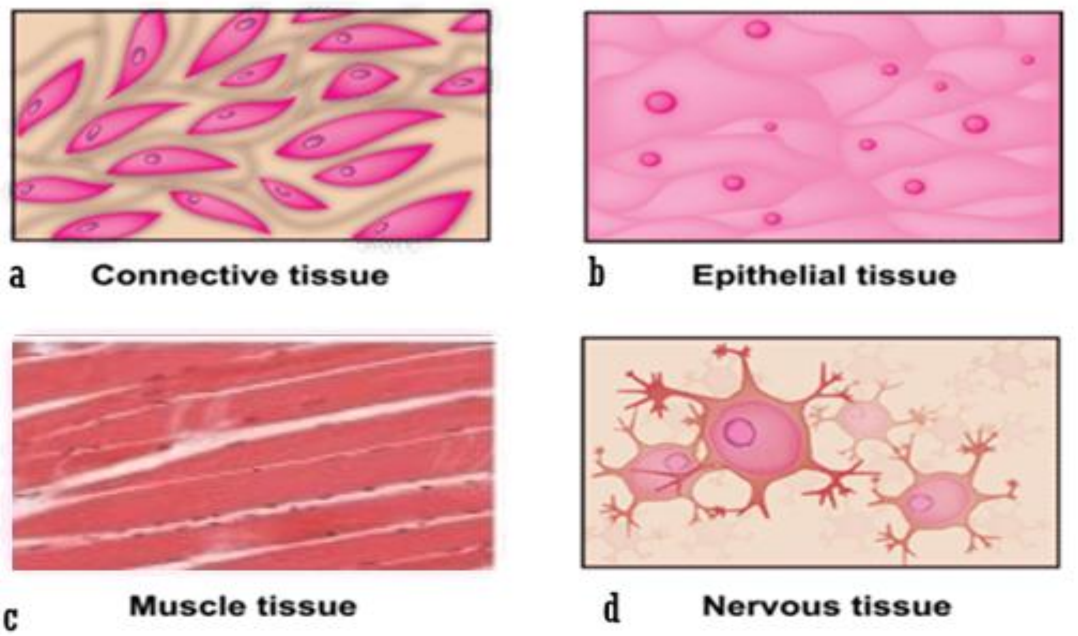


Figure 2.6: Four types of tissues [70].

2.8 Radiation Inter-Human Body

Uranium and Radon are alpha-emitters that enter the body through the digestive and respiratory systems through food, water, and or air [66,72]. These radioisotopes act chemically and physiologically like calcium [73]. Some of it is exhaled, while other portions remain in our lungs and pass through the blood towards the bone marrow, if these particles are taken orally and the food is subsequently absorbed into the bloodstream and sent to the body's organs, they will mostly target the kidney, bones, and liver. These particles are stored inside the human body and emit low-level radiation that is emitted for a very long period, stimulating the bone marrow cells [74].

2.9 Biological Effect of Radiation

There are two ways that radiation eventually impacts cells, despite the fact that all subsequent biological consequences can be linked to the interaction of radiation with atoms. These two paths although at differing intensities, the various forms of ionizing radiation cause equivalent harm to living cells. Radiation affects people by introducing energy into body tissues, which causes molecules to disintegrate and subsequently harm the internal human system and alter the chemical equilibrium of the cell. Multiple factors, including the dose received, the intensity, and the exposure time might cause cell damage [75].

2.9.1 Direct Effect

Radiation has a direct effect when it interacts with atoms in the DNA molecule or another biological component that is essential to the survival of the cell. Such a relationship might impact the cell's capacity for survival and reproduction. The cell may be killed by "direct" interference with its life-sustaining mechanism if enough atoms are impacted to prevent the proper replication of the chromosomes or if the information contained by the (DNA) molecule is significantly altered [76].

2.9.2 Indirect Effect

The probability of radiation interacting with the (DNA) molecule in a radiation-exposed cell is extremely low because these vital components make up such a small percentage of the cell. But much like the human body, each cell is primarily made of water. Because water makes up the majority of the cell's volume, there is a significantly larger likelihood that radiation will interact with it. Radiation interaction with water can result in the water molecule's bonds being broken, releasing fragments such as hydrogen (H) and hydroxyls (OH). These pieces may combine again or interact with different fragments or ions to create compounds like water that wouldn't damage the cell .They might still combine to create harmful molecules like hydrogen peroxide (H_2O_2), which might assist in cell death [76].

2.10 Radiation with Living Cells

Radiation damage to living things can affect their cells, tissues, organs, systems, or entire bodies. Radiation has three stages that affect living things: physical, chemical, and biological.

1- Physical Stage: Radiation energy has the power to drive electrons from their orbit. This period occurs for (10-18) seconds and is characterized by the ionization and excitation of molecules as the initiating reactions.

2- Chemical stage: It is impossible to forecast which electrons will be released during radiation exposure, unlike in conventional chemical reactions when electrons are exchanged. The ions produced in this fashion, also known as radicals, are chemically very unstable. Due to their extremely high degrees of chemical reactivity, they cause random chemical reactions, at this phase bimolecular problems manifest free radicals emerge. Proteins and nucleic acids are destroyed, and the consequences might persist for a few seconds to several hours.

3- Biological stage: Several molecules that make up the cell are damaged as a result of radiation and the battered electrons' chaotic movement inside the cell. Additionally, chromosomal (DNA) within the cell nucleus may sustain damage, which is when biological abnormalities manifest, cell death, organismal death, cancer development, and mutations are all potential outcomes [77–79].

Somatic (physical) and genetic effects form the two categories of biological effects of radiation, the emergence of somatic and genetic effects exhibit variable dose-effect relationships. Determining the effects of radiation on living things beings include radio sensitivity of the area that has been exposed to radiation, type of radiation exposure, radiation exposure amount, and radiation exposure time, as shown in figure(2.7) [77].

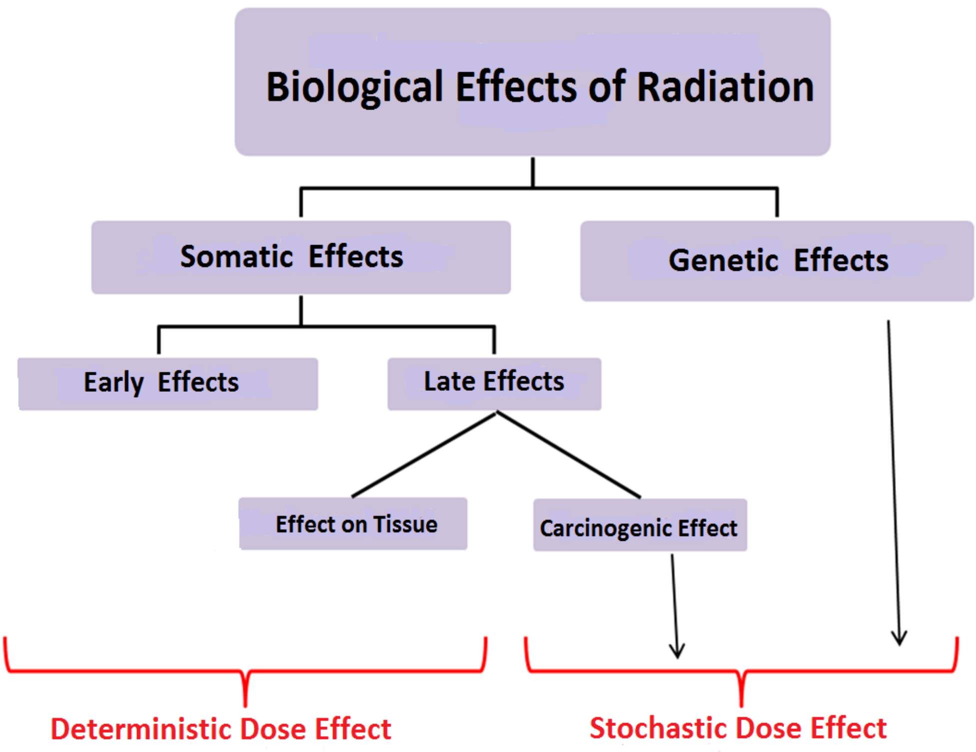


Figure 2.7: Radiation's biological effects [77].

Each cell in a living thing contains deoxyribonucleic acid (DNA). This significant molecule functions as your body's guidebook. It instructs the cells continuously on what to do and how to perform it. Like a twisted ladder, a DNA molecule is formed [79]. The phosphate and sugar molecules make up the long rails. The "backbone" of a (DNA) molecule is made up of them. Four nucleotide bases are combined to form each rung. These are thymine, adenine, guanine, and cytosine. A letter is used to identify each nucleotide. Adenine, guanine, cytosine, and thymine are all represented by the letters "A," "G," "C," and "T." Direct action can harm vital cellular systems as well. It may occasionally even cause cancer. [78,80]. Where figure (2.8) shows the change in the bases of human DNA before and after radiation, while figure (2.9) presents the direct and indirect effect of radiation on humans (DNA).

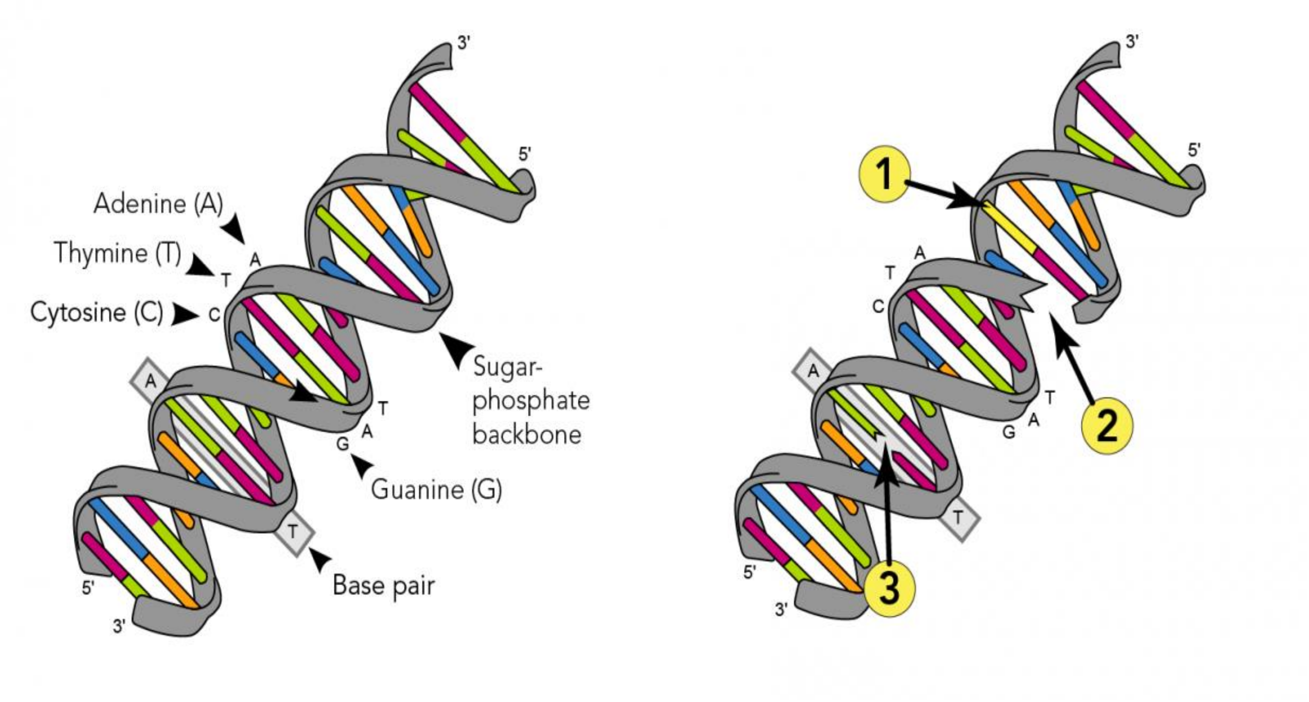


Figure 2.8: DNA before and after radiation effect [80].

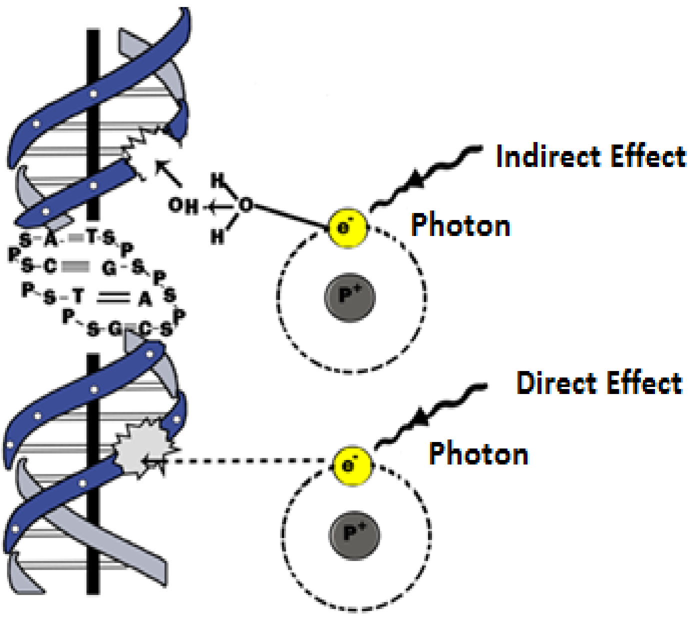


Figure 2.9: The process of both direct and indirect effects of radiation on DNA [77].

2.11 Radiation and Cancer

During military operations, the United States and the United Kingdom, armed forces (DU) employ the invasion and occupation of Iraq in 1991, and 2003 [11]. According to United Nations Environment Programme (UNEP), the overall volume of (DU) ammunition used only during the conflict in 2003 is still unknown, however speculative calculations from various studies range between 170 and 1,700 metric tons is a closer estimate of the number [81]. Before and during the military occupation of Iraq in 2003, populated areas and cities, such as Baghdad, Basra, Najaf, Amarah, Samawa, Tikrit, Karbala, Falluja, and Baquba, were exposed to greater radioactive contamination [12].

When nanoparticle aerosols of depleted uranium oxides are ingested or inhaled, they pass through the lung-blood barrier and enter the cells, where they generate free radicals. Up to six neighboring cells in the affected tissue or organ will be affected by this much energy. The nuclear (DNA) strand in a human cell can be severed with only 6–10 electron volts (*eV*) of energy [11]. The antioxidant molecules in the organ that are normally found in the presence of magnesium are also replaced by (DU), which damages the body's repair mechanisms. The consequences of this damage include an increase in tumors and chronic diseases. Free radicals can also interfere with the process of how proteins are produced and folded within cellular (DNA). Some diseases, such as many malignancies, are caused by proteins that have been misrouted [15].

As a result of epidemiological research finding a link between uranium and cancer, uranium may be carcinogenic [82,83]. Radon gas has been linked to cancer, either directly or indirectly, according to the World Health Organization (WHO) [1]. The relationship between lung cancer and high radon concentration is the only proven relationship, while recent research has proven a relationship between alpha emitters and leukemia cancer, especially among children. A limited number of studies show this relationship with other types of cancer [84–86].

Following the events of the two Gulf Wars, Several investigators have found radioactive contamination in the Iraqi environment throughout the country. Moreover, the annual registration rate of cancer illnesses by the Iraqi Cancer Board has dramatically grown between (1991 – 2003) [11]. Leukemia is the most prevalent type of cancer in children and it is ten times more prevalent than cancers in industrialized nations from that time the rate of cancer diseases had significantly increased in Iraq. In 2019, when the country's population was 39,127,889, there were 35,864 cancer cases and 10,957 deaths, with 1,291 of those deaths occurring in the province of Karbala, which had 1,283,484 residents [17].

2.12 Solid-State Nuclear Track Detectors or Etched-Track Detectors (SSNTDs).

The most popular nuclear track detectors for extended radon monitoring periods are the SSNTDs. Their operation is predicated on the idea that highly charged particles will ionize a variety of materials as they pass through an intermediate [87]. Nearly all molecules in its path are ionized by an alpha particle. This fundamental ionizing component sets off a sequence of new chemical reactions that produce free radical damage and other chemical species, which are then produced by the drilling process. A latent path is a term used to describe this damaged area [88]. Based on the materials, there seem to be two kinds of solid-state nuclear track detectors: a-Inorganic detectors, which are compounds due to carbon and hydrogen that are prohibited from the structure and form ionic bonds between their atoms. b- Organic compounds that contain carbon and hydrogen and have a "covalent link" between their atoms are known as organic detectors because the bonds between (C-C and C-H) are easily broken after radiation exposure, this type of SSNTDs has a larger sensitivity than inorganic detectors. Additionally, organic detectors have a higher analysis ability than inorganic detectors and also have lower threshold energy than inorganic detectors [89].

2.12.1 Nuclear Track Detector (CR-39)

Cartwright and Shirk discovered the CR-39 detector in 1978 at the University of California in the United States. The chemical formula for (CR-39) is ($C_{12}H_{18}O_7$) as in figure (2.10), and it is one of the organic detectors created by polymerizing the liquid monomer. It is denoted by the (CR) from a (Columbia Resin) [90]. The density of (CR-39) is 1.3 ($gm.cm^{-3}$) and it is insoluble in chemical solutions [91]. Because of its great sensitivity, it has been used to measure radon, nuclear fission, high-energy nuclear fragmentation, fusion plasmas, and cosmic-ray [92].

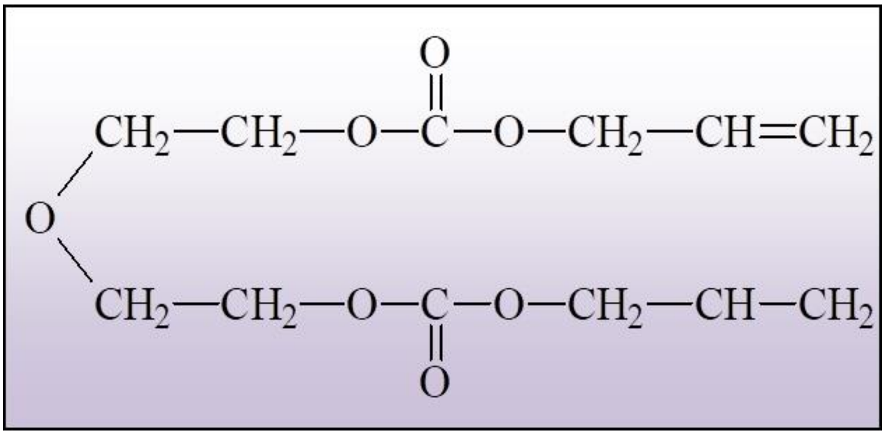


Figure 2.10: Chemical form of (CR-39) detector [91].

To measure Radon concentrations, a CR-39 detector with a thickness of 1 mm and 2.5×2.5 cm^2 (from Track Analysis Systems Ltd., UK) was used in this study under normal laboratory condition storage as shown in figure (2.11).

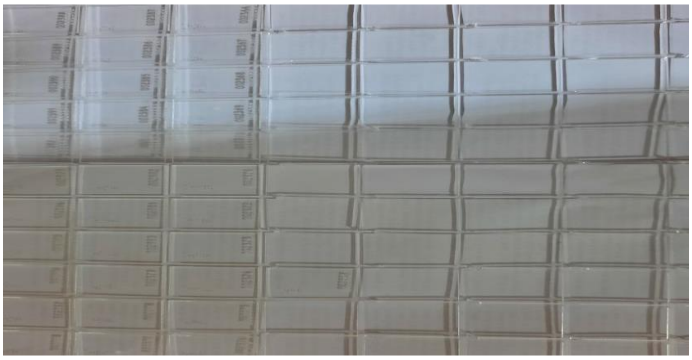


Figure 2.11: (CR-39) detector

2.12.2 TASL*Image*™ Systems

It is a system for measuring etch tracks in Solid State Nuclear Track Detectors (SSNTDs) like the (CR-39) and others (SSNTDs). Based on an in-depth knowledge of the geometry of etching tracks in nuclear track detectors, the system employs powerful track recognition software. The energy of certain nuclear particles can be estimated through measurements made on each individual recorded track. This allows us to collect spectral data on groups of tracks, which is beneficial to applications such as radon detectors [93].

In general, TASL*Image*™ has a variety of characteristics that can be summed up as follows [94]:

- Fully automated, high-performance image analysis system with unmatched precision and reliability.
- Nikon optics have an objective of x10 or x20. extremely reliable, long-lasting LED light source.
- Camera format with typical image magnification of 0.5 x 0.5 µm per pixel, which are the most recent high specification cameras.
- effective autofocus, with live plastic surface tracking
- Incredibly fast scanning, often 100 mm^2 s^{-1} on exposed plastics.

2.13 Toxic Pollution

Another vital serious environmental problem around the world has suffered since the expansion of industry and technology is environmental pollution with toxic components [95]. To be considered a heavy metal (HM), an element must have an atomic number larger than 20, have an atomic density greater than (5 g/cm^3), and display metal-like characteristics. If its concentrations are extremely low, it is reasonable to classify it as a trace element The term "micronutrients" refers to those essential elements that are frequently needed in trace levels at a level of (10-15 *ppm*) [96]. The metabolic activities carried out by plants do not even remotely depend on non-essential heavy metals such as As, Pb and Cd [96]. However; some of them are essential for preserving the integrity of a variety of physiological and metabolic processes that occur within living tissues [95]. The classification of these substances and their transformation into pollutants detrimental to the environment and the human race are determined by changes in the concentrations of these substances in the body. The subcategories

A- WHO Classification, Nineteen trace elements have been categorized into three groups, as follows:

1 - Essential components

2 - Probably fundamental components.

3 - Substances that could be hazardous.

B- Frieden's Classification of Elements, based on the abundance of trace elements in tissues, Frieden established a biological description of these elements [97].

1 - The essential trace elements are required zinc, boron, cobalt, copper, iodine, iron, Manganese, and molybdenum.

2 - Chromium, Fluorine, Nickel, Selenium, and Vanadium are likely necessary trace elements.

3 - Trace elements that are physically promoting: bromine, lithium, silicon, tin, and titanium.

2.14 Effects of Trace Elements on the Human Body

The effect of heavy elements depends on several factors, the most important of which are the amount of the dose, its concentration, the level of exposure to toxicity, and the effect of the element on the vital functions of the human being. For instance, Lead has a biological life of about 20 to 30 years in the bones but just a few weeks in the blood [98]. This impact could be summarized in three basic processes:

A- Inhibition of Enzymatic Activity

Many heavy elements, including Lead, can bind to sulfur, attacking sulfur bonds in living organisms, inhibiting enzymatic activity, attacking the bonds of amino and carboxy acids, and causing the formation of numerous free radicals, which are known to play a part in the development of cancerous cells [75].

B- Preventing The Metabolism of Ketone

Some heavy elements damage or replace some fundamental elements, such as Lead, which enters the metabolism of zinc and copper and substitutes calcium in the body, leading to an imbalance in the body's ability to absorb and store vital elements [21].

C- Attacking Cell Receptors

The cell membrane and receptors are affected by heavy elements, which alter the cell's structure and prevent the entry of useful elements, raising the blood's acidity because the blood gets its Calcium from the bones. A change in the body's concentrations of essential substances results in an imbalance in the way that its organs function [95,98].

2.15 Trace Elements and Cancer

Due to the fact that toxic substances might enter the body either by inhaling dust particles containing them or by consuming contaminated food and water [99]. Particularly because of the extreme pollution that has affected Iraq and the rest of the world, including water [99], air [99], soil [100], and food [101]. Toxic substances in the body of a person move through the bloodstream into different organs, where they cause several health issues for those who are exposed to them [83]. On the other hand, trace elements and their concentrations in the human body play important roles due to their relationship to the speed of (DNA) formation and the formation of enzymes and immune indicators, however, the effect of these elements may include changing the structure of cell organisms and the permeability of their membranes, which affects the absorption of the main elements to maintain life normally and cause diseases such as cancer [23,102]. The group of trace elements that have been examined:

2.15.1 Essential trace elements (Nickel, Zinc and Manganese)

Toxic substances in the human body travel through the bloodstream. The essential trace elements such as Nickel (Ni), Zinc (Zn), and Manganese (Mn) make up only 5% of the average human diet, however; they are essential for human metabolism as they are involved in each and every metabolic activity and live cell function. They are also extremely relevant to human medicine, including diagnosis and treatment, as well as biochemical and metabolic interactions [103,104].

A- Nickel (Ni)

It is present in the highest concentrations in Ribonucleic acid, particularly (RNA), and is recognized to be essential for the structure and operation of proteins. The production of human breast milk may be affected by Nickel because It might aid in prolactin production, (Ni) is a small yet necessary component of the human body [104]. (Ni), in turn, facilitates the ability for iron (Fe) to be absorbed and may be crucial for the growth of red blood cells [103]. The normal amount of Nickel in the blood of a healthy and non-smoking person (0.01-0.26$\mu g/L$) [105].

B- Zinc (Zn)

Zinc is essential to all living things and is a fundamental substance for sustaining life. It is present in many proteins, including ribosomal proteins, transcription factors, and enzymes [106] However, acute Zinc poisoning and high Zinc intake from contaminated drinks and foods relate to vague gastrointestinal symptoms. High zinc intakes relate to long-term disruptions in the metabolism of other trace elements [104]. The normal human body contains (2–4 *g*) of Zinc [107].

C- Manganese (Mn)

Iron and steel contain Manganese, a common element that constructs the Earth's crust, dry cell batteries, and the manufacture of glass and ceramics [108]. Decreased skeletal development, impaired glucose tolerance, impaired growth, altered carbohydrate, and abnormalities in lipid metabolism are signs of insufficiency. (Mn) insufficiency is rare, despite this. The toxicity resulting from excessive intake of (Mn) is more worrying, Leading to pulmonary inflammation and reduced lung function [103]. Normal whole blood (Mn(level range between (7 to 12$\mu g/L$) [109].

2.15.2 Non-Essential trace elements (Lead, Cadmium, Arsine).

Lead (Pb), Cadmium (Cd), Arsenic (As). These substances are listed by the organization Agency for Toxic Substances and Disease Registry (ATSDR) as being among the top 5 most dangerous substances on earth and thus are everywhere within the human race.

A- Lead (Pb)

The oldest element in the environment, Lead, is present almost everywhere and is frequently found in combination with other elements in nature [60]. (Pb) has a wide range of applications, including the production of pigments, storage batteries, radiation shielding, and water pipelines although it doesn't dissolve in water. It can replace calcium and Zinc in the body's biological processes and has a significant impact on human health [99,110].

B- Cadmium (Cd)

In nature, Cadmium finds in groups of organic and inorganic chemicals, amino acids, and other elements. It doesn't belong in living systems since it poses serious health risks to the body when its percentage rises and where it enters the food chain [111]. Its concentration was modest before the industrial revolution, but it has significantly increased in the present, especially given that it is a byproduct of the burning of fuel, phosphate fertilizers, and pesticides [101] and is utilized in plating alloying, pigments, plastics, batteries, and other products [99].

C- Arsenic (As)

Arsenic may be present in groundwater, dust, soil, or food. Moreover, Arsine causes hemolysis in people, which results in elevated plasma levels of potassium, iron, and hemoglobin as well as anemia and renal damage because it affects a sulfhydryl group of cells and interferes with mitosis, respiration, and cell enzymes, the arsenic is completed toxin. Arsine is commonly used in the semiconductor industry to produce light-emitting diodes and as a doping agent for silicon-based solid-state electronic device services [112,113].

2.16 Detection of Trace Elements (Inductively Coupled Plasma Mass Spectrometry).

It is an analysis method used to measure trace levels of components in biological fluids (multicomponent analysis) [34]. A significant level of accuracy, sensitivity, and higher analysis mass resolution capacity allows for the major elimination of spectral interferences [114,115]. In the past three decades, Inductively Coupled Plasma Mass Spectrometry (ICP-MS) has emerged as the most popular instrument for determining trace electrical components [116]. The (ICP-MS) apparatus creates the ionization state for elements using inert argon gas as a plasma source. A mass spectrometer (MS) and quadrupole mass filter are employed in parallel to separate the generated ions for detection and research. Most elements in the periodic table have analytical concentrations .(ICP-MS) is used for quantitative, semi-quantitative, qualitative, and isotope ratio analysis. Additionally, it can establish the isotopic ratios in liquid [116]. A peristaltic pump with a nebulizer system was used to introduce the sample, which is subsequently transformed into an aerosol before entering the plasma. Without thoroughly calibrating the standard sequence, the semi-quantitative analysis provides a quick assessment of whether certain elements are present in the sample matrices or not. Additionally, quickly scanning and comparing with at least one standard gives us useful information about the composition and elemental concentration. The semi-quantitative analysis also includes the interferences that can be expected in the newly introduced unknown sample [116]. Figure (2.12) shows the schematic diagram of an (ICP-MS) system.

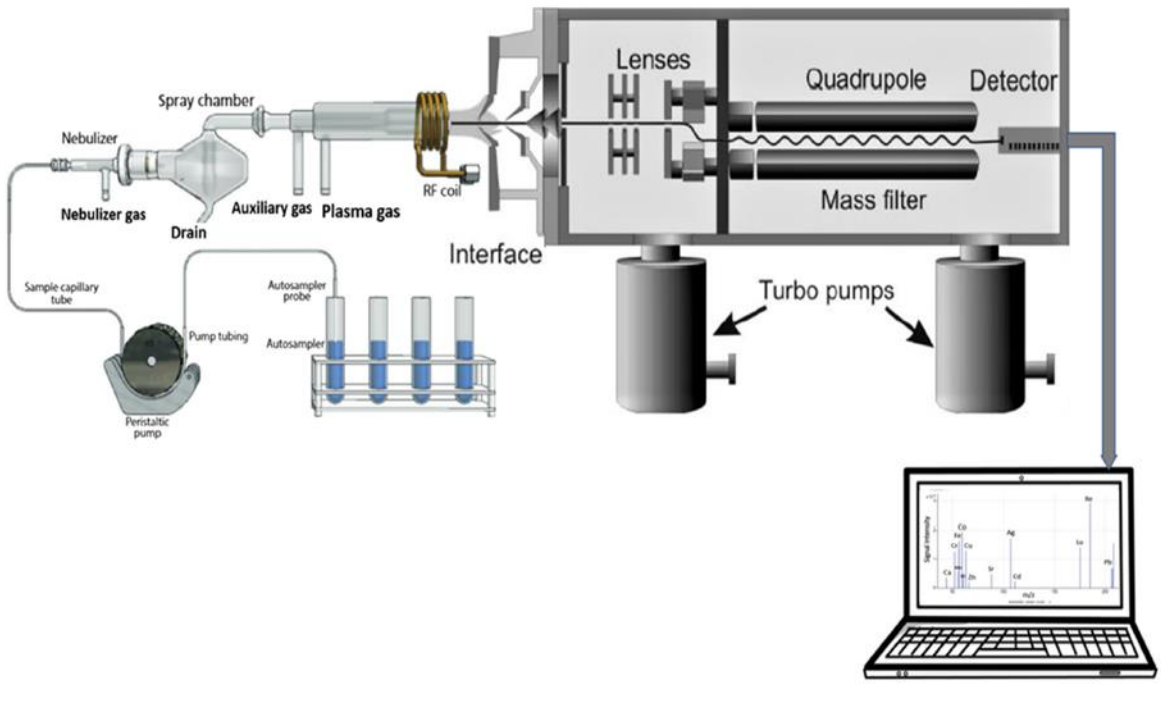


Figure 2.12: A schematic diagram of an ICP-MS system [117].

The spectrometer receives a liquid sample, which is then converted into an aerosol and delivered into an inductively coupled argon plasma. When aerosol dries, the dissolved and colloidal evaporates, molecules scatter in the sample, turn into atoms, and it's ionized inside the high-temperature plasma (10,000 kelvin). A mass separation device that distinguishes the generated ions based on their mass-to-charge ratio (m/z), is then used to separate them from one another [118]. Principal benefits applications also advantage from the following characteristics: extensive dynamic range, use of collision cell technology to effectively eliminate polyatomic spectral interferences, quick analyzing semi-quantitative data, isotopic evaluation and capability for specificity [119].

2.17 Raman Effect

Chandrasekhara Venkata Raman (C.V. Raman) accepted the Nobel Prize in Physics on December 10 (1930) in recognition of his work "... on the scattering of light and for the discovery of the effect named after him." [29]. For the first time, the applications of Raman spectra were in several issues in physical, inorganic, and organic chemistry, as well as problems with crystal structure and molecular structure [120]. At this time, Raman spectroscopy has become a modern measurement method used to examine biological materials, including human tissues. It is used in medicine as a diagnostic method and offers information about its molecular structure. For tissue examination changes introduced by pathology and disease processes, Raman spectroscopy may utilize. This method is believed to be non-invasive and applies to in vivo measurements [121,122].

2-17-1 Principle of Raman effect

Raman effect, which explains the excitation of photons(laser) to virtual energy levels and the consequent decrease (Stokes) or gain (anti-Stokes) of energy, takes place as a result of light's interaction with vibrational modes linked to chemical bonds inside the object. This change in energy indicates different modes of vibration of polarizable molecules, enabling the qualitative evaluation of the biological characteristics [123,124]. Stokes Raman scattering is more intense than anti-Stokes scattering because there is a higher likelihood that a molecule will be in the ground vibrational state. Raman scattering discrepancy to Rayleigh scattering is a rare phenomenon with an extremely low probability of occurring (1 in 108); for this reason, A non-sensitive method seems to be a common description of it [124]. A molecule's ability to create a dipole moment (or an extra dipole moment) in response to an external electric field of strength. *E* refers to its polarizability [109]. Where figure (2.13) showed the scattering of the laser beam from the surface. Fluorescence, Rayleigh scattering, and Raman scattering all occur depending on the photon's energy level [125]. As indicated in figure (2.14).

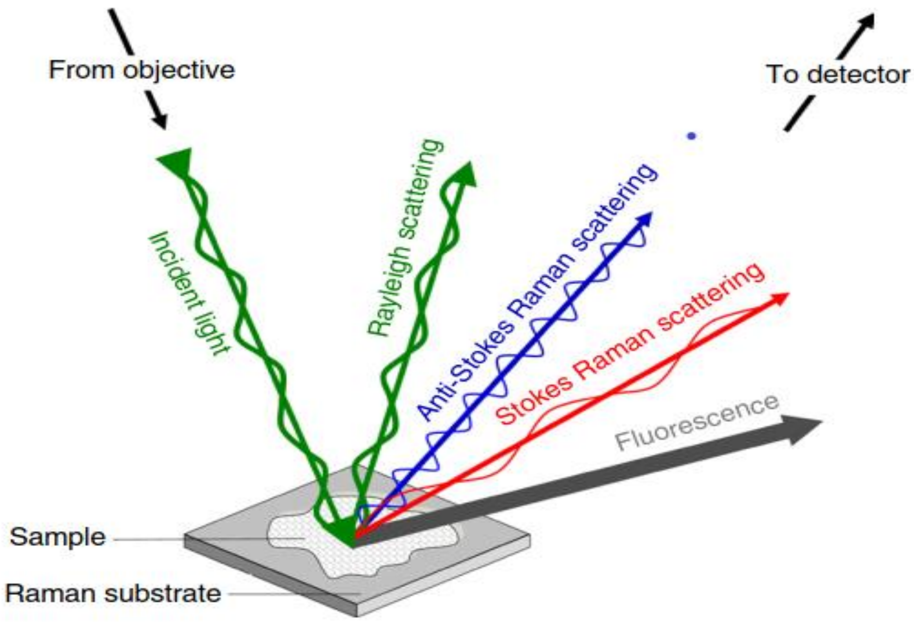


Figure 2.13: Light scattering by laser irradiation on a test surface [124].

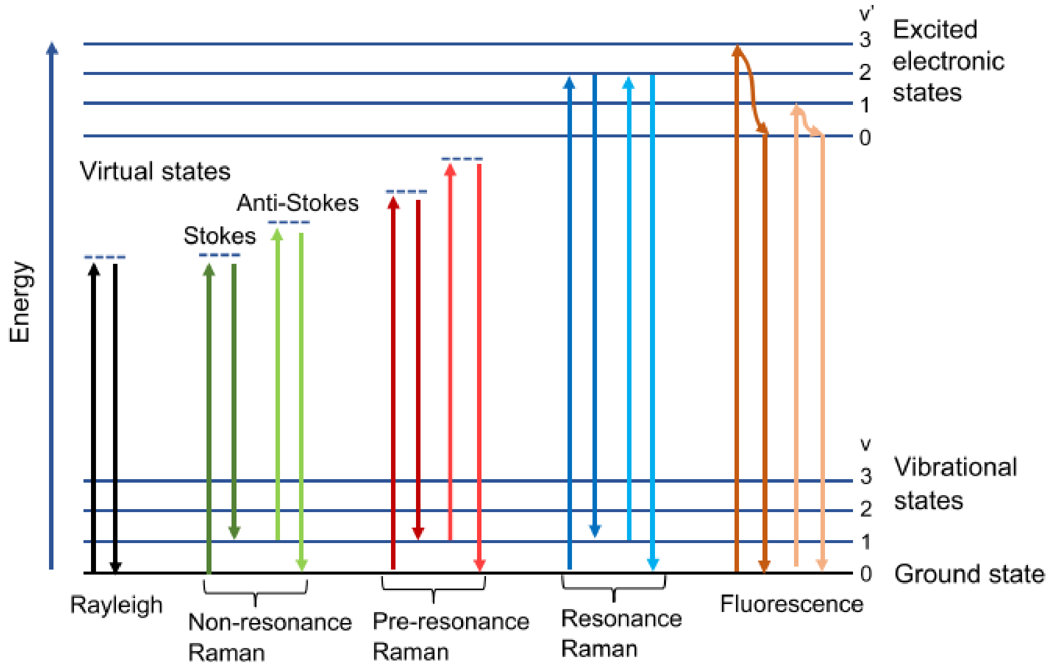


Figure 2.14: Energy level of Fluorescence, Rayleigh scattering, and Raman scattering [125].

The transition between the initial ($h\nu_i$) and the final excited state($h\nu_f$) of a molecule's vibrational state is indicated by the difference in energy between the incident photon ($h\nu_0$) and the scattered photon ($h\nu_S$), according to the law of conservation of energy:

$$h\nu_0 - h\nu_s = h\nu_f - h\nu_i \qquad \text{.......(2-1)}$$

where (ν) is the frequency of the electromagnetic wave and (h) is Planck's constant.

As a result, the molecule's modification of vibrational state could be expressed as follows:

$$\Delta E_{f-i} = h(\nu_0\_\nu_s) \qquad \text{......(2-2)}$$

If we replace the definition of frequency in (2-2) with the number of waves that make up the distance that light travels in one second, where (c) is light's speed and is its wavelength, we discover that:

$$\Delta E_{f-i} = h\,(\frac{c}{\lambda_0} - \frac{c}{\lambda_s})$$ ……(2-3)

Because (c) and (h) are constants, the variation in the energy difference can be represented in terms of the wavenumber, which is the reciprocal of the wavelength and has the dimension cm^{-1}. The standard unit for both Raman and infrared spectroscopy is this one. The interaction between the electromagnetic radiation and the sample can consider as a disturbance of the molecule's electric field to investigate Raman scattering in classical terms. According to equation (2-4), the dipole moment, (P), produced in a molecule by an external electric field, (E), is proportional to this field.

$$p = \alpha E$$ …….(2-4)

(α) the polarizability of the molecule serves as the proportionality constant [126].

the incident light's electric field by

$$E = E_0\, COS(2\pi/v_0)$$ ……(2-5)

where (v_0) is the oscillation frequency and (E_0) is the field strength. The constituent atoms in a molecule are constrained to particular vibrational modes for every molecular connection. As a result of a specific vibrational mode, atoms' displacement from their equilibrium position, (Q) can be described as:

$$Q = Q_0\, COS(2\pi/v_v)$$ ……(2-6)

where (Q_0) denotes the vibration's amplitude and v_v its frequency. A Taylor series expansion in normal coordinates can be used to approximate polarizability for modest displacements (like those of a typical diatomic molecule):

$$\alpha = \alpha_0 + \left(\frac{\partial \alpha}{\partial Q}\right)_0 Q_0$$ …… (2-7)

There are static and sinusoidal oscillation terms in the polarizability. Raman scattering requires a change in polarizability due to vibration.$\left(\frac{\partial\alpha}{\partial Q}\right)$≠0 the subscript zero in this instance denotes that the parameters α ,$\left(\frac{\partial\alpha}{\partial Q}\right)$ 0 and induced dipole moment can be expressed at a small field:

$$\mu_{ind} = \alpha E \quad ....(2\text{-}8)$$

the equilibrium position of the atoms. Substituting (2-5), (2-6), (2-7) and (2-8) yields:

$$\mu_{ind} = E_0 cos\left(\frac{2\pi}{v_0}\right) + \left(\frac{\partial\alpha}{\partial Q}\right)_0 \frac{E0Q0}{2}(cos2\pi v_0 + v(v)t) + cos(2\pi(v_0 v_v)t \quad ....(2\text{-}9)$$

At the frequency of oscillation is emitted by an oscillating induced dipole mome nt, an oscillating dipole that emits radiation at the same frequency, v_0, as the incident light is represented by the equation's first term (Rayleigh scattering). Raman scattering is shown in the equation's second term. An induced dipole moment that oscillates and emits radiation at frequencies is created by the oscillating polarizability, which is different from the incident light ($v_0 \pm v_v$) the traditional image misses the mark in many Raman scattering features. experimentally observable phenomena, such as the intensities of scattered light. Quantum mechanical analysis can offer a more thorough description using quantized energy levels and the molecule's wave properties [120,124,126,127].

2-17-2 Raman and Cancer Detection

Early (1970s) studies on the structure of hemoglobin marked the beginning of the use of Raman spectroscopy for blood-related investigations. Additional usages emerged in tandem with advancements and developments in Raman spectroscopy equipment and methods [29]. As (RS) technology and techniques advanced, new applications began to emerge. These included the examination of whole blood, dry or liquid, or different blood components, as well as the analysis of various malignant and non-cancerous tissues [111–114]. In particular, the highly colored hemoglobin makes for fascinating spectroscopic investigations of human tissue. Instead of the acute energy levels observed in free atoms and molecules, rather broad energy bands are present when atoms and molecules combine to produce solid or liquid objects. This is caused by the significant perturbations that the constituent components' interactions have on one another. Broad absorption and emission bands match broad energy bands. Since a high spectroscopic resolution is not required to examine human tissue, equipment opportunities are provided as a result. the drawback, the broad structures overlap frequently, which creates it difficult to identify individual components in a complex material like human tissue [132].

As a result of Raman spectroscopy's success in biology, numerous organizations have come to understand its potential in the analysis and diagnosis of disease. Early attempts to measure the Raman spectra of tissues and cells, however, were hampered by two factors: (1) the high fluorescence of these samples;(2) the limitations of the instruments, which required long integrated times and high power densities to achieve spectra with good signal-to-noise (S/N) ratios [123].

Raman spectroscopy offers profiles of the intensity of scattered light as a function of frequency. The frequency of vibration calculates as the difference in frequency between the incident and dispersed light. Raman bands are unique to the vibrational modes of particular bond types in the molecule and appear at a vibrational frequency [125]. Currently, blood and tissues examine using vibrational spectroscopy to detect cancer. These samples offer important biomolecule data, such as proteins, lipids, sugars, and nuclei. Blood and tissue examination uses vibrational spectroscopy to detect cancer, and nuclide acids, which are applied to distinguish samples using spectrochemical patterns. Raman is a water-free, nearly destructive technique for vibrational spectroscopy that can record the spectrochemical signatures of samples with little to no sample preparation [133,134].

2.17.3 Raman Spectroscopy (RS)

Raman spectroscopy is an optical technique that depends on a photon's interaction with a vibrating molecule to cause inelastic light scattering. The energy needed to trigger a molecule's particular vibration is related to the difference in energy between the incident photon and the elastically scattered photon. (RS) has a high capacity for providing accurate, quantitative, and chemically-specific data for cancer diagnostics regarding critical biological elements in the cellular and tissue surroundings [135]. The most important benefit of Raman spectroscopy for analyzing biological samples is the low water interference. No matter the specimen's size or shape, this technique provides scattering light. These advantages promote the viability of biological material analysis both in vitro and in vivo [136]. Figure (2.15) revealed the essential parts of a Raman spectroscopy.

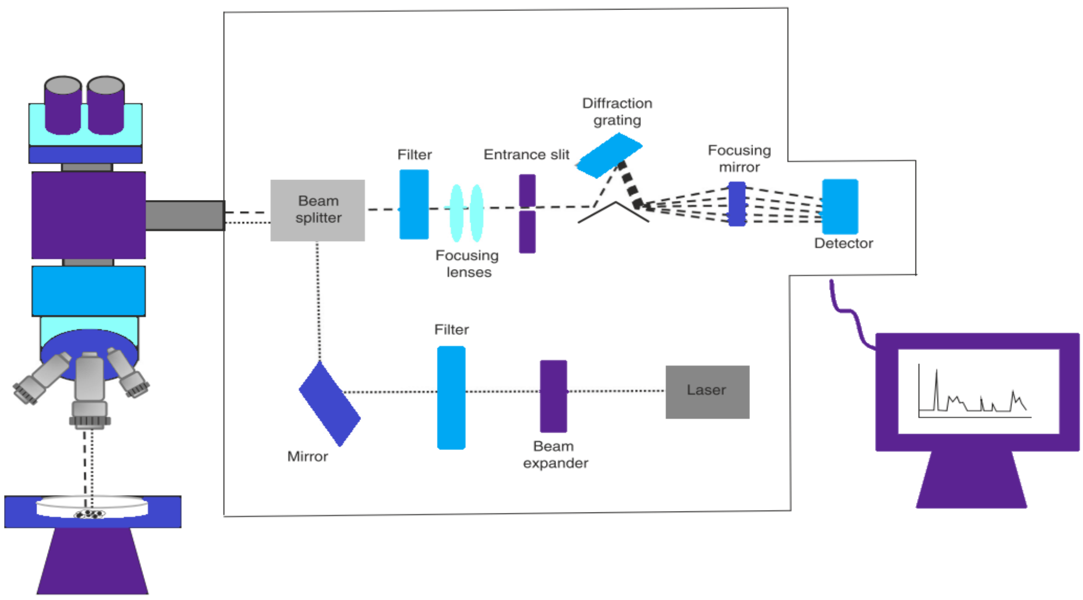


Figure 2.15: Shows the important components of a normal spontaneous Raman spectroscopy system [137].

Through the use of a beam expander, laser light is directed onto a set of mirrors, where it is focused onto the sample through an objective microscope lens. In a 180° backscatter sampling geometry, the scattered light is gathered using the same objective lens. Edge filters are employed to minimize Rayleigh scattered light, after which Raman scattered light is focused via an entry slit and scattered onto the detector by a diffraction grating. Usually, manufacturers will have a few variations on this basic setup [137].

2.17.4 Laser in Raman spectroscopy

For Raman spectroscopy, lasers with wavelengths ranging from ultraviolet through near-infrared to visible can be employed. Typical illustrations consist of, but are not limited to:

Near-infrared: 785, 830, 980, and 1064 nanometers

Visible: 458, 473, 515, 532, 594, 633, and 660 nanometers

Ultraviolet: 244, 266, 320, 355 and 405 nanometers

The three most popular excitation options are 532 *nm*, 785 *nm*, and 1064 *nm*. However, there are many other excitation alternatives to maximize the measurement of various samples by their choice of Raman excitation laser wavelength. typical Raman spectroscopy laser wavelengths [138].

The 785 *nm* excitation system is the most widely used because it provides the best overall balance of signal intensity, sensitivity to fluorescence, affordability, and performance and can be used to rapidly record. The excitation efficiency is the most noticeable change, where is the laser wavelength, and the Raman scattering effectiveness is proportional to (λ^{-4}). Another issue is the sensitivity of the detector. Raman signals from 785 *nm* systems occur within the (NIR) range (750-1050 *nm*), where the response is still generally good for most silicon-based A charge-coupled device (CCD) detectors. Fluorescence is a crucial feature that also happens and obstructs the measurement of the Raman spectrum. It is produced using a method very similar to Raman scattering but is based on the photoluminescence mechanism. The fluorescence is anchored to a particular frequency or wavelength, which prevents it from shifting with the excitation laser while the Raman peaks retain a consistent distance from the excitation frequency [138]. (NIR) lasers can frequently be helped with fluorescence suppression. A photon must first be absorbed in the two-photon process of fluorescence before a fluorescent photon may be released. However, the Raman process just uses one photon and does not require absorption. While a lot of materials absorb in the visible range, not as many do so in the NIR range.

As a result,(NIR)lasers frequently do not cause fluorescence (because there is no absorption). When samples glow strongly under visible stimulation, (NIR) Raman can offer a solution and still enable the acquisition of a high-quality Raman spectrum. Diode lasers are a type of laser that produces laser light by passing it through a semiconductor. It provides wavelengths in the (810–1064 *nm*) range. Solid-state devices called diode lasers are small and portable. Depending on the wavelength and tissue biotype, they can reach depths of 2 to 3 mm or more in soft tissue and are only utilized for soft tissue treatments [136,138].

2.18 Literature Review

This part will present a presentation of previous studies of the use of Raman spectroscopy in the diagnosis of cancer, and then a presentation of the experiments of measurements of alpha particles Radon and Uranium, and trace elements in human biological samples.

2.18.1 Usages of Raman Spectroscopy in the Diagnosis of Cancer

Y. Zhou et al. (2012) analyzed six different types of human brain tissue in vitro with the Raman spectral excitation at (532 *nm*). The enhanced peak at (amide II) is observed in all of the tissue specimens of meningeal tissue when they are compared to spectra that were taken from normal and benign tissues. The fatty acids (lipids) are less pronounced in the spectra taken from meningeal cancer tumors [139].

C.H. Liu et al. (2013) studied the normal benign and malignant breast samples from 15 patients and were used to collect the (RS) spectra. The main peaks in the spectra were indicative of the vibrations of proteins and lipids when the 785 nm excitation occurred. Both the peak positions and the intensity ratios of the typical Raman peaks in the spectral region of (700–1800 cm^{-1}) showed differences between the normal and malignant breast tissues. The resonance Raman (RR) spectra with (532 *nm*) excitation showed a strong pattern of peaks in the range of (500-4000 cm^{-1}). Four unique peaks at, (1521, 2854, and 3013 cm^{-1}) that were observed in the spectra of normal breast tissue were discovered to have greater intensities than those seen in the spectra of malignant breast tissue. It was demonstrated that the analysis of the Raman spectral data produced a high performance in the classification of cancerous and benign lesions from normal breast tissue by the twelve dramatically enhanced characteristic peaks, including the enhanced amide II peak at 1548 cm^{-1}, in the spectra collected from cancerous breast tissue [119].

M. Velicka et al. (2017) revealed a unique method for identifying areas of malignant kidney tissue by analyzing the surface-enhanced Raman scattering spectra of extracellular fluid extracted from kidney tissue with a wavelength of (1064 *nm*). The most significant spectral differences in spectral markers were discovered in the wavenumber range between (400 and 1800 cm^{-1}), where spectral bands associated with various vibrations of carbohydrates, amino acids, and nucleic acids are located [141].

R. Sekine et al. (2018) discovered with Raman Spectroscopy both the diagnosis and classification of colorectal cancer during peak position changs (lipids, collagen, and amides) between normal and cancerous tissue bands and between early-stage cancer and advanced cancer with great accuracy. A tissue's in vivo performance was evaluated [142].

J. Desroches et al. (2019) applied a novel Raman spectroscopy technique in vivo that targeted brain cancer tissue biopsy. The results identified notable peaks of CH_2 symmetric and asymmetric stretches of proteins and lipids (2845–2885 cm^{-1}), symmetric CH_3 stretches predominantly caused by proteins (2930 cm^{-1}), and the OH stretching from water molecules (at 3450 cm^{-1}). The hand-held contact p robe's sapphire tip lens, which has a peak of 3240 cm^{-1}, is responsible and showed 80% and 90% sensitivity and specificity, respectively [143].

H.F. Nargis et al. (2019) compared blood plasma samples between healthy and stages 2, 3, and 4 of breast cancer using Raman vertical line spectra. 689 (nucleotide conformation), 770 (phosphate), 788 (phosphodiester bands in DNA), 828 (tyrosine/protein), 848 (single bond stretching vibrations for the amino acids and valine and polysaccharides), 885 (disaccharide (cellobiose), (C-O-C) skeletal mode), 1138 (n(C-C)-lipids, fatty acids), In contrast, the mean Raman spectra of control/healthy volunteers exhibit higher intensities than the patient samples at 700 (n (C-S) trans (amino acid methionine)), 761 (Tryptophan, d (ring)), 798 (CH out of plane deformation), and 1410 cm^{-1} (ns COO2) [144].

D. Cullen et al. (2020) approached a new method based on Raman spectroscopy. The blood samples were taken from individuals who underwent irradiation for prostate cancer and had either experienced significant late radiation damage or had little to no late radiation toxicity. Along with the chromosomal radio sensitivity assay and the (DNA) damage assay, the radiation response to in vitro radiation was evaluated using Raman spectroscopy. By determining whether patients are in danger of radiation poisoning, this technology might in the future provide personalized patient treatment [145].

Qi Zhan et al. (2020) demonstrated that RS has a sensitivity and specificity of 0.91 and 0.85 in detecting oral cancer in vivo, respectively. In the frozen tissue subgroup in vitro, the oral cancer group showed higher diagnostic accuracy with a 0.9968 compared with the tissue group from a healthy mouth. The study also comes to the conclusion that the (RS) offers the benefits of being noninvasive and capable of real-time and on-site outcomes [146].

K. Hanna (2021) examined the use of Raman spectroscopy in breast cancer, including a discussion of its ability to analyze in vivo samples as well as ex vivo tissue and liquid biopsy samples by changes to peak positions in cancer samples compared to normal samples. This method also has the potential to be utilized in easily accessible areas, like the breast, as an additional screening tool to identify, prioritize, and streamline the most at-risk patients for further testing, even though it is not a replacement for conventional diagnosis [137].

P. Giamougiannis et al. (2021) examined the effectiveness of these three biofluids (ascitic fluid, blood plasma, and serum) for ovarian cancer detection using Raman micro spectroscopy. In comparison to 60–73% with plasma or serum, ascitic fluid had the highest results, with sensitivities and specificities above 80%. There is evidence that ascitic fluid contains a lot of collagen since the signaling bands at (1004 cm^{-1}) for phenylalanine, (1334 cm^{-1}) for CH_3CH_2 wagging vibration, (1448 cm^{-1}) for CH_2 deformation, and (1657 cm^{-1}) for amide I showed a lot of statistical significance for class distinction ($P> 0.001$) [133].

M. Kanmalar et al. (2022) referred to molecular identification as a substitute or a supplementary tactic for the early detection of bladder cancer tissues that might be chemoresistant to chemotherapy. Furthermore, the study revealed that the lipid content, protein genes, and cholesterol metabolites in bladder cancer tissues with chemo sensitivity are typically higher. These are to be connected to chemotherapy treatment resistance in bladder cancer with (RS) [147].

2.18.2 Measurements of Radon and Uranium in Human Samples

S. Al-jobori (2013) used the (CR-39) detectors to determine uranium in some cancerous and non-cancerous human biological samples. Results showed that the uranium concentration in biological cancer patients was higher than the international standard. Leukemia patients were shown to be more susceptible to uranium concentrations needed to cause the disease (66–202 *ppb*), whereas cancer in organs and tissues required values of (116–1910 *ppb*) [148].

A. Al-Hamzawi et al. (2014) with a (CR-39) track detector found that the highest concentration of uranium in blood samples of leukemia patients was (4.71 *ppb*) for (female, 45 years old, from Basrah) while the minimum concentration was (1.91 *ppb*) for (male, 3 years old, from Muthanna) [86].

A. Al-Hamzawi et al. (2015) used the (CR-39) detector to analyze the amounts of uranium in cancerous samples of human cancerous tissues (kidney, breast, stomach, and uterus). The study demonstrated that uranium concentrations in healthy tissues were noticeably lower than those in cancerous tissues ($P < 0.001$) [149].

B.A.Almayahi A.B, et al. (2016) applied the (CR-39) detector to assess the presence of alpha particles in human tissue. The tissue uterus was discovered to have the highest rate of alpha particle emission (0.198 $mBq\ cm^{-2}$), while the pelvic muscle had the lowest rate (0.122 $mBq\ cm^{-2}$). Overall, it was found that the alpha particle emission rates are low. This indicates that the samples were not contaminated by alpha particles found in the human tissue under investigation [150].

B.A. Hassan et al. (2019) employed a solid-state nuclear track detector (LR-115) to diagnose cancer, and samples from patients released alpha particles. Radon, radium, and uranium concentrations were measured at mean values of (64.325.92 Bq/m^3), (3.11.24 *Bq/kg*), and (1.40.58 *ppm*). The findings also revealed that the patient group's Alpha emitter levels were substantially more significant than the controls ($P < 0.05$), according to the data [151].

F. A. Showard, et al. (2019) declared that the blood sample for the leukemia patient taken in the city's center had the highest amounts with (CR-39) detector, which were (13.98 ± 0.94 Bq/m^3), according to the findings. The lowest concentration, (5.24 ± 0.94 0.54 Bq/m^3), was found at Al-Mudhatia, while the average value was (7.79± 0.51 Bq/m^3). The concentration of alpha particles released by radon, on the other hand, was higher in male blood samples than in female blood samples [85].

C.Peng et al. (2020) provided information on the molecular mechanisms of radon exposure that may affect the genesis of breast cancer. By applying transcriptase-wide gene expression data from breast tumors and nearby normal tissues, one may comprehend the molecular mechanisms that connect radon exposure with the biology of breast cancer [84].

F. A. Showard, et al. (2020) compared the uranium concentration by (CR-39) detector, and the results revealed that the city center of Babylon has the highest average concentrations, with blood and soil samples finding (1.09 ± 0.22 *ppb*) and (2.10 ± 0.23 *ppm*), respectively. The outcomes have further demonstrated that uranium concentrations are influenced by gender and occupation. Furthermore, blood sample concentrations are typically lower than soil sample concentrations [152].

T.F. Naji et al. (2021) revealed that the radon concentration in lung cancer patients' serum was measured using a (CR-39) detector, and the findings revealed that it is significantly higher in lung cancer patients than in healthy individuals (19.2234 ± 2.15907 Bq/m^3) [153].

A. H. Abboud et al. (2021) estimated a possible association between heavy metals and the quantity of alpha emitted by women's blood and breast milk. The findings revealed that Pb, Cd, and Cu concentrations in milk are(0.2239± 0.0007 *ppm*), (0.0156± 0.0001 *ppm*), and (0.1811±0.0006 ppm), respectively. While the blood levels of Pb, Cd, and Cu were (0.0898 ±0.0008, 0.0432± 0.0010, and 0.1729± 0.0004 *ppm*), respectively. The study declared, that there is no statistically significant difference between Pb, Cd, Cu, and alpha emitters in milk and blood at a level of 0.01 [154].

A.A. Abojassimet al. (2022) used the CN-85 SSNT detector to compare the concentrations of serum samples for cancer patients in the center of Najaf Governorate and the city of Kufa, where all results showed that all radon concentrations and some of its offspring were within the internationally permissible limits [155].

S.A. Kadhim et al. (2022) studied the difference between uranium concentrations by the (CR-39) detector in plasma samples of cancer patients with and without chemotherapy and healthy people. The results showed that radon and uranium levels were higher in inpatients without chemotherapy, followed by cancerous patients without treatments and then the healthy group [156].

2.18.3 Measurements Trace Elements in Human Samples

V. Vacchina et al. (2014) described the development of an inductively coupled plasma mass spectrometry (ICP MS) method to measure some toxic elements such as arsenic, Lead, Cadmium, and some other elements determined in dried blood spots. The results declared that concern about pollution must be taken into account to preserve the non-contamination of samples in this method. It is useful in cases of unavailability of small amounts of blood, in children, and in cases of poisoning with chemical elements (forensic analysis) [157].

A.A. Al-Hamzawi et al. (2014) measured the Pb, Ni, and Cd amounts in biological samples from cancer patients in southern Iraq by inductively coupled plasma optical emission spectroscopy (ICP-OES). The concentrations of Pb, Ni, and Cd in urine and soft tissue in the kidney tissues of the cancer patient group are 2.21, 1.28, and 13.25 (*mg/l*), respectively. While the relevant components are present in breast tissue samples from cancer patients in amounts of 1.65, 1.03, and 0.68 (*mg/l*), respectively [158]**.**

K. Zabocka-Sowiska et al. (2017) supported the theory that changes in the trace element status of Zn, Mn, and Cu are related to disrupted redox status in lung cancer patients. Additionally, the kind of biological fluid (serum, blood) affects interactions with redox status measures as well as changes in the metal profile, where it is preferable to use whole blood, especially in the measurement of the element Manganese [159].

M. Sohrab et al.(2018) revealed that the Zn, Cr, Cu, Al, and Pb in colon cancerous tissues were significantly higher than those of healthy tissues ($P < 0.05$). However, Mn, Sn, and Fe were significantly lower than those of non-cancerous tissues ($P < 0.05$). Also, the results discovered that some trace element levels may be influenced by gender and smoking history. And the component had considerably differing amounts in healthy and malignant tissues [160].

N. Cabré et al.(2018) measured trace elements B, Cu, Zn, and Sn by inductively coupled plasma mass spectrometry (ICP-MS) in blood samples from breast cancer patients before and after radiation treatment, revealing that the boron concentration was affected by radiation while other elements did not show any change during treatment. The results were compared with samples from healthy women [161].

A. Caglayan et al. (2019) studied the concentrations of some trace elements using inductivity coupled mass plasma (ICP-MS) for first-epithelial ovarian cancer patients and healthy ones and showed that the use of whole blood is preferable to the use of serum or tissue. Especially in the element Manganese, the study clarified the relationship between the concentrations of the elements and the stages of cancer development [162].

C. Jiang et al. (2020) analyzed some trace elements by inductivity coupled mass plasma (ICP-MS) of blood samples from cervical cancer patients with radiologic and chemotherapy treatments. These analyses revealed that there was no radiation impact factor on the trace element concentrations. However, the chemotherapy had an impact on a few elements (K, Sn, and Mg), while (Zn, Ni, and As) levels stayed the same under chemotherapy treatments [33].

M. Lener et al. (2020) demonstrated that there is a linkage between early-stage lung cancers and Cadmium levels, with 58 percent of former smokers having levels (above 0.45μ g/L) that are connected to a ratio of 3.94 or higher for lung cancer. However, In non-smokers, Cadmium levels were shown to be unrelated to the risk of lung cancer (range: 0.17 to 1.15 g/L) [163].

M. Sohrab et al. (2021) studied the trace elements in the stomach and esophagus with the flame atomic absorption spectroscopy (FAAS) method. The results indicated that there were significant variations between the two groups in the median amounts of Zn, Cr, Sn, and Cu ($P < 0.05$). Although there were no significant changes in the tissue composition of the esophageal samples, there were significant differences in the median concentrations of Zn, Cr, and Sn ($P < 0.05$) in stomach tissues. Additionally, the findings showed that gender had an impact on the levels of various trace elements and heavy metals [28].

M.K. Türkdoğan et al. (2022) clarified that the comparison of the elements Cd and Ni in the serum of healthy and patients with gastric and esophageal cancer were considerably lower in the healthy group ($p < 0.001$ and < 0.005, respectively). In addition, patients with esophageal cancer had mean serum Co levels that were considerably lower than those of controls and patients with gastric cancer ($p < 0.002$). Additionally, the mean serum levels of Fe and Mn in all cancer groups (esophageal, gastric, and colon) were markedly lower than in controls ($p < 0.001$ and < 0.002, respectively). In comparison to controls, all cancer patients' mean serum concentrations of Cu, Mg, Pb, and Zn did not differ substantially from one another [18].

E.J. Sahan (2022) analyzed the trace elements (zinc, copper, and Lead) by using flame atomic absorption spectrophotometry (FAAS). The results showed a highly significant decrease ($p < 0.01$) in the mean serum level in both pre-and postmenopausal breast cancer women and control respectively for Zinc (71.7 ±5.1, 70.4 ±5.4 µg/dL, and (89.7 ± 10.2, 97.5 ± 13.2 *µg/dL*), and for Lead (20.7 ± 2.5 *µg/dL*, 19.9 ± 1.7 *µg/dL*, and 15.1 ± 2.0 *µg/dL*,14.6 ±2.3 *µg/dl*) [164].

2.19 Summary of Previous Studies

A summary of previous studies that were conducted for the same geographical area (Karbala governorate, Iraq) and biological techniques are shown in the following tables (2.1) and (2.2):

Table 2.1: Summary of previous studies of cancer patients in biological (blood and Tissue) samples of the past at Karbala governorate, Iraq.

Experiments	Whole blood	Tissues	cancer
Raman diagnosis	×	×	×
(CR-39) for radon gas	×	×	×
ICP-MS Spectroscopy For trace elements	×	×	×

Table 2.2: Summary of previous studies of another biological sample of the past at Karbala governorate, Iraq.

Experiments	Biological samples	Method	Disease	Ref.
Raman diagnosis	×	×	×	×
Radon gas	Serum	LR-115 type II detector	cancer	[151]
Trace elements	teardrop	ICP-MS Spectroscopy	type 2 diabetes	[27]
Trace elements	Scalp Hair	ICP-OE Spectroscopy	-	[165]
Trace elements	Serum	FAAS	cancer	[166]

Chapter Three

Methodology

3.1 Introduction

This chapter presents a description of the materials and methods that used in the study, including clarification of the biological samples, the method of collecting them, and the area from which the samples were collected, based on the objective of the study, as flowchart figure (3.1) revealed the use of Raman Spectra to determine the difference between normal and cancerous blood samples, also included finding the concentration of radon gas using a nuclear track detector and calculating uranium concentrations and find the concentrations of trace elements using Inductively Coupled Plasma Mass Spectrometry (ICP-MS).

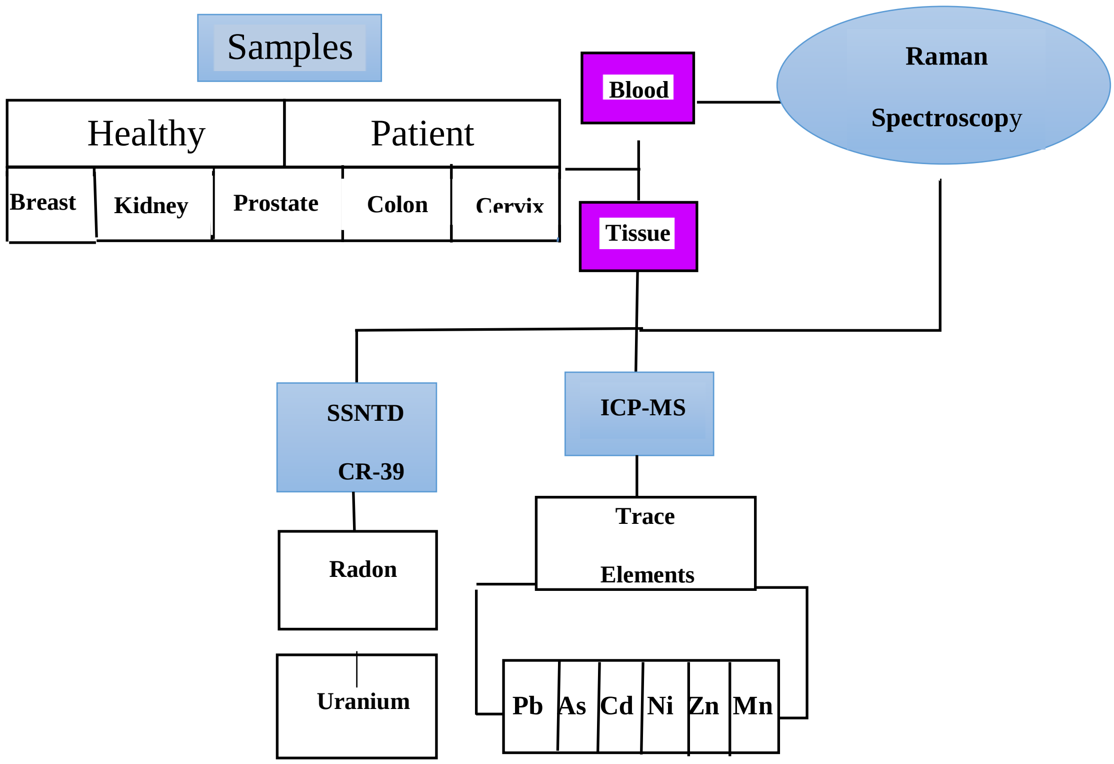


Figure 3.1: A flowchart of the study methodology.

3.2 Collection Area

The study samples were collected from Karbala Governorate, Iraq, which is located in the center of Iraq to the southwest of the capital, Baghdad, as figure (3.2) shows. In the 2019 Karbala governorate, The percentage of cancer cases (9.94%)out of the total population (543 males, 748 females) with an increase of 8.3% over the previous year [16].

Figure 3.2: The location of Karbala province

3.3 Biological Samples

Blood samples taken from cancer patients and healthy volunteers and tissue samples (cancerous and benign) were used as biological samples during this study. The consent of all patients and healthy people were obtained, such as age, gender, type of cancer, type of treatment, whether there are other diseases, and areas of residence (center or rural areas), for study and sharing their results for research only. Hereditary malignancies and cases of radiation therapy were excluded from the study.

3.3.1 Blood Samples

In this study, blood samples from cancer patients were chosen randomly and collected between October 2020 to November 2021 at Al-Amal Center for Cancer Diseases in Imam Al-Hussein Medical City in Karbala province/ Iraq). While another blood sample was randomly taken from healthy individuals whose samples were utilized as controls. The demographic descriptions of the blood samples are clearly evidenced in table (A) in appendix D, table (3.1) and table (3.2).

Table 3.1: The statistical characterizations of the blood samples.

Classification	Cancer patients	Healthy
Age range (years)	18-72	18-70
Average age total (years)	44.74±1.97	41.46± 2.65
Total number of the samples	70	30
Number of females	35	15
Number of males	35	15
Female's average age (years)	39.46±2.75	44±3.95
Male's average age (years)	46.88±3.02	38.93±3.56
Number of smokers	21	4
Urban Area	27	22
Rural Area	43	8

Table 3.2: Blood samples descriptive statically according to cancer types.

Cancer types	Breast	Cervix	Prostate	Kidney	Colon
Total number of the samples	15	8	12	17	18
Number of females	15	8	-	3	4
Number of males	-	-	12	14	14

3.3.2: Tissue Samples

The tissue samples (cancerous and benign) were collected between October 2020 to March 2022 at Al-Amal Center for Cancer Diseases in Imam Al-Hussein Medical City in Karbala province/ Iraq and AL- Kafeel Super Specialty Hospital in Karbala. The demographic characteristics of the tissue samples are clearly outlined in table (B) in appendix D, table (3.3) and table (3.4) present the tissue samples statistically and descriptively by various cancer types.

Table 3.3: The demographic characterizations of the tissue samples.

Classification	Cancer patients	Healthy
Age range (years)	17-70	17-55
Average age total (years)	52.63	39.4
Total number of the samples	30	10
Number of females	20	6
Number of males	10	4
Female's average age (years)	35.86	41.5
Male's average age (years)	49.25	36.25
Number of smokers	6	1
Urban	11	5
Rural	19	5

Table 3.4: Tissue samples statistically and descriptively by various cancer types.

Toumer types (malignant)	Breast	Cervix	Prostate	Kidney	Colon
Total number of the samples	8	6	3	6	7
Number of females	8	6	-	3	3
Number of males	-	-	3	3	4
Tumor types (benign)	Breast	Cervix	Prostate	Kidney	Colon
Total number of the samples	1	4	1	2	2
Number of females	1	4	-	1	-
Number of males	-	-	1	1	2

3.4 Collection and Store the Samples

All blood samples from (patient and healthy) were collected by using a needle and syringe (2.5 mm) deep and then stored with deep freeze until the time of measuring. While tissue samples were obtained during routine medical operations performed in the hospitals, like surgery and the removal of tumors. The formalin liquid (conservator material) was maintained with the tissue samples in clean containers, the process of collecting samples for blood and tissue samples is presented in figure (3.3).

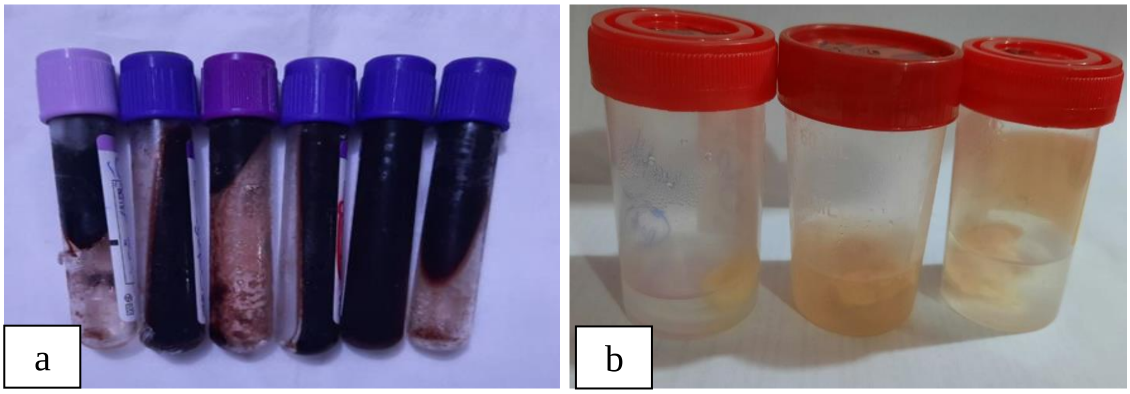


Figure 3.3: Sample under collection process: **(a)** for blood and **(b)** for tissues.

3.5 Equipment, Materials, and preparation Samples for Measurement

3.5.1 Oven

Samples (blood and tissue) were dried inside Electric Hot Air Sterilizer Oven (Series GRX-9013A, China). Temperature range and stability were (+10~250°) and ±1°C respectively.

3.5.2 Sensitive Balance

The samples (blood and tissues), and sodium hydroxide were weighed using a particularly sensitive balance (Denver type, made in Germany), four places after the decimal point used in this study.

3.5.3 Preparation of the Dried Samples

The blood samples were put in a petri dish and dried for eight hours at 25 degrees in a hot sterilizer oven and grand by mortar and pestle then sieved (0.5 *mm*) to achieve homogeneity. The tissue samples also followed the same procedure however they need to dry for 4 days. Figure (3.4) clears a summary of the operations conducted on blood (**a** and **b**) and tissue samples (**c** and **d**) from dried, followed by (**a**) grinded, sieved, then weighed and (**b**) packing until measured as shown in figure (3.5).

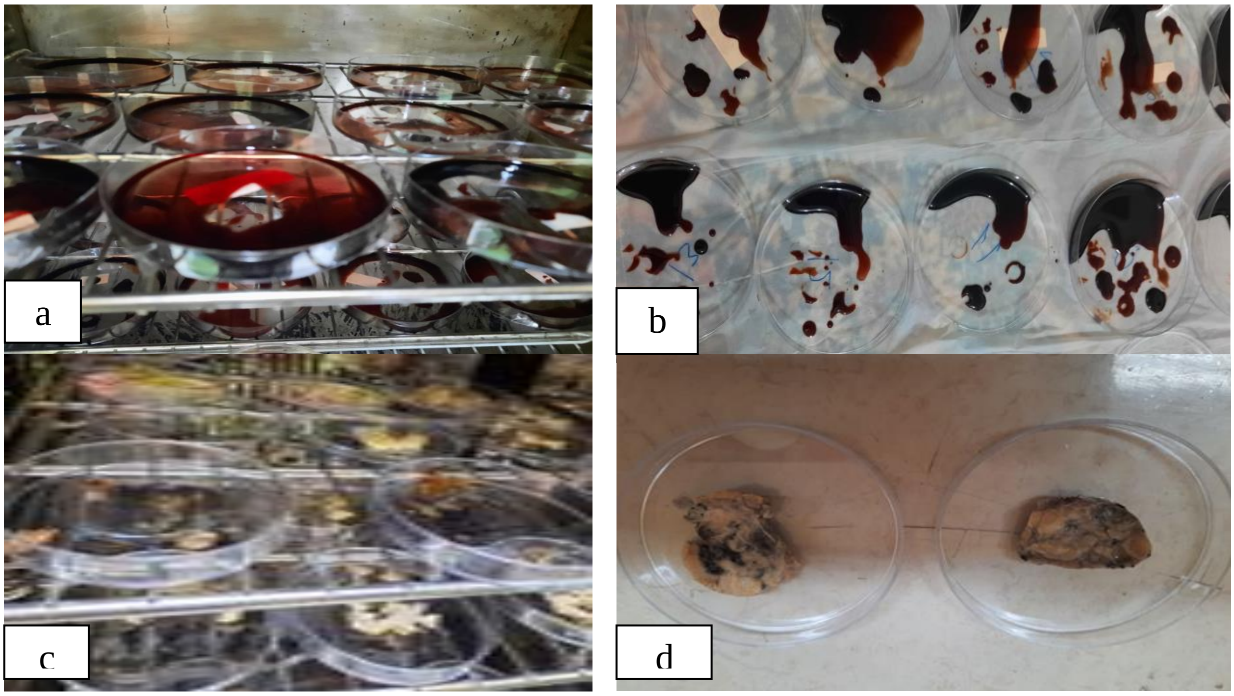


Figure 3.4: Preparing the blood and tissue samples to dry

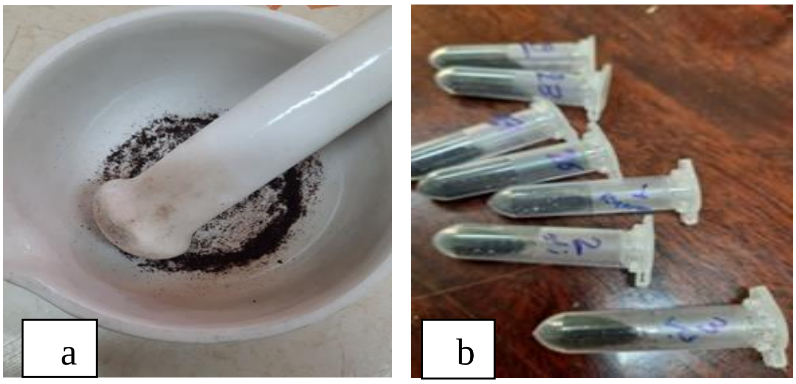


Figure 3.5:Grinded the samples (a) and stored (b) them until measuring

3.6 Raman diagnosis

Raman spectroscopy (model: TakRamN1-541) from Teksan Company, model: TakRamN1-541, made in Iran as shown in figure 3.4 had been used in the study, the measurements were taken in the central laboratory of the University of Tehran, Iran.

Figure 3.6: Raman Spectroscopy (model: TakRamN1-541).

The (10*g*) powder samples from the blood samples of cancer patients and healthy people, which were prepared as mentioned previously, are placed on a piece of glass under the lens of the Raman device. The desired wavelength is chosen, after which the scattering process takes place on the sample, giving the energy difference between the incident photon and the results dispersed as peaks on the screen.

3.7 Radon Measurements

3.7.1 Etching solution

Chemical Etching Latent tracks, or radiation hazard trails, are created when ionizing particles pass through polymeric track detectors. The easiest way to see the tracks is to use a chemical solution to etch the (SSNTDs) material. This preferentially attacks the damaged material and enlarges the original track to a size that can be seen under an optical microscope [46]. The sodium hydroxide (NaOH) salt is dissolved in a volumetric flask with distilled water according to the following equation [167]:

$$W = W_{eq} \times N \times V$$

Where: W: is the amount of sodium hydroxide required to prepare the given normality.

W_{eq}: NaOH equivalent weight.

N: normality which is equal to (6.25).

V: distilled water volume (250 *ml*).

The equivalent weight of sodium hydroxide was given by:

$$W_{eq} = W_{Na} + W_o + W_H$$

Where W_{Na}, W_o and W_H represent the sodium, oxygen and hydrogen atomic weights respectively.

$$W_{eq} = 22.98977 + 15.9994 + 1.00794 = 39.99711\ g\ mol^{-1}$$

Then the:

$$W = 40\ g\ mol^{-1} \times 6.25\ \mathrm{N} \times 250\ ml = 62.5\ g$$

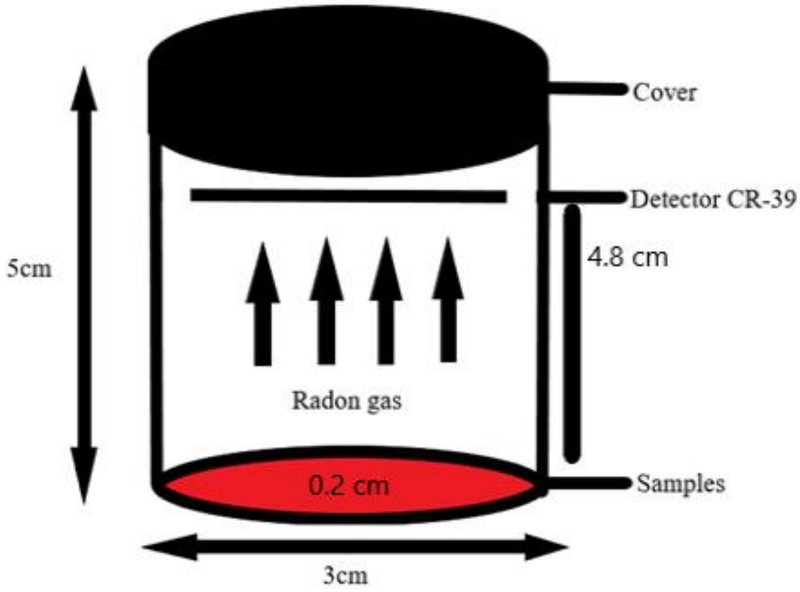
3.7.2 Water Bath

The chemical etching solution's normal temperature was maintained by using a water bath, (type Labsco, Germany). A thermostat that could work beyond 110 ^{o}C and had ± 1 ^{o}C accuracy was included in the water bath.

3.7.3 Describes the sample preparation process for Radon Measuring.

Half a gram of dried (from 2.5 *ml* liquid blood), grined, and sieved blood and tissue samples were placed in plastic containers (5 c*m*) high and (3 *cm*) wide. The nuclear trace detector (CR-39) (2.5*2.5mm) was placed on the inner lid. The samples were stored for (60) days to ensure equilibrium was reached as revealed in figure (3.7). Chemical etching was carried out in a water bath at a temperature of (70) degrees for (8) hours as shown in figure (3.5) (**a**,**b**), after which the tracks were washed with distilled water in a magnetic stirrer for (5) minutes and then dried with paper. Chemical etching was carried out using a sodium hydroxide solution with distilled water [156].

After that, the TASL *Image* dosimeter system measured the number of nuclear traces over the detection region using a high-sensitivity microscope connected to a computer system as it revealed in figure (3.9).



Figures 3.7: Alpha detector storage

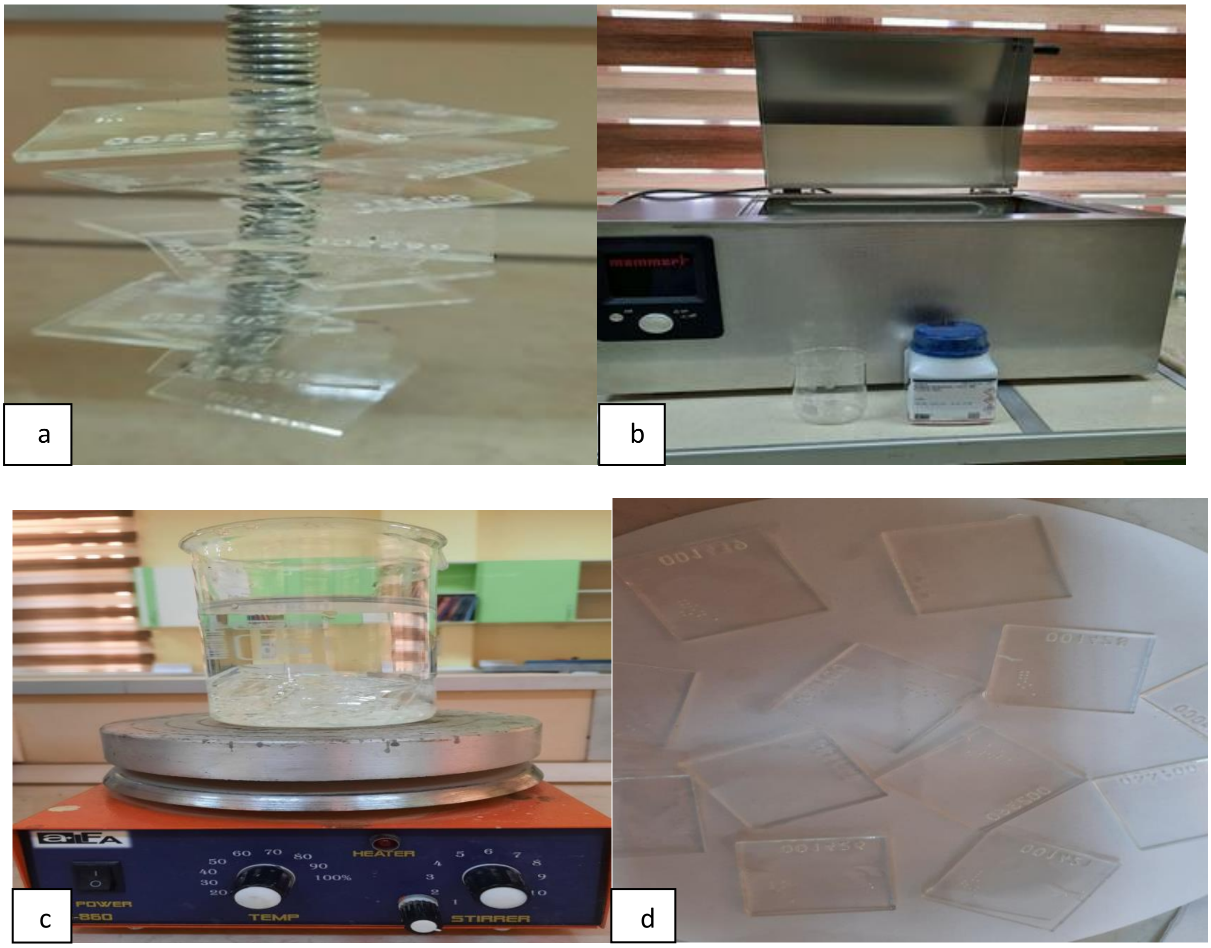


Figure 3.8: A summary of the etching method

The measurements were taken in the advanced nuclear laboratory of the University of Kufa, Iraq.

Figure 3.9: TASL*Image*™ Systems

3.7.4 Radon and Uranium Calculations

The alpha emitters concentrations in the samples were calculated using the following equation [153]:

$$C_{Rn} = \rho/Kt \qquad \text{………… (3-1)}$$

Where C_{Rn} is the radon concentrations, ρ alpha-track density, K the diffusion constant = 0.0412 (*track.cm*$^{-2}$ */Bq .cm*^{3}*.day*) calculated by

$K = 0.25\ r\ (2\cos\ \theta_c\ -r/r_a)$ where r is the radius of the container, θ_c is the critical angle of the detector CR-39= (35^0), and r_a is an alpha particle range in the air (r_a=4.15 *cm*) when t is exposure time [168–170].

The concentration of radon within the sample (C^s_{Rn}) were determined by the following equation

$$C^s_{Rn} = C_{Rn}\lambda_{Rn}\ h\ t\ /l \qquad \text{………… (3-2)}$$

Where λ_{Rn}=$(0.814\ d^{-1})$ is the decay constant of Radon gas, h (4.8 *cm*) is the distance between the detector and the sample surface, t (60 days) is the exposure time, and l(0.2 cm) is the thickness of the sample.

The concentration of radon and Radium inside the sample was given by equations (3-3) and (3-4) respectively [151,171].

$$C_{Rn}^{s,ac} = C_{Rn}^{s}\ A^{s}\ l/\ M_{s} \qquad \text{……………..(3-3)}$$

$$C_{Ra}^{s,ac} = C_{Rn}^{s}\ A^{s}\ h/\ M_{s} \qquad \text{…………...(3-4)}$$

where A^{s} and M_{s} are the surface area and mass of the sample respectively.

Radon activity in the samples is calculated according to equation (3-5), which is known as

$$A_{Rn}^{s} = C_{Rn}^{s}\ V^{s} \qquad \text{…...............(3-5)}$$

where V^{s} is the volume of the sample ($V^{s} = \pi r2$) is the volume in m^3.

The annual effective dose is defined by [172],

$$\text{E (annual effective dose)} = A_{Rn}^{s} \times \text{F} \times \text{O} \times \text{DCF} \qquad \text{…………...(3-6)}$$

Where F is the equilibrium factor (0.4), O is the average indoor occupancy time per person (7000 $h\ y^{-1}$), and DCF is the dose conversion factor (9.0 $nSv/\ h\ .Bq.\ m^{-3}$).

N_{U}^{S} is the number of uranium atoms in the samples found by the podgorsak formula [171]

$$N_{U}^{S} = A_{Rn}^{S}/\lambda_{U} \qquad \text{………..(3-7)}$$

λ_{U} is the constant decay of uranium

M_U^S is the uranium weight in grams calculated with the next equation (M^S) is the sample weight in grams [6].

$$M_U^S = N_U^S A_U / N_A$$

uranium concentrations in part per million (*ppm*) C_U^S [151].

$$C_U^S\ (ppm) = M_U^S / M^S \qquad \text{..........(3-8)}$$

3.8 Describes the sample preparation process for trace elements measuring.

After confirming that the falcon's tube was uncontaminated by nitric acid, the dissolved (25 *g*) from the sample inside of it, before analyzing the samples using ICP-MS, the calibration procedure was carried out as it added in appendix C. Fundamental solutions for calibration were created by diluting standard multi-element solutions to a concentration of (100 *mg/L*). The supplement contains a graph depicting the calibration curves of the standard solution. Concentrations of Pb, As, Ni, Mn, Zn, and Cd were measured for specific trace elements in biological samples. Inductively Coupled Plasma Mass Spectrometry model Agilent 7500 made in the USA, had used to measure trace elements concentrations in this study as shown in figure (3.10), the measurements were taken in the central laboratory of the University of Tehran, Iran

Figure 3.10: Inductively Coupled Plasma Mass Spectroscopy

3.9 Statistical Analysis

The SPSS (Statistical Package for the Social Sciences 23) program was used to evaluate the acquired data statistically. The statistical analysis included the use of Descriptive Analysis, Independent Sample T-Test, Way ANOVA Test as well as Pearson Correlation, Various tests were employed to compare each group's results to those of the other groups and determine the significance of the probability level (P) for each of the parameters under study. The difference between the parameters under study is considered significant when the P-value is ($P <0.05$), and a P-value of ($P > 0.05$) is regarded as non-significant.

Chapter Four

Results and Discussion

4.1 Introduction

In this chapter, the results obtained through conducting the experiment are presented: where the selected chemical bond sites are compared in blood samples of patients with cancer and healthy ones, which were measured using Raman spectroscopy, then the results obtained from measuring radon gas concentrations and uranium calculations for the same samples are presented. the results of the concentrations of trace elements and the same samples, as well as displaying the statistical results and their significant and intangible indications from the results.in addition, this chapter reveals the results of discussions.

4.2 Raman Diagnosis

The nitrogenous bases of deoxygenated (DNA) were tested for whole blood samples of patients and healthy ones as shown in the following tables.

The results of adenine for the patients showed that the change of 624,727 cm^{-1} and 729 to 626, 726, and 731 cm^{-1} respectively, while the values of 1335 fluctuated between 1333-1335 cm^{-1} and also 1339 cm^{-1} stayed and changed between 1338 to 1343 cm^{-1}.

Spectral analysis of materials generally depends on the locations of the vibrating bonds. In the (DNA) compounds, the region 500 to 800 cm^{-1} is a region of weak bonds in C and T, while it has a medium weakness at A and G, with the exception of the bonds 770 cm^{-1} in the group C and T and 670 cm^{-1} in the group A and G respectively [119]. Although the bonds 624 were changed to 626 they are the same (ring breathing in DNA). The band assignment for 727, 729 and 731 cm^{-1} located in (Tryptophan), the 729 cm^{-1} increased change to 731 cm^{-1} like [145] for cancer patients as shown in table (4.1). While the 1335 cm^{-1}

band belongs to CH_3CH_2 wagging of nucleic acid and decreased in located and 1338 (CH_2 deformation) like the result with [140] and [141].

Therefore, any effect on the body will change the structure of these bonds, which consist mainly of carbon, oxygen, and nitrogen leading to a change in the structure of (DNA), which in turn is responsible for the basic processes in the cell.

Table 4.1: The locations of peaks corresponding to the Raman intensities of the Adenine (A**)** for the blood samples for the two groups under study.

Sample Code	624 cm^{-1}	727 cm^{-1}	729 cm^{-1}	1335 cm^{-1}	1339 cm^{-1}
B1	626	726	731	1332	1339
B2	626	726.03	731	1332	*1338
B3	626.59	726	730	1332	*1338
B4	626	726	731	1332	1342
B5	626	726	731	1332	1342
B6	626	726	731	1332	*1338
B7	626	726	731	1332	*1338
B8	626	726	731	1332	*1338
B9	266	726	731	1332	*1338
B10	626.59	726	731	1332.2	1343.5
B11	626	726.59	731.84	1332.8	1338.16
B12	626	726	731	1332.8	*1338
B13	626	726	731	1332.8	*1338

B14	266	726	731	1335	*1338
B15	626	726	731	1335	*1338
B16	626	726	731	1335	1342
B17	626	726	731	1335	1338.16
B18	626	726	731	1335	1343
B19	626	726	731	1335	1343
B20	266	726	731	1335	1343
B21	626	726	731	1335	1338.16
B22	626	726	731	1335	1342
B23	626	726	731	1335	1343
B24	626	726	731	1332	1342
B25	626.95	726	731.8	1332.82	1338.16
B26	266	726	731	1335	1343
B27	626.95	726	731	-	1343
B28	626	726	731	1335	1338.29
B29	626	726	731	1333.7	1342
B30	626	728	731	133371	1342
B31	626	726	731	1332	1338.29
B32	266	726	731	1332	*1338
B33	626	726	731	1332	*1338
B34	626	733	731	1332	*1338
B35	626	726	731	1332	*1338

B36	626	726	731	1332	*1338
B37	626	726	731	1332	*1338
B38	626	733	731	1332	*1338
B39	626	726	731	1332	*1338
B40	626	726	731	1333.71	-
B41	626	726	731	1332	1342
B42	626	726	731	1332	1338.16
B43	626	726	731	1332	1342
B44	626	726	731	1332	1338.16
B45	626	726	731	1332	1339
B46	626	726	731	1332	1342
B47	626	726	731	1332	*1338
B48	626	726	731	1335	*1338
B49	626	726	731	1335	1339
B50	626	726	731	1335	1342
B71	624	727	729	1333	1338
B72	624	727	729	1335	1338
B73	624	727	729	1335	1338
B74	624	727	729	1333	1338
B75	624	727	729	1333	1338
B76	624	727	729	1333	1338
B77	624	727	729	1333	1338

B78	624	727	729	1335	1338
B79	624	727	729	1333	1338
B80	624	727	729	1333	1338
B81	624	727	729	1335	1338
B82	624	727	729	1335	1338
B83	624	727	729	1335	1338
B84	624	727	729	1335	1339
B85	624	727	729	1335	1339
B86	624	727	729	1335	1338
B87	624	727	729	1335	1338
B88	624	727	729	1335	1338
B89	624	727	729	1335	1338
B90	624	727	729	1335	1338

- No band appears, *The band was found in patient and healthy samples.

The change of Raman peaks with respect to Cytosine for the patient samples, where 780 cm^{-1} replaced 781 cm^{-1} or the two peaks (780 and 782 cm^{-1}) disappeared and became one peak at (784 cm^{-1}) these bands belong to stretching and ring breathing in (DNA) where increased change while 1250 cm^{-1} changed from up (1250.8- 1252) cm^{-1} to down 1246 cm^{-1} (CH_3CH_2 wagging nucleic acid) [124], of healthy subjects revealed the constant locations of 780 cm^{-1} and 1250 cm^{-1} and the presence of 785 cm^{-1} instead of 782 cm^{-1} as shown in table (4.2). Our results were close to the measurement value of the reference [145].

Table 4.2 : The locations of peaks corresponding to the Raman intensities of the base Cytosine (C) for the blood samples for the two groups under study

Sample Code	780 cm^{-1}	782 cm^{-1}	1250 cm^{-1}
B1	781	784	1252
B2	781	784	1252
B3	781	784	1252
B4	781	784	1252
B5	784	784	1252
B6	784	784	1252
B7	784	784	1252
B8	784	784	1252
B9	784	784	1252
B10	784	784.02	1250.88
B11	784	784	1250.88
B12	784	784	1250.88
B13	780	784	1250.88
B14	781	784	1252
B15	781	784	1252
B16	784	784	1252
B17	784	784	1250.88
B18	784	784	1252
B19	784	784	1252

B20	781	478	1252
B21	784	784	1252
B22	784	784	1246
B23	784	784	1252
B24	784	784	1252
B25	784	784	1250.88
B26	784	784	1252
B27	784	784	1246
B28	780	782	1252
B29	784	784	1255
B30	780	785	1250
B31	784	784	1250.88
B32	784	784	1252
B33	784	784	1252
B34	784	784	1252
B35	784	784	1252
B36	784	785	1252
B37	784	784	1252
B38	784	784	1252
B39	784	784	1252
B40	781	784	1252
B41	784	784	1252

B42	784	784	1252
B43	781	784	1250.88
B44	784	784	1252
B45	784	784	1252
B46	784	784	1252
B47	784	784	1250.88
B48	784	785	1252
B49	781	784	1252
B50	780	785	1250
B71	780	785	1250
B72	780	785	1250
B73	780	785	1250
B74	780	785	1250
B75	780	785	1250
B76	780	785	1250
B77	780	785	1250
B78	780	785	1250
B79	780	785	1250
B80	780	785	1250
B81	780	785	1250
B82	780	785	1250
B83	780	785	1250

B84	780	785	1250
B85	780	785	1250
B86	780	785	1250
B87	780	785	1250
B88	780	785	1250
B89	780	785	1250
B90	780	785	1250

The change of Raman peaks with respect to Guanine (G) for patient samples, where the level of 666 cm^{-1} increased to 667 cm^{-1} and the rise of 681, 1316 cm^{-1}. On the other hand, the height of the peaks 682 cm^{-1} and 1315 cm^{-1} decreased to 680 $cm^{-1}$and 1315 cm^{-1} respectively. While 1333 $cm^{-1}$was not affected for the healthy samples. Although the bond 666 $cm^{-1}$was changed to 667 cm^{-1} they are in the (ring breathing in DNA) band group. The band assignment for 1320 to 1350 cm^{-1} belongs to the CH_3-CH_2 wagging of (DNA). As shown in table (4.3).

Table 4.3 : The locations of peaks corresponding to the Raman intensities of the base**),** Guanine (G) for the blood samples for the two groups under study

Sample Code	666 cm^{-1}	682 cm^{-1}	1316 cm^{-1}	1318 cm^{-1}	1333 cm^{-1}
B1	667	681	1317	1322	1332
B2	667.67	681	1317	1322	1332
B3	667	681	1317	1317	1332
B4	667	681	1317	1317	1332

B5	667	681	1316	1317	1332
B6	667.67	681	1317	1322	1332.8
B7	667	681	1317	1322	1332
B8	667	681	1317	1322	1332
B9	667	681	1317	1317	1332
B10	667	681	1317	1322	1332
B11	667	681	1317	1322	1332
B12	667	681	1316	1322	1332
B13	667	681	1317	1322	1332
B14	667	681	1317	1317	1332
B15	667	681	1317	1317	1332
B16	667	681	1317	1317	1332
B17	667	681	1316	1317	1332
B18	667	681	1317	1317	1332
B19	667	681	1317	1317	1332
B20	667	681	1317	1317	1332
B21	667	681	1317	1317	1332
B22	667	681	1317	1317	1332
B23	667	681	1317	1317	1332
B24	667	681	1316	1317	1332
B25	667	681	1317	1317	1332
B26	667	681	1317	1317	1332

B27	667	681	1316	1317	1332
B28	667	681	1316	1317	1332
B29	667	681	1317	1317	1332
B30	665.03	681	1315	1319	1333.71
B31	667	681	1317	1317	1332
B32	667	681	1317	1317	1332
B33	667	681	1317	1317	1332
B34	667	681	1317	1317	1332
B35	667	681	1317	1317	1332
B36	667	681	1317	1317	1332
B37	667	681	1317	1317	1332
B38	667	681	1317	1317	1332
B39	667	681	1317	1317	1332
B40	667	681	1317	1317	1332
B41	667	681	1317	1317	1332
B42	667	681	1317	1317	1332
B43	667	681	1317	1317	1332
B44	667	681	1317	1317	1332
B45	667	681	1317	1317	1332
B46	667	681	1317	1317	1332
B47	667	681	1317	1317	1332
B48	667	681	1317	1317	1332

B49	667	681	1317	1317	1332
B50	667	681	1317	1317	1332
B71	665	680	1315	1319	1333
B72	665	680	1315	1319	1333
B73	665	680	1315	1319	1333
B74	665	680	1315	1319	1333
B75	665	680	1315	1319	1333
B76	665	680	1315	1319	1333
B77	665	680	1315	1319	1333
B78	665	680	1315	1319	1333
B79	665	680	1315	1319	1333
B80	665	680	1315	1319	1333
B81	665	680	1315	1319	1333
B82	665	680	1315	1319	1333
B83	665	680	1315	1319	1333
B84	665	680	1315	1319	1333
B85	665	680	1315	1319	1333
B86	665	680	1315	1319	1333
B87	665	680	1315	1319	1333
B88	665	680	1315	1319	1333
B89	665	680	1315	1319	1333
B90	665	680	1315	1319	1333

The Raman peaks of Thymine (T) for blood samples of cancer patients, the peak 642 cm^{-1} remained constant, while the values of 748, 777 cm^{-1} and 1209 cm^{-1} rose to 749, 778 cm^{-1} and 1209 cm^{-1} successively, while the values of 1239 cm^{-1} decreased to 1238 cm^{-1}. The band 1200 to 1240 cm^{-1} are hydroxyproline tyrosine band assignments. On the other hand, none of the peaks were affected in healthy blood samples. Even though some peaks were within the same chemical group, all of the Raman technique results generally demonstrated a difference between blood samples from cancer patients and healthy individuals. This indicated the chemical differences between the samples under the study of (DNA) and its bases, as changing them eventually results in a change in cell activity and transformation into a cancerous cell as shown in table (4.4).

Table 4.4 : The locations of peaks corresponding to the Raman intensities of the base **)** Thymine (T) for the blood samples for the two groups under study.

Sample Code	642 cm^{-1}	748 cm^{-1}	777 cm^{-1}	1208 cm^{-1}	1239 cm^{-1}
B1	642	749	778	1209	1238
B2	642	749	778	1209	1238
B3	642	749	778	1209	1238
B4	642	749	778	1208	1238
B5	642	749	778	1209	1238
B6	642	749	778	1209	1238
B7	642	749	778	1209	1238
B8	642	749	778	1209	1238
B9	642	749	778	1209	1238

B10	642	749	778	1209	1238
B11	642	749	778	1208	1238
B12	642	749	778	1209	1238
B13	642	749	778	1208	1238
B14	642	749	778	1208	1238
B15	642	749	778	1209	1238
B16	642	749	778	1209	1238
B17	642	749	778	1208	1238
B18	642	749	778	1209	1238
B19	642	749	778	1205	1238
B20	642	749	778	1208	1238
B21	642	749	778	1208	1238
B22	642	749	778	1208	1238
B23	642	749	778	1209	1238
B24	642	749	778	1209	1238
B25	642	749	778	1209	1238
B26	642	749	778	1209	1238
B27	642	749	778	1209.6	1238
B28	642	749	778	1205	1238
B29	642	749	778	1209	1238
B30	642	749	778	1208	1238
B31	642	749	778	5120	1238

B32	642	749	778	1209.6	1238
B33	642	749	778	1208	1238
B34	642	749	778	1205	1238
B35	642	749	778	1205	1238
B36	642	749	778	5120	1238
B37	642	749	778	1208	1238
B38	642	749	778	1209	1238
B39	642	749	778	1209	1238
B40	642	749	778	1209	1238
B41	642	749	778	1209	1238
B42	642	749	778	1209	1238
B43	642	749	778	1209	1238
B44	642	749	778	1209	1238
B45	642	749	778	1209	1238
B46	642	749	778	1209	1238
B47	642	749	778	1209	1238
B48	642	749	778	1208	1238
B49	642	749	778	1209	1238
B50	642	749	778	1209	1238
B71	642	748	777	1208	1239
B72	642	748	777	1208	1239
B73	642	748	777	1208	1239

B74	642	748	777	1208	1239
B75	642	748	777	1208	1239
B76	642	748	777	1208	1239
B77	642	748	777	1208	1239
B78	642	748	777	1208	1239
B79	642	748	777	1208	1239
B80	642	748	777	1208	1239
B81	642	748	777	1208	1239
B82	642	748	777	1208	1239
B83	642	748	777	1208	1239
B84	642	748	777	1208	1239
B85	642	748	777	1208	1239
B86	642	748	777	1208	1239
B87	642	748	777	1208	1239
B88	642	748	777	1208	1239
B89	642	748	777	1208	1239
B90	642	748	777	1208	1239

Figure (4.1) shows the Raman spectrum of whole blood samples for cancer patients, **(a**) sample (B1) is a female non-smoking breast cancer patient who lives in the city for 50 years, (**b**) sample (B2) and (**c)** sample (B3), They also belong to two female patients who live in rural areas, non-smokers, and suffer from cervix and kidney cancer and 52, 68 years, respectively. While figure (4.2) shows the Raman spectrum of samples of healthy people (**a**) for sample (B51), (**b**) for sample (B52) and (**c**) for sample (B53). The samples belong to three non-smoking women, the first and the second live in the countryside and the third in the city, ages 39, 56 and 35 years and type of disease breast, cervix and kidneys, respectively. Where the two figures show the relationship between the wave number on the x-axis and the laser intensity on the y-axis.

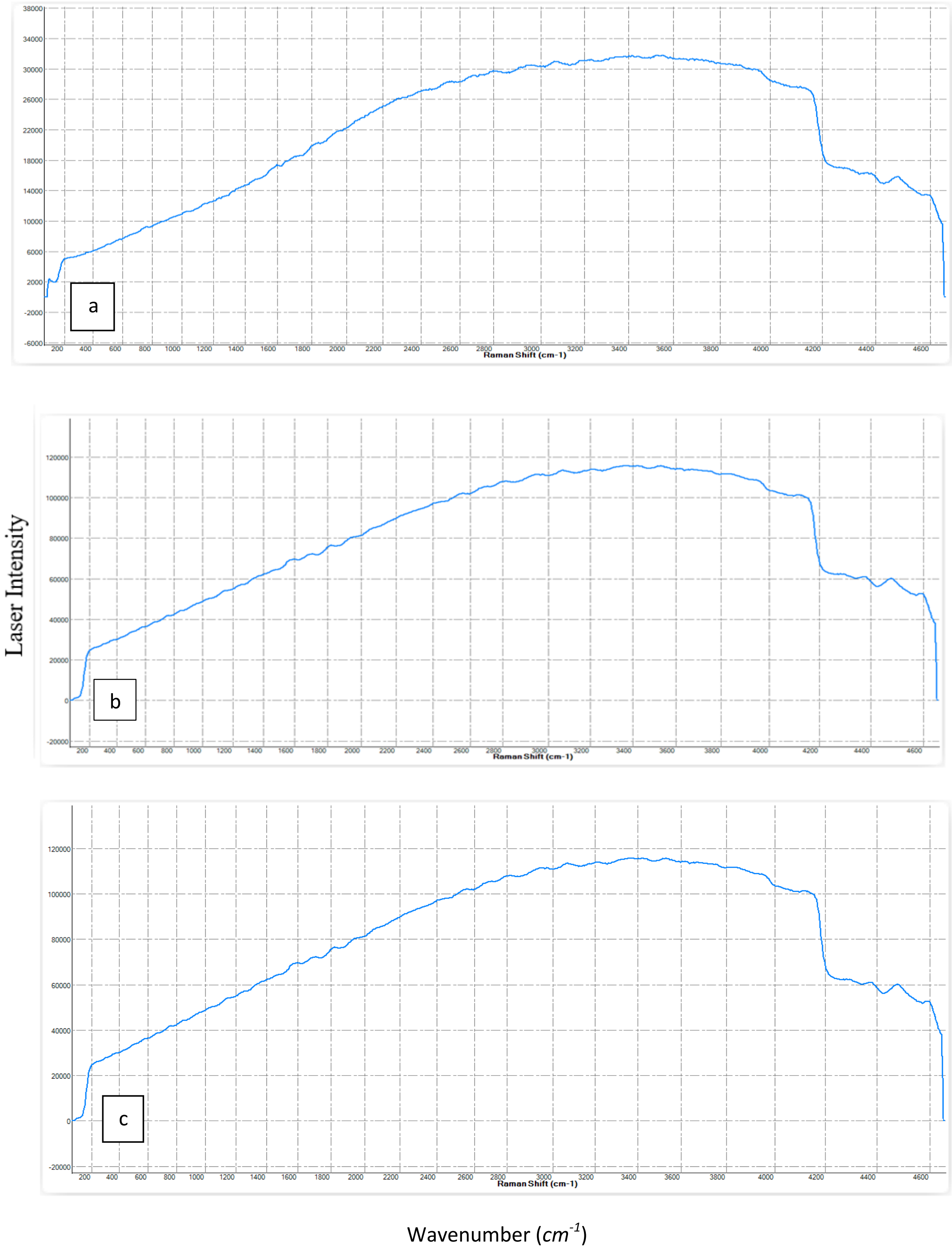


Figure 4.1: Represents the Raman spectrum of some blood samples (B1, B2 and B3) from cancer patients.

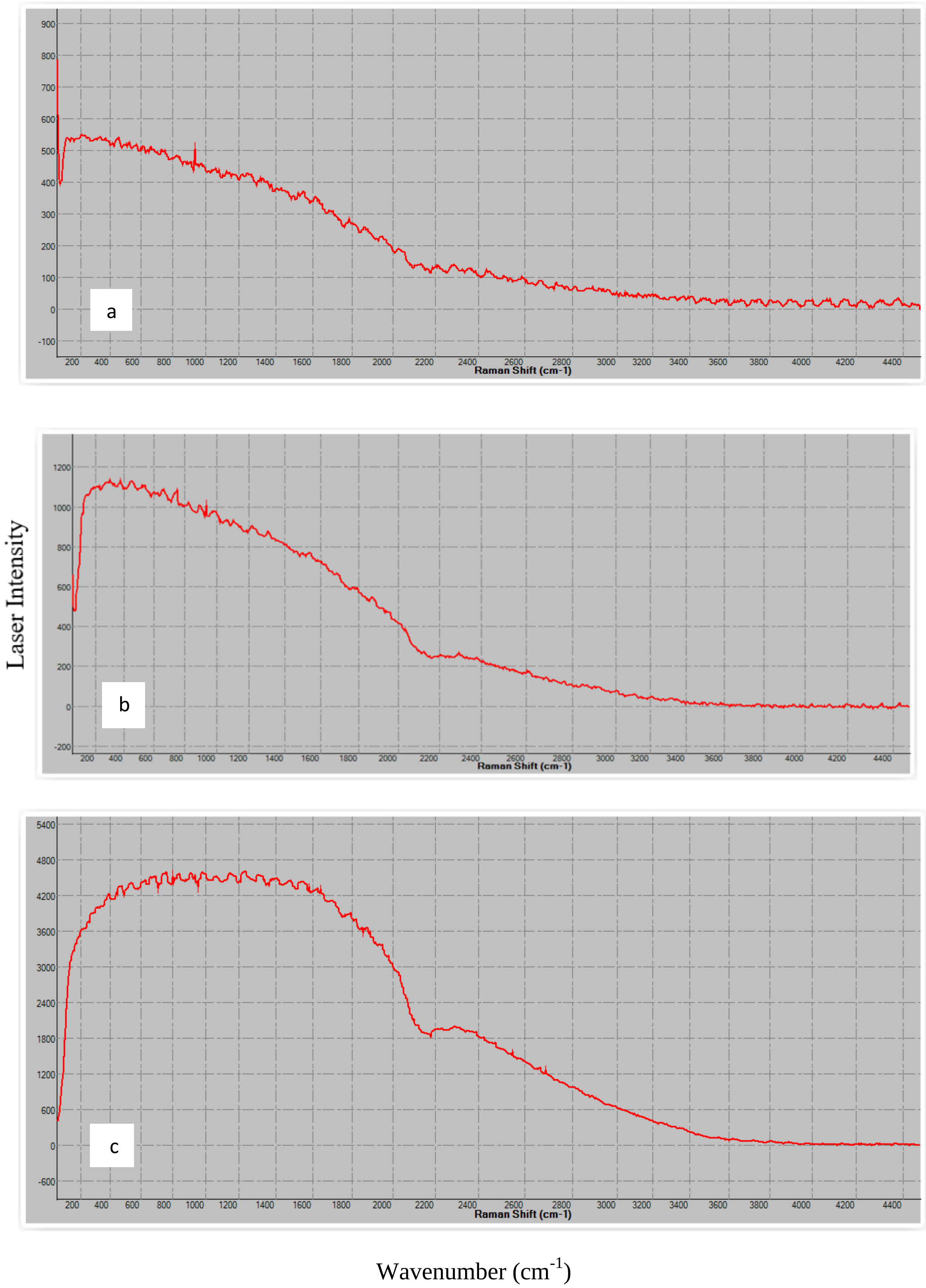


Figure 4.2 : Represents the Raman spectrum of some blood samples(B51, B52, and B53) from the healthy group.

4.3 Radon measurements and Uranium calculations

4.3.1: blood samples

Table (4.5) showed the levels of track density ρ (*track/cm*^{2}), radon gas in the sample C_{Rn} (Bq/m^3), inner the sample $C_{Rn}^{s,ac}$(*Bq/kg*), radium concentrations $C_{Ra}^{s,ac}$ (*mBq/kg*), annual effective dose E (*mSv/y*) and uranium concentrations (U) in units (*ppm*) from whole blood samples taken from cancer patients and healthy volunteers. The highest patient values were found in the sample marked by the symbol (B33) which is male, 20 years old, a smoker, living in a rural area, and suffering from kidney cancer the values of this sample were (188 *track/cm*^{2}, 75.242 Bq/m^3, 55.543 *Bq/kg*, 5.103 *mBq/kg* 0.699 *mSv/y* and 4.479 *ppm*. While the lowest value for the two samples (B41), (B52) and (B63) for the first one on age74 year, a non-smoker male who lives in the countryside and suffers from prostate cancer, and the second one female non-smoker 56 years old lives in rural area, suffering from breast cancer, while the last one who is male age is 26 years, smoker, lives in the city center and suffers from kidney cancer the values were 3 *track/cm*^{2}, 0.404 Bq/m^3, 0.298 Bq/kg,0.027 *mBq/kg*, 0.003 *mSv/y* and 0.024 *ppm*. For the healthy subjects, the highest value was with the sample with the symbol (B88) 54 year-old, male, non-smoker, living in the city center with 4 *track/cm*^{2}, 0.809 Bq/m^3, 0.597 *Bq/kg*,0.054 *mBq/kg*, 0.135*mSv/y* and 0.866 *ppm*, and the lowest values were equal for the five samples (B75, B78, B85, B87 and B98) the first three samples was non-smoker, female living in the city with age 18,4 and 64 years respectively, the forth was a male, non-smoker age 58 years living in the city side, and the fifth one is non-smoker male 21 years old and lives in a rural area, with 4 *track/cm*^{2}, 0.809 Bq/m^3, 0.587 *Bq/kg*,0.054 *mBq/kg*,0.0074*mSv/y* and 0.048*ppm*.

It was evident from the results there are significant differences ($p< 0.05$), between patients and healthy individuals in addition there are positive correlations among patient and healthy groups as in table (4.6) for the same measurements, which means that the increase in the concentration of any of the values in the group of patients under study is accompanied by an increase in the healthy group and vice versa, meaning that the increase in alpha emitters in the group of patients corresponds to a decrease in the healthy group and vice versa.

In general, The concluding results demonstrate that there was a considerable significant variation in the levels of radon concentration (C_{Rn}), radon concentration inner samples ($C_{Rn}^{s,ac}$), radium concentrations ($C_{Ra}^{s,ac}$), annual effective dose (E) and uranium (U) in whole blood samples from healthy people and patients, This outcome was in line with the researcher's[133] findings about the radon concentration for lung cancer patients (19.234$\pm$2.1509 Bq/m^3) over the year 2021 in the Babylon Governorate, Iraq, utilizing the TASL*image*™system with (CR-39) nuclear track. The results were also consistent with another study that examined the whole blood of breast cancer patients in the Iraqi province of Najaf, including both new cases and those receiving chemotherapy, and found that radon (2.073 Bq/m^3), radon inside the sample (0.0681 *Bq/kg*), radium (1.74E-3*Bq.kg*), and uranium levels (5.501*ppm*) were significantly higher in healthy people than patients, and higher in new case [156]. The results were also close to the measured uranium concentrations for the study of cancer patients in the governorates of Baghdad and Basra when the highest rate of uranium concentration in human blood was (1.654 *ppm*) in Basrah governorate and the lowest rate of uranium concentration in human blood was (0.153 *ppm*) in Baghdad governorate [173]. The values of uranium in human blood in Syria in 1993 and in the USA in 1985 were lower than what was obtained from the current study, at rates equal to (0.65*ppb*) and (0.14$\pm$0.09 *ppb*) respectively [59,174].

Nevertheless, the same results demonstrated that the radon value and annual dose did not exceed the permitted and recommended levels for International

Atomic Energy Agency (ICRP), which were (200 Bq/m^3) for air [178,179]. However, it is clear that the values of radon in Karbala are lower than those in blood in Babylon, while the concentrations of uranium in blood samples were lower in Najaf governorate than their rates in Karbala relative to Iraq. Although the concentration of alpha emitters is still below the permissible limits, continuous and permanent exposure to radon gas contributes to damaging living cells and changing their functions, which increases the risk of cancer [177,178]. As mentioned previously, each milligram of uranium, inhaled or ingested with contaminated food, can produce approximately one million alpha particles, each of which has a capacity of more than four million electron volts, which are capable of destroying six neighboring healthy cells of the living organism and make it cancerous [11].

Table 4.5: The levels of track density, radon gas in, inner the sample, the radium concentration, annual effective dose and uranium for patients and healthy group in whole blood samples.

Sample Code	Track Density (*track/cm*^{2})	C_{Rn} (Bq/m^3)	$C_{Rn}^{s,ac}$ (*Bq/kg*)	$C_{Ra}^{s,ac}$ (*mBq/kg*)	E (*mSv/y*)	U(*ppm*)
	Cancer Patients					
B1	19	6.877	5.076	0.466	0.063	0.4093
B2	11	3.640	2.687	0.249	0.033	0.2167
B3	109	43.284	31.952	2.935	0.402	2.576
B4	9	2.831	2.090	0.192	0.026	0.168
B5	29	10.922	8.062	0.740	0.101	0.650
B6	92	36.407	26.876	2.469	0.338	2.167

B7	32	12.135	8.958	0.823	0.112	0.722
B8	24	8.899	6.569	0.603	0.082	0.529
B9	43	16.585	12.243	1.124	0.154	0.987
B10	10	3.236	2.388	0.219	0.030	0.192
B11	29	10.922	8.062	0.740	0.101	0.650
B12	6	1.618	1.194	0.109	0.015	0.096
B13	18	6.472	4.777	0.438	0.060	0.385
B14	9	2.831	2.090	0.192	0.026	0.168
B15	13	4.449	3.284	0.301	0.041	0.264
B16	6	1.618	1.194	0.109	0.015	0.096
B17	12	4.045	2.986	0.274	0.037	0.240
B18	14	4.854	3.583	0.329	0.045	0.288
B19	142	56.634	41.807	3.841	0.526	3.371
B20	116	46.116	34.043	3.127	0.428	2.745
B21	23	8.495	6.271	0.576	0.079	0.505
B22	11	3.640	2.687	0.246	0.033	0.216
B23	40	15.372	11.347	1.042	0.142	0.915
B24	25	9.3042	6.868	0.631	0.086	0.553
B25	30	11.326	8.361	0.768	0.105	0.674
B26	14	4.854	3.583	0.329	0.045	0.288
B27	8	2.427	1.791	0.164	0.022	0.144
B28	43	16.585	12.243	1.124	0.154	0.987

B29	7	2.022	1.493	0.137	0.018	0.120
B30	65	25.485	18.813	1.728	0.237	1.517
B31	6	1.618	1.194	0.109	0.015	0.096
B32	23	8.495	6.271	0.576	0.079	0.505
B33	188	75.242	55.543	5.103	0.699	4.479
B34	12	4.045	2.986	0.274	0.037	0.240
B35	31	11.731	8.660	0.795	0.109	0.698
B36	12	4.045	2.986	0.274	0.037	0.240
B37	23	8.495	6.271	0.576	0.079	0.505
B38	38	14.563	10.750	0.987	0.135	0.866
B39	79	31.148	22.993	2.112	0.289	1.854
B40	32	12.135	8.958	0.823	0.112	0.722
B41	3	0.404	0.298	0.027	0.003	0.024
B42	77	30.339	22.396	2.057	0.282	1.806
B43	89	35.194	25.980	2.387	0.327	2.095
B44	10	3.236	2.388	0.219	0.030	0.192
B45	16	5.663	4.180	0.384	0.052	0.337
B46	33	12.540	9.257	0.850	0.116	0.746
B47	7	2.022	1.493	0.137	0.0188	0.120
B48	14	4.854	3.583	0.329	0.045	0.288
B49	25	9.304	6.868	0.631	0.086	0.553
B50	13	4.449	3.284	0.301	0.041	0.264

B51	7	2.022	1.493	0.137	0.018	0.120
B52	3	0.404	0.298	0.027	0.003	0.024
B53	7	2.022	1.493	0.137	0.018	0.120
B54	6	1.618	1.194	0.109	0.015	0.096
B55	15	5.258	3.882	0.356	0.0489	0.313
B56	4	0.809	0.597	0.054	0.007	0.048
B57	15	5.258	3.882	0.356	0.048	0.313
B58	5	1.213	0.895	0.082	0.011	0.072
B59	16	5.663	4.180	0.384	0.052	0.337
B60	4	0.809	0.597	0.054	0.007	0.048
B61	4	0.809	0.597	0.054	0.007	0.048
B62	15	5.258	3.882	0.356	0.048	0.313
B63	3	0.404	0.298	0.027	0.003	0.024
B64	14	5.663	4.180	0.384	0.052	0.337
B65	4	0.809	0.597	0.054	0.007	0.048
B66	7	2.831	2.090	0.192	0.026	0.168
B67	17	6.877	5.076	0.466	0.063	0.409
B68	23	9.304	6.868	0.631	0.086	0.553
B69	5	1.213	0.895	0.082	0.011	0.072
B70	7	2.022	1.493	0.137	0.018	0.120
Max	188	75.242	55.543	5.103	0.699	4.479
Min	3	0.404	0.298	0.027	0.003	0.024

Mean	42.54	0.701±0.113	7.631±1.238	0.701±0.113	0.01±0.096	0.615±0.099
Healthy Group						
B71	5	1.213	0.895	0.082	0.011	0.072
B72	19	6.877	5.076	0.466	0.063	0.409
B73	5	1.213	0.895	0.082	0.011	0.072
B74	12	4.045	2.986	0.274	0.037	0.240
B75	4	0.809	0.597	0.054	0.007	0.048
B76	27	10.113	7.465	0.685	0.094	0.602
B77	24	8.899	6.569	0.603	0.082	0.529
B78	4	0.809	0.597	0.054	0.007	0.048
B79	8	2.427	1.791	0.164	0.022	0.144
B80	24	8.899	6.569	0.603	0.082	0.529
B81	15	5.258	3.882	0.356	0.048	0.313
B82	7	2.427	1.791	0.164	0.022	0.144
B83	6	1.618	1.194	0.109	0.015	0.096
B84	10	3.236	2.388	0.219	0.030	0.1926
B85	4	0.809	0.597	0.054	0.007	0.048
B86	4	0.809	0.597	0.054	0.007	0.048
B87	6	1.6181	1.194	0.109	0.015	0.096
B88	38	14.563	10.750	0.9877	0.135	0.866
B89	19	6.877	5.076	0.466	0.063	0.409

B90	23	8.495	6.271	0.576	0.079	0.505
B91	19	6.877	5.076	0.466	0.063	0.409
B92	18	6.472	4.777	0.438	0.060	0.385
B93	6	1.618	1.194	0.109	0.015	0.096
B94	14	4.854	3.583	0.329	0.045	0.288
B95	9	2.831	2.090	0.192	0.026	0.168
B96	8	2.427	1.791	0.164	0.022	0.144
B97	28	10.113	7.465	0.685	0.094	0.094
B98	4	0.809	0.597	0.054	0.007	0.007
B99	8	2.022	1.493	0.137	0.018	0.018
B100	5	1.213	0.8958	0.082	0.011	0.0112
Max	38	14.563	10.750	0.9877	0.135	0.866
Min	4	0.809	0.597	0.054	0.007	0.048
Mean	12.76	4.341±0.668	3.205±0.49	0.294±0.045	0.006±0.04	0.234±0.039
P-Values	-	0.023	0.023	0.023	0.023	0.015

A significant difference at ($p < 0.05$).

Table 4.6: The correlations of C_{Rn} , $C_{Rn}^{s,ac}$ and $C_{Ra}^{s,ac}$ between the healthy and patient groups for blood samples.

		C_{Rn} patient	C_{Rn} healthy
C_{Rn} patient	Pearson Correlation	1	.134
	Sig. (2-tailed)		.481
	N	70	30
C_{Rn} healthy	Pearson Correlation	.134	1
	Sig. (2-tailed)	.481	
	N	30	30
		$C_{Rn}^{s,ac}$ patient	$C_{Rn}^{s,ac}$ healthy
$C_{Rn}^{s,ac}$ patient	Pearson Correlation	1	.134
	Sig. (2-tailed)		.481
	N	70	30
$C_{Rn}^{s,ac}$ healthy	Pearson Correlation	.134	1
	Sig. (2-tailed)	.481	
	N	30	30
		$C_{Ra}^{s,ac}$ patient	$C_{Ra}^{s,ac}$ healthy
$C_{Ra}^{s,ac}$ patient	Pearson Correlation	1	.134
	Sig. (2-tailed)		.481
	N	70	30
$C_{Ra}^{s,ac}$ healthy	Pearson Correlation	.134	1
	Sig. (2-tailed)	.481	
	N	30	30

The effect of gender, smoking, residence and age factors on the concentrations of radon and uranium was statistically tested for blood samples of a group of healthy people and cancer patients, in addition to the variety of cancers for those infected, as shown in the tables from (4.7) to (4.12):

There is no significant difference ($p < 0.05$), between patients and healthy individuals under the gender factor for patient samples, while male concentrations were slightly higher than females. This is similar to the results of the researcher when studying some samples of cancer patients in Najaf governorate using detector CN-85 that the values of radon were higher in men when compared with women [179]. The results obtained from the study were interpreted on the basis of the smoking factor, which appeared significantly clear in the blood samples of cancer patients, as shown in the statistical results that reveal there was a significant difference taken into consideration between smokers and non-smokers in the group of cancer patients. The results also showed that radon concentrations were higher in the group of smokers with cancer than in healthy smokers, while this difference was not significant in the healthy group. These results agreed with the study that compared the levels of uranium and radon in Babylon Governorate [180]. The statistical comparisons of radon concentrations between a group of cancer patients and healthy people under the rural or urban housing factor found that there is a significant increase of radon and uranium concentrations in cancer patients who live in rural areas compared to urban residents, although the differences in the area of residence did not give importance to the healthy group. The reason can be attributed to the fact that the rural areas, especially those close to the outskirts of the city of Karbala, contain phosphate rocks, in addition to the presence of the Al-Khayrat power station, as well as the use of fertilizers and some nutrient solutions in agriculture, Together or separately, these causes raise the percentage of alpha emitters in the environment, and consequently their transmission to humans.

The results of a study that examined the impact of age on radon levels in the blood of cancer patients and healthy people did not indicate any considerable changes between groups or within the same group. This was in accordance with what the researcher indicated when he confirmed that there was no effect of the age factor on radon and uranium concentrations in serum samples for cancer patients using the LR-115 detector [151]. For cancer patients, the highest values were for the age group 51-60, whose values were close to the age group under 30, and the lowest value was for the age group 31-40. For healthy subjects, the highest radon values were for ages after 60, and the lowest for age group 31-40. According to (ICRP) [181] to which she attributed that uranium concentrations depend on the accumulation, which increases with age or with daily intake, they can work together or independently on changing proportions according to age. For cancer affecting both genders, there was an increase in radon and uranium concentrations of kidney cancer, however for cancers affecting only women, breast cancer was slightly higher than cervical cancer. The Nuclear Information and Resources Services (NIRS) data show that radiation is more damaging for women since cancer and mortality incidences were 50% greater in women than in males after receiving the same radiation dose (men are more affected by radiation exposure when it co-occurs, women are more affected throughout time). Women are more vulnerable to ion radiation damage than males because they have more reproductive tissues than men. Reproductive tissues are known to be more sensitive to radiation damage. Moreover, as a result of how hormones and their roles relate to cancer, the most frequent malignancy in women is breast cancer [182,183].

Table 4.7: Statistical results for radon concentrations (*Bq/kg*) and uranium concentrations (*ppm*) in blood samples of the study group under gender function.

Classification	Gender	Number of the samples	Means ± Stander Error For radon concentrations	P-Values
Patients group	Female	35	7.542±1.718	p> 0.05
	Male	35	7.721±1.808	
Healthy group	Female	15	2.886±0.628	p> 0.05
	Male	15	3.523±0.773	
Classification	Gender	Number of the samples	Means ± Stander Error For uranium concentrations	P-Values
Patients group	Female	35	0.608±0 .138	p> 0.05
	Male	35	0.622±0.145	
Healthy group	Female	15	0.232+0.050	p> 0.05
	Male	15	0. 236±0 .062	

The non-significant difference (p< 0.05) between patients and healthy groups, while males were slightly higher than females.

Table 4.8: Statistical results for radon concentrations (*Bq/kg*) uranium (*ppm*) concentrations and in blood samples of the study group with smoking habits.

Classification	Smoker habit	Number of the samples	Means ± Stander Error For radon concentrations	P-Values
Patients group	Smokers	22	12.664±3.0508	0.05
	Non-smokers	48	5.3254±1.008	
Healthy group	Smokers	4	2.239±0.627	p> 0.05
	Non-smokers	26	3.353±0.558	
Classification	Smoker habit	Number of the samples	Means ± Stander Error For uranium concentrations	P-Values
Patients group	Smokers	22	1.021±0.246	0.05
	Non-smokers	48	0.429±0. 081	
Healthy group	Smokers	4	0. 139±0. 072	p> 0.05
	Non-smokers	26	0. 249±0.0438	

A significant difference at ($p < 0.05$) in patients groups.

Table 4.9: Statistical results for radon concentration (*Bq/kg*) and uranium concentration (*ppm*) in blood samples of the study group with living area.

Classification	Living area	Number of the samples	Means ± Stander Error For radon concentrations	P-Values
Patients group	Rural	43	8.673±1.802	<0.05 .005
	Urban	27	5.972±1.419	
Healthy group	Rural	7	2.602±0.536	> 0.05 0.425
	Urban	23	3.388±0.623	
Classification	**Living area**	**Number of the samples**	**Means ± Stander Error For uranium concentrations**	**P-Values**
Patients group	Rural	43	0.699±0. 145	<0.05
	Urban	27	0.4816±0.114	
Healthy group	Rural	7	0.186±0.054	> 0.05
	Urban	23	0.249±0.0488	

A significant difference at ($p< 0.05$) in the patient's group

Table 4.10: Statistical results for radon concentrations (*Bq/kg*) in blood samples o study subjects with age groups.

Classification	Age group (years)	Number of the samples	Means ± Stander Error For radon concentrations	P-Values
Patients group	Under 30	17	11.330±3.874	p> 0.05
	31-40	9	3.848±1.277	
	41-50	17	6.148±1.509	
	51-60	8	11.683±4.337	
	Above 60	17	6.903± 2.064	
Healthy group	Under 30	8	2.874±0.972	p> 0.05
	31-40	5	1.612±0.260	
	41-50	6	3.683±1.247	
	51-60	3	1.891±1.010	
	Above 60	8	4.665+1.098	

The non-significant difference at ($p < 0.05$).

Table 4.11: Statistical results for uranium concentrations (*ppm*) in blood samples of study subjects with age groups.

Classification	Age group (years)	Number of the samples	Means ± Stander Error For uranium concentrations	P-Values
Patients group	Under 30	17	0.604±0.208	p> 0.05
	31-40	9	0.279±0.096	
	41-50	17	0.304±0.060	
	51-60	8	0.924±0.355	
	Above 60	17	0.658±0.168	
Healthy group	Under 30	8	0.155±0.062	p> 0.05
	31-40	5	0.130±0.020	
	41-50	6	0.387±0.077	
	51-60	3	0.152±0.081	
	Above 60	8	0.144±0.055	

The non-significant difference at ($p< 0.05$).

Table 4.12: Statistical results for radon concentrations (*Bq/kg*) and uranium concentrations (*ppm*) in blood samples of the patient group with type of cancer.

Cancer type	Number of the samples	Means $\pm$ Stander Error For radon concentrations	P- Values
Breast	15	7.704±2.55	p> 0.05
Cervix	8	7.689±4.915	
Kidney	17	11.558±3.553	
Colon	18	5.325±0.876	
Prostate	12	5.673±2.116	
Cancer type	**Number of the samples**	**Means $\pm$ Stander Error For uranium concentrations**	**P- Values**
Breast	15	0.621±0.206	p> 0.05
Cervix	8	0.620±0.396	
Kidney	17	0.932±0.286	
Colon	18	0.429±0.070	
Prostate	12	0.435±0.170	

The non-significant difference at (p< 0.05).

4.3.2:Tissue Samples

The values of alpha which include track density (*track/cm²*), radon gas in the sample C_{Rn} (Bq/m^3), inner the sample $C_{Rn}^{s,ac}$(*Bq/kg*), radium concentrations $C_{Ra}^{s,ac}$ (*mBq/kg*), annual effective dose E (*mSv/y*) and uranium concentrations U in units (*ppm*) in the tissue samples for malignant and benign tumors are revealed in table (4.13), regarding cancer patients, the highest values were for tissue with the symbol (T17), a female of age (43), lives in the city, and suffers from breast cancer with 78 *track/cm²*, 30.744 Bq/m^3, 22.695*Bq/kg*, 2.085*mBq/kg*,0.285 *mSv/y* and 1.830 *ppm*. While the lowest value was with the symbol (T15) which was a female of age (67) living in the countryside and suffering from cervix cancer with 8 *track/cm*, 2.427 Bq/m^3, 1.791 *Bq/kg*,0.164 *mBq/kg*,0.285 *mSv/y* and 0.144 *ppm*. As for the owners of benign tumors with, the highest value was for (T4), a female who lives in an urban area at age 37 and suffers from cervix cancer, cancer with 36 *track/cm²*,2.427 Bq/m^3, 13.757 *Bq/kg*,0.93 *mBq/kg*,0.22 *mSv/y* and 0.818 *ppm* and the lowest percentage was for (T9), a man suffering from prostate cancer at age 24 who is not one of the city's residents. cancer with 6 *track/cm²*,1.168 Bq/m^3, 1.94 *Bq/kg*,0.169 *mBq/kg*,0.127 *mSv/y* and 0.096 *ppm*.

There are clearly significant differences between the healthy and the patient samples, according to results and table (4.1) revealed it was found that there is a negative correlation between the values under study, that is, the increase in values in the group of patients corresponds to a decrease in the healthy group and vice versa. The results obtained from the study indicated that the difference was statistically significant and should be taken into account between benign and cancerous tissue samples. These results were statistically consistent with the results of the researcher who found uranium concentrations in tissue samples in different regions of Iraq [149]. The results were close to the results of the study of tissue and blood samples of people with cancer from different regions of Iraq

(1910*ppb*) [148]. This confirms what has been reached about the study of blood samples about the relationship between alpha emitters and cancer.

Table 4.13: The levels of track density, radon gas, inner the sample, the radium concentration, annual effective dose and uranium for patients and healthy group in tissue samples.

Sample Code	Track density (*track/cm*^{2})	C_{Rn} (Bq/m^3)	$C_{Rn}^{s,ac}$ (Bq/kg)	$C_{Ra}^{s,ac}$ (mBq/kg)	E (*mSv/y*)	U (*ppm*)
T11	9	2.831	2.090	0.192	0.026	0.168
T12	12	4.045	2.986	0.274	0.0376	0.240
T13	15	5.258	3.882	0.356	0.0489	0.313
T14	16	5.663	4.180	0.384	0.052	0.337
T15	8	2.427	1.791	0.164	0.022	0.144
T16	21	7.686	5.673	0.521	0.071	0.457
T17	78	30.744	22.695	2.085	0.285	1.830
T18	16	5.663	4.180	0.384	0.052	0.337
T19	35	13.349	9.854	0.905	0.124	0.794
T20	36	13.754	10.153	0.932	0.127	0.818
T21	23	8.495	6.271	0.576	0.079	0.505
T22	16	5.663	4.180	0.384	0.052	0.337
T23	50	19.417	14.333	1.316	0.180	1.155
T24	42	16.181	11.944	1.097	0.150	0.963
T25	22	8.090	5.972	0.548	0.0752	0.481
T26	28	10.517	7.764	0.713	0.097	0.626
T27	17	6.067	4.479	0.411	0.056	0.361
T28	31	11.731	8.660	0.795	0.109	0.698

T29	19	6.877	5.076	0.466	0.063	0.409
T30	12	4.045	2.986	0.274	0.037	0.240
T31	23	8.495	6.271	0.576	0.079	0.505
T32	31	11.731	8.660	0.795	0.109	0.698
T33	23	8.495	6.271	0.576	0.079	0.505
T34	36	13.754	10.153	0.932	0.127	0.818
T35	48	18.608	13.736	1.262	0.173	1.107
T36	15	5.258	3.882	0.356	0.048	0.313
T37	33	12.540	9.257	0.850	0.116	0.746
T38	14	4.854	3.583	0.329	0.045	0.288
T39	23	8.495	6.271	0.576	0.079	0.505
T40	50	19.417	14.333	1.316	0.180	0.38
Max	78	30.744	22.695	2.085	0.285	1.830
Min	8	2.427	1.79174	0.16462	0.285	0.457
Mean	30.26	10.005±1.123	7.385±0.838	0.678±0.077	0.093±0.010	0.595±0.211
T1	16	5.663	4.180	0.384	0.037	0.337
T2	21	7.686	5.673	0.521	0.048	0.457
T3	22	8.090	5.972	0.548	0.052	0.481
T4	36	13.754	10.153	0.932	0.022	0.818
T5	11	3.640	2.687	0.246	0.071	0.216
T6	13	4.4498	3.284	0.301	0.285	0.264
T7	9	2.831	2.090	0.192	0.052	0.168
T8	12	4.045	2.986	0.274	0.124	0.240
T9	6	1.618	1.194	0.109	0.127	0.096
T10	10	3.236	2.388985	0.219	0.0790	1.155
Max	36	13.754	10.153	0.9328	0.052	0.818

Min	6	1.618	1.194493	0.109	0.180	0.096
Mean	15.5	5.501 ±1.136	4.593± 0.829	0.373±0.076	0.010±0.051	0.093±0.370
P-Values		0.036	0.0369	0.0369	0.0367	0.0367

A significance at ($p<0.05$).

Table 4.14: The correlations of C_{Rn}, $C_{Rn}^{s,ac}$ and $C_{Ra}^{s,ac}$ between the healthy and patient groups for tissues sample.

		C_{Rn} patient	C_{Rn} healthy
C_{Rn} patient	Pearson Correlation	1	-.425
	Sig. (2-tailed)		.220
	N	30	10
C_{Rn} healthy	Pearson Correlation	-.425	1
	Sig. (2-tailed)	.220	
	N	10	10
		$C_{Rn}^{s,ac}$ patient	$C_{Rn}^{s,ac}$ healthy
$C_{Rn}^{s,ac}$ patient	Pearson Correlation	1	-.425
	Sig. (2-tailed)		.220
	N	30	10
$C_{Rn}^{s,ac}$ healthy	Pearson Correlation	-.425	1
	Sig. (2-tailed)	.220	
	N	10	10
		$C_{Ra}^{s,ac}$ patient	$C_{Ra}^{s,ac}$ healthy
$C_{Ra}^{s,ac}$ patient	Pearson Correlation	1	-.425
	Sig. (2-tailed)		.220

	N	30	10
$C_{Ra}^{s,ac}$ healthy	Pearson Correlation	-.425	1
	Sig. (2-tailed)	.220	
	N	10	10

The effects of gender, smoking, residence, and age on the amounts of radon and uranium in tissue samples from a group of healthy individuals and cancer patients, as well as the range of cancers for those infected, were statistically examined and discussed: The tables (4.18) and (4.19) show the relationship between radiation concentrations and age. Ages were divided into five categories, and the highest values of radon and uranium in tissue samples from cancer patients were in the age group (51-60), followed by the highest group of sixty, and the lowest values were for ages (31-40). In contrast, the same tables showed that for tissue samples from healthy people, the highest values were in category (31-40), followed by category 51-60, and the lowest concentration was in the under thirty category.

Tables (4.20) and (4.21) showed the relationship of cancer type to the change in the concentration of radon and uranium in cancer tissue samples, where the highest values of radioactive elements were found in cervix cancer patients, followed by breast cancer for cancers affecting women only. colon, which was close to radiation concentrations for prostate cancer in males. At the same time, the percentages of radiation among the benign tumor group were lower than their concentrations in the cancerous tumors, where the highest in the cancers that affected both genders was higher in the kidney tumors, followed by the colon. Furthermore, radiation was more common in women with cervical tumors than in women with breast tumors, with the lowest percentages in men with prostate benign tumors.

There is no significant difference between men and women within the same sample at ($p<0.05$), whether it was a group of cancerous and benign tumors, with a slight increase towards men, which was not related to the smoking factor; as the results showed that there was no significant difference between smokers and non-smokers for tissue samples affected by cancer, also the percentage of radiation was higher in non-smokers. That could be related to the housing factor, work, or even the type of work. The results showed an increase in radon and uranium in the tissues of cancer patients in urban areas.

Regarding the relationship between radon and uranium concentrations in tissue samples under the influence of age, the results were consistent with the previous results of blood samples, where the highest values were in the age group (51-60 years). when calculating the ages of this category in the years 1991, we find that it was the age of men who joined the Iraqi army at the time and women who were more exposed to radiation due to the conditions of life at that time associated with the absence of the male component from public life. It also became clear from the results that the highest values of radon and uranium for both sexes were in kidney cancer, which agreed with the researcher who studied four types of cancers and their relationship to the concentration of uranium for the provinces of Basra, Muthanna and Dhi Qar with concentration (6.51 ± 0.02 *ppb*) [184], which were all lower than the concentrations of the current study of Karbala province and in turn was less than uranium concentration in the kidneys tissues cancer of Baghdad governorate (650*ppb*) [148], and less than what in America (0.4 ± 0.02*ppb*) and Japan (0.34*ppb*) for the same type of cancer [185,186]. In cancers that affect women, cervical cancer prevails over the rest of the cancers, which is attributed to the relationship of radiation with types of cancer, as shown in the results of blood samples.

Table 4.15: Statistical analysis results for radon concentration (*Bq/kg*) and uranium concentration (*ppm*) of tissue samples of study groups under gender factor.

Classification	Gender	Number of the samples	Means ± Stander Error For radon concentrations	p-value
Patients group	Female	20	7.542± 1.718	> 0.05
	Male	10	7.721± 1.808	
Healthy group	Female	5	2.886± 0.628	
	Male	5	3.523± 0.77	
Classification	Gender	Number of the samples	Means ± Stander Error For uranium concentrations	
Patients group	Female	20	0.582±0.093	> 0.05
	Male	10	0.621±0.086	
Healthy group	Female	5	0.417±0.093	
	Male	5	0.192±0 .0380	

The non-significance at ($p<0.05$).

Table 4.16: Statistical analysis results for radon concentration (*Bq/kg*) and uranium (*ppm*) of tissue samples of study groups with smoking habits.

Classification	Smoker habit	Number of the samples	Means ± Stander Error For radon concentrations	P-Values
Patients group	Smokers	6	10.451±4.242	p> 0.05
	Non-smokers	24	6.914±0.736	
Healthy group	Smokers	1	3.2848500	
	Non-smokers	9	4.147± 0.922	
Classification	**Smoker habit**	**Number of the samples**	**Means ± Stander Error For uranium concentrations**	**P-Values**
Patients group	Smokers	6	0.510±0.1402	p> 0.05
	Non-smokers	24	0.645±0.070	
Healthy group	Smokers	1	0.264±0.00	
	Non-smokers	9	0.334±0.264	

The non-significance at (p<0.05).

Table 4.17: Statistical analysis results for radon concentration (*Bq/kg*) and uranium (*ppm*) of tissue samples of study groups under living area.

Classification	Living area	Number of the samples	Means ± Stander Error For radon concentrations	P-Values
Patients group	Rural	19	7.276±1.166	p> 0.05
	Urban	11	7.574±1.153	
Healthy group	Rural	5	4.777±1.568	
	Urban	5	3.344±0 .614	
Classification	Living area	Number of the samples	Means ± Stander Error For uranium concentration	P-Values
Patients group	Rural	19	0.586±0.094	p> 0.05
	Urban	11	0.610.±0.092	
Healthy group	Rural	5	0.385±0 .126	
	Urban	5	0.269±0.049	

The non-significance at ($p<0.05$).

Table 4.18: Statistical results for radon concentrations (*Bq/kg*) in tissue samples of study subjects with age groups.

Classification	Age group (years)	Number of the samples	Means ± Stander Error	P-Values
Patients group	Under 30	1	6.271	p> 0.05
	31-40	3	4.578±0.850	
	41-50	8	6.047±1.447	
	51-60	11	8.850±1.731	
	Above 60	7	7.977±1.465	
Healthy group	Under 30	3	1.512±1.334	p> 0.05
	31-40	4	1.795±1.301	
	41-50	1	0.219	
	51-60	2	3.082±2.890	
	Above 60	-	-	

The non-significance at ($p<0.05$).

Table 4.19: Statistical results for uranium concentrations (*ppm*) in tissues samples of study subjects with age groups

Classification	Age group (years)	Number of the samples	Means ± Stander Error For uranium concentrations	P-Values
Patients group	Under 30	1	0.505	p> 0.05
	31-40	3	0.369±0.068	
	41-50	8	0.487±0.119	
	51-60	11	0.685±0.140	
	Above 60	6	0.634±0.341	
Healthy group	Under 30	2	0.156±0.06	p> 0.05
	31-40	4	0.445±0.133	
	41-50	2	0.264±0.072	
	51-60	2	0.325±0.156	
	Above 60	0	-	

The non-significance at ($p<0.05$).

Table 4.20: Statistical results for radon concentrations (*Bq/kg*) in tissue samples of study subjects with cancer types.

Cancer type	Number of the samples	Means ± Stander Error For radon concentrations in tissues	P- Values
Breast	8	4.815± 1.003	p> 0.05
Cervix	6	9.157± 8.162	
Kidney	6	8.162± 1.423	
Colon	7	7.849± 1.461	
Prostate	3	8.062± 3.230	
Benign type	**Number of the samples**	**Means ± Stander Error For radon concentrations in tissues**	**P- Values**
Breast	1	2.687	P>0.05
Cervix	4	5.673± 1.662	
Kidney	2	3.882± 1.791	
Colon	2	3.135± 0.149	
Prostate	1	1.194	

The non-significance at (p<0.05).

Table 4.21: Statistical results for uranium concentrations (*ppm*) in tissue samples of study subjects with tumor types.

Cancer type patient	Number of the samples	Means $\pm$ Stander Error For uranium concentrations in tissues	P- Values
Breast	8	0.388± 0.080	p> 0.05
Cervix	6	0.738± 0.239	
Kidney	6	0.606± 0.111	
Colon	7	0.632± 0.117	
Prostate	3	0.650± 0.260	
Benign type	**Number of the samples**	**Means + Stander Error For uranium concentrations in tissues**	**P- Values**
Breast	1	0.21673	p> 0.05
Cervix	4	0.457± 0.134	
Kidney	2	0.3130± 0.144	
Colon	2	0.252± 0.012	
Prostate	1	0.096	

The non-significance at ($p<0.05$).

4.4 Trace Elements

4.4.1: Blood Samples

The concentration of toxic elements Arsenic (As), Cadmium (Cd), and Lead (Pb) in blood samples are presented in table(4.22).

for blood samples of cancer patients as well as healthy ones, in units of *ppm*. The highest value of Arsenic in the blood of the sample was with the symbol (B39), which was a male, of the age 45 years, a smoker, living in the city side and suffering from kidney cancer with (1.667*ppm*). Also, The sample with the symbol (B7)'s highest Lead reading belongs to an elderly 70 years, nonsmoking female who lives in the city's center and has colon cancer with (46.52*ppm*). The greatest value of Cadmium is for a non-smoking woman with breast cancer who lives in a rural location and is 39 years old with (2.526*ppm*). The statistical results for the comparison between patients and healthy people. The results proved that there are significant differences taken into consideration for the three elements, in addition to the fact that the concentration of Lead was higher than that of Arsenic, which in turn was higher than cadmium for the two groups (patient and healthy). While some samples were nondeductible in the study, the values of all toxic elements were higher than those recommended globally also, the ratios of detectable were (26%, 33% and 23%) for Arsenic, Cadmium and Lead, respectively. Table (4.23) revealed with regard in patient samples, there was a highly significant correlation at ($p<0.01$) between Cadmium and Lead, meaning that they rise and fall together for the same sample, indicating that an increase in the element in the patient group is accompanied by a decrease in the healthy group. This significant ratio between patients and healthy subjects agreed with the results of the research [164] when measuring Lead concentrations for whole blood samples of breast cancer patients in Baghdad/ Iraq, which ranged between (20.7 ± 2.5 and 19.9 ± 1.7 *µg/dL*) for postmenopausal and premenopausal respectively. The results were in agreement with the researcher when studying the concentration of Lead and arsine in blood samples of cancer patients in the Kurdistan Region, Iraq [187]. The researcher [154] found an increase in Lead concentrations compared to the cadmium concentration in blood samples from women in Diwaniyah Governorate, Iraq, with (0.0898$\pm$0.0008 and 0.0432$\pm$0.0010 *ppm*) respectively. In Tunisia the values were (2.72 *μg/L* for patients and 1.37 *μg/L* for healthy) for Cd and 8.78 *μg/L* for patients and 3.31 *μg/L* for healthy) for Arsine [188], while in China the Cd levels in cancer patients (1.57–3.15 *μg/L*) and in controls (1.77, 1.34–2.57*μg/L*) [189]. Cadmium has a particularly long biological half-life, which contributes to a virtually irreversible buildup of the metal in the body throughout life Cadmium level in blood is usually less than (0.5*μg/100ml*) [190]. Considering how the World Health Organization classifies trace elements and the inclusion of some elements under the heading of toxic elements, regardless of how small a percentage of those elements is found in the body, they are toxic because the body does not benefit from them and they have a negative impact on essential functions.

In addition, the information obtained from the International Agency for Research on Cancer and the inclusion of the elements Lead, Cadmium and Arsenic are among the elements that have a significant impact on cancer This in turn confirms the findings that these components' concentrations in the blood of patients increased more than in the blood of healthy people and that this increase was associated with cancer [2]. Lead may influence the development of cancer by raising the probability of (DNA) damage that is permanent, either by preventing (DNA) repair or by replacing zinc in (DNA-binding proteins). Both of these occurrences are crucial for defending (DNA) against mutagenic injury. According to these molecular ideas, Lead facilitates or enhances the genotoxic consequences of other exposures, making it a "permissive" or "facilitative" carcinogen. Lead in the blood allowed according to the World Health Organization is lower than (0.1*ppm*), while the level of exposure in the workplace in most countries (50-40 *µg/dL*), which is four to five times the recommended amount for children [191]. The dysregulation of cell development, interference with proteins involved in the cellular response to (DNA) damage, and resistance to apoptosis all seem to play a role in the carcinogenicity of cadmium. Cadmium has been demonstrated to impair nucleotide excision repair, base excision repair, and mismatch repair in this context. Proteins with Zinc-binding structures, such as those found in (DNA) repair proteins and tumor suppressor proteins, seem to be particularly susceptible targets. In particular, the interaction of these several processes may result in cadmium-adapted cells exhibiting a high level of genomic instability that is relevant for both the early stages of tumor growth and later stages as well [192]. Arsenate decouples oxidative phosphorylation, arsenate inactivates certain enzymes, and arsine will lyse red blood cells [193].

Table 4.22: Arsenic, Cadmium, and Lead concentrations (*ppm*) in whole blood samples from cancer patients and healthy individuals.

Sample Code	As (*ppm*)	Cd (*ppm*)	Pb (*ppm*)
B1	0.13	0.201	13.21
B2	0.12	0.2404	2.3
B3	ND	ND	ND
B4	ND	ND	ND
B5	0.21	0.305	19.74
B6	1.46	0.44	3.421
B7	0.79	0.908	46.52

B8	0.32	0.136	2.623
B9	0.88	0.232	45.8
B10	0.102	0.355	ND
B11	0.11	0.105	2.823
B12	0.13	0.438	8.21
B13	0.28	0.112	0.112
B14	<0.1	0.301	0.16
B15	0.11	0.186	0.17
B16	0.19	0.13	0.251
B17	0.168	0.221	0.18
B18	0.12	ND	1.642
B19	0.411	0.1109	0.151
B20	0.11	0.103	0.112
B21	0.15	0.151	0.121
B22	0.12	0.53	0.14
B23	0.11	0.306	2.51
B24	0.12	0.206	0.17
B25	0.112	0.13	0.52
B26	0.66	0.277	0.111
B27	0.59	0.369	5.95
B28	0.42	0.21	15.5
B29	0.2	0.501	40.26

B30	0.12	0.754	1.74
B31	0.54	0.13	0.16
B32	1.03	0.12	7.38
B33	ND	ND	7.67
B34	ND	ND	ND
B35	0.4	0.253	4.06
B36	0.354	0.266	0.312
B37	ND	ND	8.9
B38	ND	ND	10.46
B39	1.667	0.317	ND
B40	0.6	0.2	0.12
B41	ND	ND	0.18
B42	0.123	0.19	ND
B43	0.22	0.216	4.47
B44	0.11	0.321	0.14
B45	0.2	0.2108	0.11
B46	0.14	0.4013	0.3
B47	0.151	0.408	0.109
B48	ND	ND	0.31
B49	0.59	0.24	ND
B50	0.42	0.213	15.5
B51	0.127	2.526	40.26

B52	0.107	0.253	1.14
B53	0.23	0.2108	1.04
B54	0.108	0.1046	0.194
B55	0.18	0.16	0.11
B56	0.126	0.183	0.19
B57	0.107	0.452	0.106
B58	ND	ND	0.33
B59	0.157	0.317	ND
B60	0.178	0.28	0.181
B61	0.79	0.2102	0.943
B62	0.14	0.181	1.65
B63	0.151	0.407	11.478
B64	0.42	0.303	2.67
B65	0.109	0.38	0.19
B66	ND	ND	0.985
B67	0.192	0.143	ND
B68	0.102	0.4501	9.12
B69	0.114	ND	1.878
B70	0.161	0.521	0.554
Max	1.667	2.526	46.5200

Min	ND	ND	ND
Mean	0.309±0.042	0.314±0.043	5.699±1.410
B71	0.113	0.111	0.1098
B72	0.104	0.105	0.113
B73	0.2	0.166	0.102
B74	0.108	0.161	0.198
B75	0.11	0.1027	0.18
B76	0.105	0.109	0.199
B77	0.117	0.12	0.26
B78	0.109	ND	ND
B79	ND	ND	0.2
B80	0.206	ND	0.155
B81	0.115	ND	0.1044
B82	ND	ND	0.24
B83	ND	ND	0.122
B84	0.137	ND	ND
B85	ND	ND	ND
B86	ND	0.1098	0.114
B87	ND	ND	ND
B88	0.157	0.129	0.1227

B89	ND	ND	ND
B90	ND	ND	ND
B91	ND	ND	ND
B92	ND	ND	ND
B93	0.12	ND	ND
B94	ND	ND	1.35
B95	ND	ND	ND
B96	ND	ND	ND
B97	ND	ND	ND
B98	ND	ND	ND
B99	0.169	ND	ND
B100	ND	0.108	0.13
Max	0.206	0.166	1.35
Min	ND	ND	ND
Mean	0.124±0.125	0.111±0.012	0.217±0.072
Limited range	0.0ppm	0.005ppm	0.1ppm
P- Values	0.0317	0.0488	0.0447

ND: Nondeductible.

A significance at ($p<0.05$).

Pb>Cd> As for patients

Pb>As>Cd for healthy

Table 4.23: The correlations for Arsenic, Cadmium, and Lead concentrations in whole blood samples from cancer patients and healthy individuals.

		As patient	As healthy	Cd patient	Cd healthy	Pb patient	Pb healthy
As patient	Pearson Correlation	1	-.047	.100	.029	.202	.012
	Sig. (2-tailed)		.698	.408	.878	.094	.949
	N	70	70	70	30	70	30
As healthy	Pearson Correlation	-.047	1	.001	.440*	.208	-.059
	Sig. (2-tailed)	.698		.992	.015	.083	.757
	N	70	70	70	30	70	30
Cd patient	Pearson Correlation	.100	.001	1	.021	.524**	.046
	Sig. (2-tailed)	.408	.992		.914	.000	.810
	N	70	70	70	30	70	30
Cd healthy	Pearson Correlation	.029	.440*	.021	1	.059	.084
	Sig. (2-tailed)	.878	.015	.914		.757	.660
	N	30	30	30	30	30	30
Pb patient	Pearson Correlation	.202	.208	.524**	.059	1	.038
	Sig. (2-tailed)	.094	.083	.000	.757		.841
	N	70	70	70	30	70	30
Pb healthy	Pearson Correlation	.012	-.059	.046	.084	.038	1
	Sig. (2-tailed)	.949	.757	.810	.660	.841	
	N	30	30	30	30	30	30

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

The concentrations in (*ppm*) for essential components Manganese (Mn), Nickel (Ni), and Zinc (Zn) in healthy and cancer patients' whole blood samples are revealed below.

Table (4.24) displays the parts per million concentrations of the essential components Manganese, Nickel, and Zinc in healthy and cancer patient's whole blood samples. The results showed that the highest values of Manganese were in the blood of the sample with the symbol (B35), a smoker man whose age 48years, lives in the city suffering from kidney cancer with (25.73*ppm*). While the highest value of Nickel was in the blood of (B43) a non-smoking man 20 years age who lives in the countryside and also suffers from kidney cancer with (2.141*ppm*). The highest values of Zinc were in the blood of (B13) a non-smoking woman, her age 50 years, living in the city, suffering from breast cancer with (674.38*ppm*), for patients, while for the healthy, the sample was distinguished that the concentrations of all the basic elements were higher than all the healthy ones, and it belongs to the blood of (B75) a woman of the age 18 years, who lives in the city with (3.301,1.130 and 1.2*ppm*) for Mn, Ni and Zn respectively. Also, there are significant difference between the three elements taken into account, in addition to the fact that the concentration of Zinc was higher than that of Manganese, which was higher than Nickel. The values of Nikel and Zinc were above the permissible limits and Manganese was lower, the ratios of detectable were (74%, 67%, and 77%) for Manganese, Nickel, and Zinc respectively. There is a significant positive correlation with a significant value between the concentrations of Nickel for groups of patients and healthy ones, as well as Zinc. Also, it was found that there is a positive correlation with a significant value between these three elements in the blood of healthy people in table (4.25), which means these three elements affect human health at the same time.

The current results agreed with the differences in the increasing of Zinc in the blood of cancer patients (1097.50*µg/dl*) compared to the healthy ones (1018.50*µg/dl*) in Turkey [162]. This is in conformity with the results of the Nigerian researcher who discovered that whole blood samples of malignant cells included increased concentrations of Zinc (30 ± 6, 14 ± 4*ppm*) for cancer patients and the healthy group respectively [194]. Also, the levels of nickel and Manganese in the blood of cancer patients increased compared to the healthy ones. The values of Nickel and Manganese in the blood of cancer patients were (5.12 and 2.8250*µg/l*), compared with high Zinc (927.60 *µg/l*) [33], which is consistent with the current study. As follows in China these results support the scientific fact that these elements are of great importance as they are involved in the synthesis of enzymes. Zinc is an essential trace element for the activation or structural stabilization of a great number of enzymes and transcription factors as well as the immune and antioxidant response, apoptosis, and mental health. Supplementation and an optimal intake of Zinc restore the normal immune response and reduce the risk of infection; However, the optimal immunostimulatory dose of Zinc has not been determined. At the same time, it has been demonstrated that an excess amount of Zinc can be dangerous due to its immunosuppressive effect. Knowledge of the dual effect of Zinc is needed to evaluate its beneficial and negative effects in the prevention and treatment of cancer [195]. Nickel works mainly to make modifications in cells and pigments, which in turn target vital enzymes in the body, or it may interfere with (DNA) and destroy it, and the result is a genetic change that eventually causes the cell to change and turn into a cancerous cell [196]. While Manganese superoxide dismutase is one of the mitochondria's main antioxidant enzymes (MnSOD). Numerous research on MnSOD has shown that MnSOD is essential for the initiation and development of cancer. While certain cancer cells have high levels of MnSOD expression and activity, many human cancer cells have low amounts of MnSOD proteins and enzymatic activity. According to this apparent difference in MnSOD levels among cancer cells, MnSOD is differentially regulated in cancer cells, and this regulation may be related to the type and stage of cancer growth [197].

Table 4.24: Manganese, Nickel, and Zinc concentrations in whole blood samples from cancer patients and healthy individuals.

Sample Code	Mn (*ppm*)	Ni (*ppm*)	Zn (*ppm*)
Cancer Patients			
B1	3.54	1.22	94.39
B2	4.51	0.92	163.58
B3	ND	ND	63.55
B4	6.3	ND	14.85
B5	3.14	0.8	120.08
B6	ND	ND	32.82
B7	13.65	ND	32.59
B8	ND	ND	40
B9	6.16	ND	46.96
B10	0.507	ND	72.772
B11	0.912	ND	532.143
B12	0.87	ND	255.109
B13	0.23	ND	674.38
B14	ND	ND	190.789
B15	0.18	0.12	203.448
B16	ND	ND	40.574
B17	ND	ND	458.38

B18	ND	ND	328.125
B19	ND	ND	50.342
B20	ND	ND	32.353
B21	ND	ND	199.115
B22	ND	ND	ND
B23	ND	ND	ND
B24	ND	ND	260.95
B25	ND	ND	ND
B26	7.79	ND	271.11
B27	8.75	ND	334.12
B28	ND	ND	273.71
B29	ND	ND	260.77
B30	ND	ND	ND
B31	ND	ND	173.33
B32	10.01	ND	170
B33	ND	ND	52.73
B34	3.49	ND	256.84
B35	25.73	ND	258.67
B36	ND	ND	325.16
B37	2.89	ND	124.38
B38	ND	ND	64.679
B39	ND	1.111	35.556

B40	ND	ND	30.91
B41	ND	ND	63.889
B42	ND	ND	33.75
B43	4.04	2.141	34.71
B44	ND	ND	284.043
B45	ND	ND	49.01
B46	ND	ND	37.838
B47	ND	ND	66.807
B48	ND	ND	60.596
B49	ND	ND	ND
B50	ND	ND	ND
B51	3.14	0.8	120.08
B52	ND	ND	ND
B53	ND	ND	ND
B54	ND	ND	ND
B55	ND	ND	ND
B56	ND	ND	ND
B57	ND	ND	ND
B58	1.179	0.713	42.857
B59	1.49	0.346	450
B60	ND	ND	55.369
B61	ND	ND	284.043

B62	ND	ND	0.37
B63	ND	ND	0.436
B64	ND	0.36	0.223
B65	ND	ND	ND
B66	0.713	0.846	106.612
B67	ND	ND	ND
B68	ND	0.21	ND
B69	ND	ND	ND
B70	ND	ND	ND
Max	25.73	2.141	674.38
Min	ND	ND	ND
Mean	4.964±1.245	0.798±0.158	155.281±20.537
Healthy group			
B71	0.66	0.384	30.769
B72	1.042	0.25	30.233
B73	0.691	0.102	23.469
B74	1.531	0.829	71.186
B75	3.301	1.132	128.07
B76	0.916	0.133	28.125
B77	ND	ND	21.54
B78	ND	ND	19.14

B79	ND	ND	24.67
B80	0.88	0.37	32.587
B81	ND	ND	ND
B82	ND	ND	ND
B83	ND	ND	ND
B84	ND	ND	ND
B85	ND	ND	ND
B86	0.817	0.176	28.378
B87	0.528	ND	30.159
B88	0.406	ND	22.34
B89	0.391	ND	21.302
B90	0.744	ND	29.189
B91	0.929	0.163	31.492
B92	ND	ND	12.67
B93	ND	ND	18.85
B94	ND	0.37	13.03
B95	0.807	0.145	34.532
B96	ND	ND	ND
B97	ND	ND	ND
B98	ND	ND	ND
B99	ND	ND	ND
B100	ND	ND	ND

Max	3.301	1.132	128.07
Min	ND	ND	ND
Mean	0.974±0.194	0.368±0.094	32.586±5.695
Range	7-12 *ppb*	0.01-0.26 *ppb*	2-4 *g*
P- Values	0.0162	0.03457	0.000522

ND: Nondeductible.

A significance at (p<0.05).

Zn>Mn>Ni for the patient and healthy groups.

Table 4.25: Manganese, Nickel, and Zinc correlation in whole blood samples from cancer patients and healthy individuals.

		Mn patient	Mn healthy	Ni patient	Ni healthy	Zn patient	Zn healthy
Mn patient	Pearson Correlation	1	.045	.089	.146	.158	.099
	Sig. (2-tailed)		.712	.462	.442	.191	.415
	N	70	70	70	30	70	70
Mn healthy	Pearson Correlation	.045	1	.195	.869**	-.035	.954**
	Sig. (2-tailed)	.712		.106	.000	.775	.000
	N	70	70	70	30	70	70
Ni patient	Pearson Correlation	.089	.195	1	.513**	-.068	.152
	Sig. (2-tailed)	.462	.106		.004	.579	.208
	N	70	70	70	30	70	70
Ni healthy	Pearson Correlation	.146	.869**	.513**	1	-.215	.878**
	Sig. (2-tailed)	.442	.000	.004		.253	.000
	N	30	30	30	30	30	30
Zn patient	Pearson Correlation	.158	-.035	-.068	-.215	1	-.054
	Sig. (2-tailed)	.191	.775	.579	.253		.655
	N	70	70	70	30	70	70
Zn healthy	Pearson Correlation	.099	.954**	.152	.878**	-.054	1
	Sig. (2-tailed)	.415	.000	.208	.000	.655	
	N	70	70	70	30	70	70

**. Correlation is significant at the 0.01 level (2-tailed).

The results were as given in tables (4.26, 4.27) and (4.28) when comparing the concentrations of elements with factors of gender, smoking habits and residence in whole blood samples of cancer patients and healthy group. Male patients had greater Arsenic levels than female patients, which was in line with the researcher's findings [198]; female patients had higher Lead and Cadmium concentrations than male patients. The healthy women had greater levels of Lead, Arsenic, and Cadmium in their blood, despite the statistical results not showing a significant difference between the gender. Although there is no statistically significant difference taken into account between the concentrations of Arsenic, Lead and Cadmium when compared in the blood of patients and healthy people, the concentrations of these three elements were higher in the groups of smokers compared to non-smokers. This is consistent with the results of the researcher when studying the effect of a smoking factor on the concentration of Cadmium for cancer patients and healthy people [163].

Additionally, it is in agreement with the researcher's findings when examining how smoking affected the levels of Cadmium and Arsenic in blood samples, which were both much higher in smokers [199]. This shows how smoking is strongly associated with an increase in harmful substances in the body and a high risk of cancer. When housing was taken into account, it was found that Arsenic levels were greater in healthy individuals and cancer patients' blood samples from cities than from rural areas and that Lead levels were lower but cadmium levels were higher in cancer patients. studying in Spain showed how trace elements affect the ecosystem [198]. The researcher linked the rise of Arsenic to the location of factories and polluted water, these findings can be explained by the rising use of Lead and Cadmium-containing fertilizers in rural regions as well as the construction of small factories there that do not meet international norms. [199].

Table 4.26: Statistical analysis results for Arsenic (As), Cadmium (Cd), and Lead (Pb) concentration (*ppm*) of blood samples of study groups under gender factor.

Classification	Element	Gender	Number of the samples	Means ± Stander Error For blood samples	p-value
Patients group	As	Female	30	0.216±0.048	p> 0.05
		Male	28	0.306±0.089	
Healthy group	As	Female	11	0.094±0.017	
		Male	3	0.029±0.016	
Patients group	Cd	Female	31	0.295±0.072	
		Male	28	0.234±0.030	
Healthy group	Cd	Female	7	0.058±0.017	
		Male	3	0.023±0.012	
Patients group	Pb	Female	31	5.555±.145	
		Male	30	4.277±1.308	
Healthy group	Pb	Female	12	0.132±0.021	
		Male	3	0.114±0.089	

The non-significance at (p<0.05).

Table 4.27: Statistical analysis results for Arsenic (As), Cadmium (Cd), and Lead (Pb) concentration (*ppm*) of blood samples of study groups under the smoking factor.

Classification	Element	Smoker	Number of the samples	Means ± Stander Error For blood	p-value
Patients group	As	Smoker	17	0.334±0.095	p> 0.05
		Non smoker	41	0.227±0.034	
Healthy group	As	Smoker	2	0.0692±0.041	
		Non smoker	12	0.0612±0.014	
Patients group	Cd	Smoker	17	0.271±0.053	
		Non-smoker	40	0.248±0.041	
Healthy group	Cd	Smoker	2	0.067±0.040	
		Non-smoker	28	0.036±0.011	
Patients group	Pb	Smoker	20	5.477±1.989	
		Non-smoker	42	4.731±1.590	
Healthy group	Pb	Smoker	3	0.419±0.3128	
		Non-smoker	13	0.077±0.017	

The non-significance at ($p<0.05$).

Table 4.28: Statistical analysis results for Arsenic (As), Cadmium (Cd), and Lead (Pb) concentration (*ppm*) of blood samples of study groups with living area.

Classification	Element	Living area	No.	Means ± Stander Error Blood	p-value
Patients group	As	Rural	37	0.246±0.046	p> 0.05
		Urban	23	0.284±0.065	
Healthy group	As	Rural	2	0.059±0.028	
		Rural	11	0.063±0.015	
Patients group	Cd	Rural	36	0.278±0.610	
		Urban	22	0.242±0.029	
Healthy group	Cd	Rural	2	0.038±0.025	
		Rural	13	0.041±0.012	
Patients group	Pb	Rural	3	6.040±1.924	
		Urban	13	3.256±1.017	
Healthy group	Pb	Rural	7	0.268±0.183	
		Rural	23	0.079±0.018	

The non-significance at ($p<0.05$).

Regarding the essential elements in blood samples of cancer patients and healthy people with the effect of gender difference, adding the smoking factor and the area of residence in tables (4.29,4.30 and 4.31), concerning the study of the concentrations of trace elements under the factor of genetic change, the results showed that there were no significant values to be taken into consideration, although the highest concentrations were found in women's samples, except for the concentration of Manganese in the group of men with cancer. Also, the relationship between the concentrations of the elements and smoking did not give any statistical factor to be taken into consideration, as the increase in concentration towards the non-smokers was for each of the elements Nickel and Zinc and vice versa for Manganese, which in turn shows the dependence of these concentrations on the gender factor where Manganese increased in men who are more smokers than women and vice versa in Zinc concentrations and Nickel. Although the effect of housing did not give statistical significance, the effect of the increase in elements was towards the urban population, compared to the countryside, and this may in turn be attributed to the diet

Table 4.29: Statistical analysis results for Manganese (Mn), Nickel (Ni), and Zinc (Zn) concentration (*ppm*) of blood samples of study groups under gender factor.

Classification	Element	Gender	Number of the samples	Means ± Stander Error Blood	p-value
Patients group	Mn	Female	13	1.308±0.469	p> 0.05
		Male	19	1.811±0.831	
Healthy group	Mn	Female	8	0.601±0.233	
		Male	6	0.308±0.095	
Patients group	Ni	Female	7	0.140±0.054	
		Male	5	0.133±0.071	
Healthy group	Ni	Female	8	0.213±0.088	
		Male	3	0.056±0.028	
Patients group	Zn	Female	25	130.731±29.000	
		Male	28	104.408±19.657	
Healthy group	Zn	Female	11	27.319±8.722	
		Male	9	16.129±3.441	

The non-significance at ($p<0.05$).

Table 4.30: Statistical analysis results for Manganese (Mn), Nickel (Ni), and Zinc (Zn) concentration (*ppm*) of blood samples of study groups under the smoking factor.

Classification	Element	Smoking	Number of the samples	Means ± Stander Error Blood	p-value
Patients group	Mn	Smoker	3	1.655± 1.204	p> 0.05
		Non smoker	19	1.516± 0.430	
Healthy group	Mn	Smoker	2	0.382± 0.382	
		Non smoker	13	0.465± 0.136	
Patients group	Ni	Smoker	2	0.060± 0.050	
		Non smoker	10	0.172± 0.060	
Healthy group	Ni	Smoker	2	0.299± 0.196	
		Non-smoker	9	0.109± 0.046	
Patients group	Zn	Smoker	19	117.019± 24.298	
		Non-smoker	34	117.822± 23.063	
Healthy group	Zn	Smoker	2	21.054± 16.990	
		Non-smoker	18	21.827± 4.951	

The non-significance at ($p<0.05$).

Table 4.31: Statistical analysis results for Manganese (Mn), Nickel (Ni), and Zinc (Zn) concentration (*ppm*) of blood samples of study groups with living area.

Classification	Element	Area	Number of the samples	Means ± Stander Error Blood	p-value
Patients group	Mn	Rural	14	1.203±0.429	p> 0.05
		Urban	9	2.128±1.027	
Healthy group	Mn	Rural	2	0.274±0.216	
		Urban	11	0.509±0.152	
Patients group	Ni	Rural	5	0.1252±0.059	
		Urban	5	0.154±0.068	
Healthy group	Ni	Rural	7	0.171±0.121	
		Urban	8	0.124±0.052	
Patients group	Zn	Rural	31	117.235±23.494	
		Urban	22	118.103±26.035	
Healthy group	Zn	Rural	4	18.598±9.609	
		Urban	16	22.675±5.523	

The non-significance at ($p<0.05$).

4.4.2 Tissue Samples

The values of Arsenic (As), Cadmium (Cd) and Lead (Pb) in cancerous and benign tissue samples, as well as the statistical results for comparing the concentrations of these elements for the two groups under study tissues revealed in the table (4.32), the highest values of Arsenic in the sample (T30) with (0.412 *ppm*) a non-smoking woman, his age 58 years, living in the city, suffering from cervix cancer, the highest values of Cadmium in sample (T18) with (0.2101 *ppm*) a non-smoking woman, his age 67 years, living in the city, suffering from cervix cancer, and the highest values of Lead in sample (T28) with (15.513 *ppm*) a non-smoking woman, his age 58 years, living in the city, suffering from breast cancer for patients. With regard to the highest values for healthy people, the highest value was for Arsenic and Cadmium in the two samples (T4, T3) for non-smoker women living in the countryside, who had a tumor in the cervix, with ages (55,37) and values for the elements(0.122 and 0.1206 *ppm*) respectively, for Lead the highest value with (3.65 *ppm*) that belong to sample (T9) for a non-smoking man living in the countryside suffering from a prostate tumor and age 24 years. As well as the statistical results for comparing the concentrations of these elements for the two groups under study tissues, the concentration of Lead was highest, followed by Arsenic, then Cadmium, while cancerous tissues had the highest concentration, followed by Cadmium, then Arseinc. While the values under study were higher than the permissible limits, which were (0.00*ppm*), (0.01*ppm*) [200] and (0.01-0.46*ppm*) [201] for As,Cd and Pb respectively. Table (4.33) showed a positive correlation between these elements and the groups under study, except for Lead, the correlation was negative between patients and healthy subjects, as well as the correlation was negative, but not significant, between Lead and Arsenic for patients. It was clear from the results that there were no significant differences taken into consideration between healthy patients in the concentrations of Arsenic, Lead and Cadmium, and they were close, and for patients, they were higher than the healthy ones, and the highest values were for Lead, then Arsenic, followed by cadmium, the ratios of detectable were (62%, 62% and 46%) for Arsenic, Cadmium and Lead, respectively. All values of Lead, Arsenic and Cadmium are higher than the international permissible.

This is consistent with the results of the researcher [194] when studying Lead concentrations in cancer tissues and benign tissues with (17±7 and 4±2*ppm*) respectively, where the results showed that the values of the elements are higher in cancerous tissues. In Tunisia, the concentration of cadmium in the tissues of cancer patients(13.1±1.91*ppm*) and the tissues of healthy subjects (0.54±1.18*ppm*) was lower than in our current study, while the concentration of Arsenic was higher in cancer patients (107.92±150.54ppm) compared to healthy subjects (32.10±53.10*ppm*) and was higher than its concentration in our current study [202]. These results were in line with the findings of the researcher who assessed the levels of Lead and Cadmium in the tissues of cancer patients in southern Iraq. It was found that the highest values were with patients with kidney cancer, with a concentration of (2.21±0.9*mg/l*) compared to healthy controls(1.24±0.25*mg/l*) for Lead and (13.25±1.02*mg/l*) and (8.17±0.59*mg/l*) for patients and healthy controls for cadmium, respectively. In general, it is higher than the values in the current study [158].

Table 4.32: Arsenic (As), Cadmium (Cd), and Lead (Pb) concentrations (*ppm*) in tissue samples from cancer patients and healthy individuals.

Sample Code	As (*ppm*)	Cd (*ppm*)	Pb (*ppm*)
T11	ND	ND	ND
T12	ND	ND	0.42056
T13	0.112	ND	ND
T14	0.12	0.11209	ND
T15	0.1203	0.108	1.52
T16	ND	ND	ND
T17	0.118	0.1085	<0.1
T18	0.215	0.2101	0.17241
T19	ND	ND	ND
T20	ND	ND	ND
T21	ND	0.1335	11.543
T22	0.106	ND	1.212
T23	0.13274	ND	ND
T24	ND	ND	ND
T25	ND	0.133	4.60598
T26	0.347	ND	6.72566
T27	ND	ND	ND
T28	ND	ND	15.51376
T29	ND	0.127	1.29125

T30	0.412	0.1075	ND
T31	ND	ND	0.1296
T32	0.268	0.1065	ND
T33	ND	ND	0.71429
T34	0.31	ND	0.24733
T35	ND	ND	0.58769
T36	0.12	0.11	ND
T37	0.109	0.105	ND
T38	ND	ND	ND
T39	ND	0.101	ND
T40	0.13	0.12	0.109
Max	0.412	0.2101	15.51376
Min	ND	ND	ND
Mean	0.187±0.027	0.121±0.007	3.199±1.291
T1	ND	ND	ND
T2	ND	ND	0.214
T3	ND	0.1206	ND
T4	0.122	0.1033	0.218
T5	ND	ND	ND
T6	ND	ND	ND
T7	0.114	0.109	0.13479

T8	ND	ND	0.42934
T9	0.106	0.103	3.65
T10	ND	ND	0.61422
Max	0.122	0.1206	3.6500
Min	ND	ND	ND
Mean	0.114±0.00462	0.10898±0.00411	0.12171±0.00794
Range	0.00ppm	0.01ppm	0.01-0.46ppm
P-values	p<0.05	p<0.05	p<0.05

ND: Nondeductible.

The non-significance at ($p<0.05$).

Pb>As>Cd for the patient and healthy groups.

Table 4.33: The correlations for Arsenic (As), Cadmium (Cd), and Lead (Pb) correlation in whole blood samples from cancer patients and healthy individuals

Correlations

		As patient	As healthy	Cd patient	Cd healthy	Pb patient	Pb healthy
As patient	Pearson Correlation	1	.095	.551	1.000**	-.996	.967
	Sig. (2-tailed)		.808	.258	.	.055	.165
	N	14	9	6	2	3	3
As healthy	Pearson Correlation	.095	1	-.170	1.000**	-1.000**	.970
	Sig. (2-tailed)	.808		.747	.	.	.157
	N	9	13	6	2	2	3
Cd patient	Pearson Correlation	.551	-.170	1	.b	.b	-1.000**
	Sig. (2-tailed)	.258	.747		.	.	.
	N	6	6	14	0	0	2
Cd healthy	Pearson Correlation	1.000**	1.000**	.b	1	.044	-.855
	Sig. (2-tailed)	.	.	.		.972	.347
	N	2	2	0	3	3	3
Pb patient	Pearson Correlation	-.996	-1.000**	.b	.044	1	-.555
	Sig. (2-tailed)	.055	.	.	.972		.625
	N	3	2	0	3	4	3
Pb healthy	Pearson Correlation	.967	.970	-1.000**	-.855	-.555	1
	Sig. (2-tailed)	.165	.157	.	.347	.625	
	N	3	3	2	3	3	6

**. Correlation is significant at the 0.01 level (2-tailed).

b. Cannot be computed because at least one of the variables is constant.

Table (4.34) showed the values of Manganese, Nickel and Zinc in cancerous and benign tissue samples, as well as the table showing the statistical results for comparing the concentrations of these elements for the two groups under study. In benign and cancerous tissues, Zinc concentration was dominant, followed by Manganese, then Nickel. The highest values of Manganese were in the tissue of the sample (T12), which belongs to a woman suffering from breast cancer and living in rural areas, a non-smoker, and aged 41 years with (0.525*ppm*). Also, Nikel was elevated in the tissue (T17) at 52 years, a non-smoking woman who lives in the countryside and suffers from cervix cancer with (0.1808*ppm*). As well as, the highest concentration of zinc was in the tissue (T21) of a man of his age 56 who lives in the countryside, a smoker who suffers from colon cancer with (17.2*ppm*), The highest values for the main elements (Mn, Ni and Zn) for healthy samples were with (T1, T9 and T10) the first and third samples belonged to two women of age 50 living in the countryside and non-smokers suffering from cervicx tumor and the second to a man of age24 suffering from prostate tumor non-smoker living in the countryside with (9.67, 0.327 and 0.859 *ppm*) for (Mn, Ni and Zn) respectively.

The ratios of detectable were (35%, 63%, and 13%) for Manganese, Nickel and Zinc respectively. While table (4.35) reveled the positive and negative correlations among the elements and benign and malignan groups without significant values.

In contrast to women, the tissues of cancerous men had higher concentrations of the basic components. Even with the small number of samples, the smoking effect was not statistically significant, but there was a rise in the concentrations of the elements in healthy subjects and non-smokers for Manganese and Nickel, and vice versa for Zinc. The concentrations of the elements Manganese and Nickel were higher in the tissues of patients who lived in urban areas, and the concentrations of Zinc were higher in rural areas. The Zinc concentration in

Tunisia in the tissues of cancer patients(6.20±8.29*ppm*) was higher than the healthy ones (4.09±5.54*ppm*), which is consistent with our current study, although it was significantly higher [202]. These results were consistent with the results of the researcher [158] who studied Nickel concentrations in kidney samples in cancer patients (1.28±0.16 *gm/l*) and healthy people (0.75+0.11g*m/l*) in southern Iraq, although they are higher than the values under the current study. This is consistent with the researchers [194] when studying the concentrations of Manganese in Nigeria for cancerous and benign tissues (5±4 and 4±1*ppm*) respectively, and (30±6 and 14±4*ppm*) for Zinc, as well as for cancerous and benign tissues, respectively. The results showed that the values of the elements are higher in cancerous tissues. The findings corroborated the researcher's findings from a study of Nickel content in kidney cancer patients in southern Iraq, where it was shown to be greater in cancer patients compared to healthy controls and higher than in the current study.

Table 4.34: Manganese (Mn), Nickel (Ni), and Zinc(Zn) concentrations (*ppm*) in tissue samples from cancer patients and healthy individuals.

Sample Code	Mn (*ppm*)	Ni (*ppm*)	Zn (*ppm*)
T11	0.136698	ND	1.894737
T12	0.525332	ND	7.009346
T13	0.102273	0.1804	6.652587
T14	ND	0.1065	1.778656
T15	ND	0.10109	1.445783
T16	ND	ND	3.730018
T17	0.175946	0.18086	4.83871

T18	0.072633	ND	4.679803
T19	0.380024	0.1387	10.09615
T20	0.110887	ND	5.074425
T21	0.17184	0.1206	17.27528
T22	0.179675	ND	6.557377
T23	0.210937	ND	3.067485
T24	ND	ND	2.472
T25	ND	0.12506	2.975543
T26	ND	ND	2.345133
T27	ND	ND	0.303413
T28	ND	ND	10.9633
T29	ND	0.1385	10.84648
T30	ND	ND	0.965517
T31	ND	ND	1.380368
T32	ND	ND	4.55312
T33	ND	ND	6.964286
T34	ND	0.13601	ND
T35	0.447761	ND	6.688433
T36	0.21	ND	ND
T37	0.27	0.169	ND
T38	0.14	ND	ND
T39	0.199	0.12256	ND

T40	0.136698	ND	1.894737
Max	0.525332	0.180	17.275
Min	ND	ND	ND
Mean	0.823+0.037	0.141+0.0097	4.318+0.764
T1	0.35147	ND	9.677419
T2	0.16635	ND	1.557093
T3	0.540719	0.149811	11.2782
T4	0.240149	ND	5.935252
T5	0.30278	ND	5.244755
T6	0.22668	0.181893	5.102041
T7	0.31224	ND	0.577664
T8	0.153755	ND	2.415027
T9	0.750277	0.327045	2.960526
T10	0.859475	0.114221	1.616379
Max	0.859475	0.327045	9.677419
Min	ND	ND	ND
Mean	0.390+0.077	0.196+0.023	4.636+1.128
Range	7-12 *ppb*	0.01-0.26 *ppb*	2-4 *g*
P- Values	0.073	0.027	p>0.05

ND: Nondeductible.

A significance at (p<0.05)for Mn and Ni only.

Zn>Ni>Mn for patient and healthy groups.

Table 4.35: Manganese (Mn), Nickel (Ni), and Zinc (Zn) correlation in tissue samples from cancer patients and healthy individuals.

Correlations

		Mn patient	Mn healthy	Ni patient	Ni healthy	Zn patient	Zn healthy
Mn patient	Pearson Correlation	1	.131	.311	-.004	.213	-.376
	Sig. (2-tailed)		.719	.352	.992	.258	.285
	N	30	10	11	10	30	10
Mn healthy	Pearson Correlation	.131	1	.330	.287	.480	-.001
	Sig. (2-tailed)	.719		.588	.421	.161	.997
	N	10	10	5	10	10	10
Ni patient	Pearson Correlation	.311	.330	1	.449	-.050	.112
	Sig. (2-tailed)	.352	.588		.448	.884	.857
	N	11	5	11	5	11	5
Ni healthy	Pearson Correlation	-.004	.287	.449	1	.383	-.057
	Sig. (2-tailed)	.992	.421	.448		.274	.875
	N	10	10	5	10	10	10
Zn patient	Pearson Correlation	.213	.480	-.050	.383	1	-.289
	Sig. (2-tailed)	.258	.161	.884	.274		.418
	N	30	10	11	10	30	10
Zn healthy	Pearson Correlation	-.376	-.001	.112	-.057	-.289	1
	Sig. (2-tailed)	.285	.997	.857	.875	.418	
	N	10	10	5	10	10	10

The effect of gender, smoking, and place of residence on trace elements is shown in the following tables from (4.36) to (4.41)It was evident that the concentrations of Arsenic and Cadmium increased in the tissues of male cancer patients, whereas Lead concentrations were greater in the tissues of female patients. The effect of the gender factor did not provide statistical indications to be taken into consideration. Due to the small number of samples for smokers in the statistical comparisons, there was no statistical significance or value taken into account when examining the effects of smoking; however, these was a tendency for an increase in the concentration of Arsenic and Cadmium elements for non-smoker patients compared to the healthy ones, with the exception of Lead, which was higher in healthy tissues, reinforcing the previous finding that

Leads is a carcinogen. Given that fewer women smoke than the men in the study, it is more prevalent in the tissues of women. The results showed that the highest concentrations of the elements Arsenic and Cadmium were higher in cities, both inpatients and healthy people. While Lead, although it was higher in the tissues of patients compared to healthy people in the countryside, now valued was higher in the tissues of patients in the countryside with the inability to compare with healthy people because of its lack number of samples.

Regarding the management of basic elements under the influence of gender, smoking and housing, the concentrations of Manganese, Nickel and Zinc were higher in the tissues of men with cancer compared to women, in addition to that these concentrations decreased significantly in the tissues of smokers cancer patients compared to non-smokers, while the concentration of Zinc and Manganese was higher in the cancerous tissues of the population. In cities, and conversely, Zinc was higher in cancer tissues than in the rural population.

Table 4.36: Statistical analysis results for Arsenic (As), Cadmium (Cd), and Lead (Pb) concentration (*ppm*) of tissue samples of study groups under gender

Classification	Element	Gender	Number of the samples	Means ± Stander Error For Tissue	p-value
Patients group	As	Female	3	0.117± 0.002	p>0.05
		Male	2	0.166± 0.048	
Healthy group	As	Female	1	0.122000	
		Male	2	0.110± 0.004	
Patients group	Cd	Female	2	0.110± 0.002	
		Male	2	0.159± 0.050	
Healthy group	Cd	Female	2	0.111± 0.008	
		Male	2	0.106± 0.003	
Patients group	Pb	Female	2	0.970± 0.549	
		Male	1	0.1724100	
Healthy group	Pb	Female	3	0.348± 0.132	
		Male	3	1.404± 1.125	

The non-significance at ($p<0.05$).

Table 4.37: Statistical analysis results for Arsenic (As), Cadmium (Cd), and Lead (Pb) concentration (*ppm*) of tissue samples of study groups under the smoking factor.

Classification	Element	Smoker	Number of the samples	Means ± Stander Error For Tissue	p-value
Patients group	As	Smoker	0a	-	p> 0.05
		Non Smoker	5	0.137± 0.019	
Healthy group	As	Smoker	-	-	
		Non Smoker	3	0.114± 0.004	
Patients group	Cd	Smoker	-	-	
		Non Smoker	4	0.134± 0.025	
Healthy group	Cd	Smoker	-	-	
		Non Smoker	4	0.108± 0.004	
Patients group	Pb	Smoker	-	-	
		Non Smoker	3	0.704± 0.414	
Healthy group	Pb	Smoker	-	-	
		Non Smoker	6	0.876± 0.559	

The non-significance at ($p<0.05$).

Table 4.38: Statistical analysis results for Manganese (Mn), Nickel (Ni), and Zinc (Zn) concentration (*ppm*) of tissue samples of study groups under gender factor.

Classification	Element	Gender	Number of the samples	Means ± Stander Error For Tissue	p-value
Patients group	Mn	Female	6	0.145± 0.079	p> 0.05
		Male	4	0.157± 0.082	
Healthy group	Mn	Female	6	0.410± 0.103	
		Male	4	0.360± 0.133	
Patients group	Ni	Female	3	0.131± 0.027	
		Male	2	0.159± 0.021	
Healthy group	Ni	Female	6	0.1007± 0.032	
		Male	4	0.241± 0.031	
Patients group	Zn	Female	6	3.975± 1.050	
		Male	4	5.836± 1.440	
Healthy group	Zn	Female	6	5.88± 1.641	
		Male	4	2.763± 0.931	

The non-significance at ($p<0.05$).

Table 4.39: Statistical analysis results for Manganese (Mn), Nickel (Ni), and Zinc (Zn) concentration (*ppm*) of tissue samples of study groups under smoking factor.

Classification	Element	Smoker	Number of the samples	Means± Stander Error For Tissue	p-value
Patients group	Mn	Smoker	1	0.136	p> 0.05
		Non Smoker	9	0.167± 0.058	
Healthy group	Mn	Smoker	1	0.226	
		Non Smoker	9	0.408± 0.084	
Patients group	Ni	Smoker	-	-	
		Non Smoker	5	0.142± 0.017	
Healthy group	Ni	Smoker	1		
		Non Smoker	9	0.154± 0.035	
Patients group	Zn	Smoker	1	3.730	
		Non Smoker	9	4.830± 0.952	
Healthy group	Zn	Smoker	1	5.10204000	
		Non Smoker	9	4.584± 1.260	

The non-significance at ($p<0.05$).

Table 4.40: Statistical analysis results for Arsenic (As), Cadmium (Cd), and Lead (Pb) concentration (*ppm*) of tissue samples of study groups with living area.

Classification	Element	Living Area	Number of the samples	Means± Stander Error For Tissue	p-value
Patients group	As	Rural	2	0.1160±0.0040	$p > 0.05$
		Urban	3	0.1511±0.031	
Healthy group	As	Rural	2	0.1140±0.008	
		Urban	1	0.114	
Patients group	Cd	Rural	1	0.112	
		Urban	3	0.1422±0.033	
Healthy group	Cd	Rural	3	0.108±0.005	
		Urban	1	0.109	
Patients group	Pb	Rural	-	-	
		Urban	3	0.704±0.414	
Healthy group	Pb	Rural	3	1.494±1.084	
		Urban	3	0.259±0.088	

The non-significance at ($p<0.05$).

Table 4.41: Statistical analysis results for Manganese (Mn), Nickel (Ni), and Zinc (Zn) concentration (*ppm*) of tissue samples of study groups with living area.

Classification	Element	Living Area	Number of the samples	Means± Stander Error For Tissue	p-value
Patients group	Mn	Rural	5	0.145±0.062	p> 0.05
		Urban	5	0.154±0.098	
Healthy group	Mn	Rural	5	0.548±0.116	
		Urban	5	0.232±0.033	
Patients group	Ni	Rural	3	0.114±0.023	
		Urban	2	0.140±0.039	
Healthy group	Ni	Rural	5	0.186±0.036	
		Urban	5	0.127±0.053	
Patients group	Zn	Rural	5	5.099±1.560	
		Urban	5	4.340±0.901	
Healthy group	Zn	Rural	5	6.293±1.862	
		Urban	5	2.979±0.942	

The non-significance at ($p<0.05$).

4.5 Conclusions

1-The possibility of using the Raman laser pumping technique as an effective tool for early detection of cancer by changing the positions of the chemical groups.

2- The change in the reality of the bonds according to the Raman spectra was more pronounced in the samples of patients than in the healthy ones.

3-The change in the positions of the bonds in the nitrogenous bases was complete in the adenine (A), cytosine (C), and guanine (G) bases, while the change was less in the base thymine (T) This proves that DNA changes during cancer.

4- The concentrations of alpha emitters of radon and uranium were significantly higher in blood and tissue samples of cancer patients than in healthy controls.

5- The concentrations of alpha emitters of radon and uranium were slightly higher in blood samples than in tissues

6- The concentrations of radon and uranium were higher in samples of males than in females and smokers are higher than non-smokers. In both blood and tissue for patient samples.

7- Whole blood and tissue together had the greatest levels of radon and uranium in the age (51-60) years group of cancer patients.

8- Radon and uranium were higher in the blood of patients with kidney cancer, followed by colon cancer in relation to cancers affecting both genders, while the rates were higher in cervix cancer in relation to breast cancer than in female cancers.

9- Although the gender change factor did not give clear statistical indications, the tendency to increase radon and uranium concentrations was higher in male cancer patients than in females for both blood and tissue samples.

10- Regarding to the toxic elements (As, Cd and Pb), the Lead concentrations were the highest among them for whole blood and tissue samples.

11- Based on the results, for essential elements (Mn, Ni and Zn) the highest increase was cleared in patient blood samples, while this increase was revealed with healthy tissue samples.

12-The concentration of Lead is generally higher in the blood and tissue of female cancer patients.

13- The concentration of Arsenic and Lead in smokers is higher in urban areas than in rural areas**.**

14- The proportions of toxic elements in patient samples of Arsenic, Lead and Cadmium were higher than the universally permissible in both blood and tissue samples.

15-The tissue samples gave preference when detecting the concentrations of the toxic elements Lead, Arsenic and Cadmium compared to using blood samples

16- The use of whole blood samples was better than tissue when detecting the concentrations of the basic elements in the body, Manganese, Nickel and Zinc.

17-There was a highly significant correlation between Cadmium and Lead elements in the patients' blood, meaning that they increased and decreased in the same sample. While there was a highly significant correlation between Zinc, Manganese and Nickel in blood samples, meaning that their behavior is shared by increase and decrease, and they play the same vital role in increasing or decreasing the incidence of cancer.

4-5 Recommendations:

1- Avoid living in areas that contain phosphate quarries and industrial facilities

2- Reducing the use of phosphate fertilizers in agriculture

3-Avoid smoking and passive smoking

4- Stay away from areas that are landfill areas for industrial waste

5- Avoid eating foods and drinks that contain toxic elements

6- Do not take essential trace elements without medical advice and monitor their concentrations in the body

4.6 Further studies:

1- Using lasers of different wavelengths in the Raman spectrum

2- Selection and linkage of human and environmental biological samples

3- Using the nuclear fission technique to measure uranium and compare the results with it

4- Detect a wider range of trace elements and study the overlap in their action

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Appendices

Appendix A: Facilitation of a mission to collect the biological samples

Training and Human Development Center

شعبة ادارة المعرفة
وحدة البحوث
العدد: ١٢٧٦
التاريخ / ٢٥ / ١١ / ٢٠٢٠

إلى/ مركز الامام الحسين للامراض السرطانية

الموضوع/ بيان راي

السلام عليكم...

كتاب جامعة كربلاء / كلية العلوم المرقم ١٩٣٤ في ٢٠٢٠/١١/٢٤

يرجى بيان رايكم حول امكانية تسهيل مهمة طالبة الدراسات (حوراء محمد عباس) لإنجاز بحثها الموسوم:

(الكشف عن مسببات السرطان في عينات بيولوجية مختلفة باستخدام بعض التقنيات الفيزيائية)

في مؤسستكم الصحية مع ترشيح مشرف عملي للبحث من قبل عضو لجنة البحوث على ان لا تتحمل دائرتنا اي نفقات مادية مع الاحترام.

الدكتورة
تقوى خضر عبد الكريم
مديرمركز التدريب والتنمية البشرية
٢٠٢٠/١١/٢٥

موافق د. ...

نسخة منه الى:-
قسم العمليات / مصرف الدم
مركز التدريب والتنمية البشرية مع الأوليات

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جمهورية العراق

محافظة كربلاء المقدسة
دائرة صحة كربلاء المقدسة
مركز التدريب والتنمية البشرية
شعبة ادارة المعرفة
وحدة البحوث
العدد: ١٢٩١
التاريخ / ٢٦ / ١١ / ٢٠٢٠

Holy Karbala governorate
Karbala Health Department
General manager's office
Training and Human Development Center

إلى/ جامعة كربلاء / كلية العلوم

الموضوع/ تسهيل مهمة

تحيه طيبه....

كتابكم المرقم ١٩٣٤ في ٢٠٢٠/١١/٢٤

لا مانع لدينا من تسهيل مهمة طالبة الدراسات (حوراء محمد عباس) لإنجاز بحثها الموسوم:-

(الكشف عن مسببات السرطان في عينات بيولوجية مختلفة باستخدام بعض التقنيات الفيزيائية)

في مؤسستنا الصحية / مركز الاورام السرطانية/ مصرف الدم على ان لا تتحمل دائرتنا اي نفقات مادية مع الاحترام.

الطبيب الاستشاري
د حيدر محمد حسن العطار

الدكتورة
تقوى خضر عبد الكريم
مدير مركز التدريب والتنمية البشرية
٢٠٢٠/١١/٢٦

موافق
الدكتور
نزار جبار متعب
Consultant Path.

نسخة منه إلى
مكتب المدير العام/ مركز الامام الحسين للاورام كتابكم المرقم ٣٣٣ في ٢٠٢٠/١١/٢٦
قسم الامور الفنية /شعبة مصرف الدم كتابكم المرقم ٤٠٤٩ في ٢٠٢٠/١١/٢٦
مركز التدريب والتنمية البشرية مع الاوليات
زينا /

العنوان/كربلاء المقدسة - حي الحسين(ع) – قرب دائرة كاتب العدل - رقم الهاتف / ٠٣٢٣٢٨٠٠٢
البريد الالكتروني / train.centerKH@yahoo.com / Email -
العنوان/كربلاء المقدسة - حي الحسين(ع) – قرب دائرة كاتب العدل train.centerKH@yahoo.com / -

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Republic of Iraq
Ministry Of Higher Education and Scientific Research
College of Science – University of Kerbala
Division of Postgraduate studies

جمهورية العراق
وزارة التعليم العالي والبحث العلمي
جامعة كربلاء - كلية العلوم
شعبة الدراسات العليا

العدد/ع/6/327
التاريخ/ع / 2 / 2021

جامعة كربلاء - كلية العلوم
الصادرة
العدد
التاريخ

إلى / مستشفى الكفيل
م / تسـهيل مـهمـة

نهديكم أطيب التحيات ...

يـرجى تسـهيـل مهمـة طالـبة الدراسـات العـليا في كليتنا (دكتوراه/ علوم الفيزياء) (**حوراء محمد عباس**) وذلك لغرض اكمال متطلبات بحثها الموسوم(تركيز الرادون واليورانيوم والعناصر النزرة لعينات بايولوجية لمرضى السرطان) .

... مع الـتقديـر ...

أ. م.د. جاسـم حنون هاشـم العوادي
العمـيد وكالة
2021 / 2 /

نسخة منه إلى :

- مكتب السيد معاون العميد للشؤون العلمية .. مع التقدير ..
- الدراسات العليا
- ملف الطالب

الصادر

طباعة : Ahmed.k 2021/02/01

م.د.زمان حميد كريم
مسؤول شعبة الدراسات العليا

العنوان : العراق- محافظة كربلاء المقدسة – المدينة الجامعية – كلية العلوم ص .ب. 1125
E-mail :science@uokerbala.edu.iq

جمهورية العراق

محافظة كربلاء المقدسة
دائرة صحة كربلاء المقدسة
مركز التدريب والتنمية البشرية
شعبة ادارة المعرفة
وحدة البحوث
العدد: ٦١١
التاريخ: ١٠ / ٥ / ٢٠٢١

Holy Karbala governorate
Karbala Health Department
General manager's office
Training and Human Development Center

الى/ مدينة الامام الحسين (ع) الطبية

<u>الموضوع/ بيان رأي</u>

السلام عليكم

كتاب جامعة كربلاء /كلية العلوم المرقم ١٩٣٤ في ٢٠٢٠/١١/٢٤

يرجى بيان رايكم حول امكانية تسهيل مهمة طالبة الدراسات (حوراء محمد عباس) لانجاز بحثها الموسوم:-

(الكشف عن مسببات السرطان في عينات بيولوجية مختلفة باستخدام بعض التقنيات الفيزيائية)

في مؤسستكم الصحية مع ترشيح مشرف عملي للبحث من قبل عضو لجنة البحوث على إن لا تتحمل دائرتنا اي نفقات مادية مع الاحترام.

الدكتور الاختصاص
حيدر قاسم اسد
اختصاص طب الاطفال

الدكتورة
تقوى خضر عبد الكريم
مدير مركز التدريب والتنمية البشرية
٢٠٢١/٥/١٠

<u>نسخة منه الى:-</u>
-مركز التدريب والتنمية البشرية مع الأوليات

العنوان كربلاء المقدسة- حي الحسين(ع) - قرب دائرة كاتب العدل - رقم الهاتف / ٠٣٢٣٢٨٠٠٢.
- Email / train...

Holy Karbala Governorate
Karbala Health Directorate
Imam Hussain Medical City

جمهـــــورية العــــــراق

محافظة كربلاء المقدسة
دائــــرة صحة كربلاء المقدســـــة
مدينـــــة الإمام الحسين (ع) الطبيـــــة
شعبة الأمور الإدارية والمالية
وحــــــدة إدارة الموارد البشريـــــــة

العـــدد / ٢٠٠١
التاريخ / ٢٧/٥/٢٠٢١

إلى / دائــــــــرة صحة كربلاء المقدسة /مركز التدريب والتنمية البشريـــــــــة /شعبة ادارة المعرفة / وحدة البحوث

م / تسهيل مهمة

كتابكم المرقم 610 في 2021/5/10

لا مـــانع لــدينا مـــن تســـهيل مهمـــة طالبـــة الدراســـات / حـــوراء محمد عبـــاس/ لانجـــاز بحثهـــا علـــى أن يكـــون المشـــرف العملـــي للبحـــث / الـــدكتور نـــزار جبـــار متعـــب فليفـــل / طبيـــب اختصـــاص نســـيج مرضـــي , مع الاحترام

د. علاء جلاب مطر
اختصاص الأنف والأذن والحنجرة
مستشفى الحسين (ع) التعليمي

الدكتـــــور
د. صباح كريم حمـــزة
مدير مدينة الإمام الحسين (ع) الطبية

نسخة منه إلى :

- وحدة التدريب والتطوير/ لتبليغ الطبيب
- وحدة إدارة الموارد البشرية / مع الأوليات

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Holy Karbala Governorate
Karbala Health Directorate
Imam Hussain Medical City

العدد / ٢٥٠١
التاريخ / ٢٠٢١/٥/٢٧

جمهورية العراق

محافظة كربلاء المقدسة
دائرة صحة كربلاء المقدسة
مدينة الإمام الحسين (ع) الطبية
شعبة الأمور الإدارية والمالية
وحدة إدارة الموارد البشرية

إلى / دائرة صحة كربلاء المقدسة /مركز التدريب والتنمية البشرية /شعبة ادارة المعرفة / وحدة البحوث

م / تسهيل مهمة

كتابكم المرقم 610 في 2021/5/10

لا مانع لدينا من تسهيل مهمة طالبة الدراسات / حوراء محمد عباس/ لانجاز بحثها على أن يكون المشرف العملي للبحث / الدكتور نزار جبار متعب فليفل / طبيب اختصاص نسيج مرضي , مع الاحترام

د. علاء جلاب مطر
اختصاص الأنف والأذن والحنجرة
مستشفى الحسين ع التعليمي

الدكتور
د. صباح كريم حمزة
مدير مدينة الإمام الحسين (ع) الطبية

نسخة منه إلى :

- وحدة التدريب والتطوير/ لتبليغ الطبيب
- وحدة إدارة الموارد البشرية / مع الأوليات

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Appendix B: Questionnaire of the participants in this study

Sample code( )

Questionnaire for scientific research about **(Study of Uranium, Radon and Trace Elements Concentration in Biological Samples of Cancer Patients).**

Dear Sir/ Madam

The researcher intends to conduct a study entitled (Study of Uranium, Radon and Trace Elements Concentration in Biological Samples of Cancer Patients).

Your participation in this study is voluntary practices, and your response will be kept very confidently. You are not obliged to give your name and full address in this matter. Those who will wish to know the scientific result of such a test should write down their names and addresses.

Thank you in advance for your kind assistance and cooperation.

Name (in case wishing to know the results of the test):

Address:

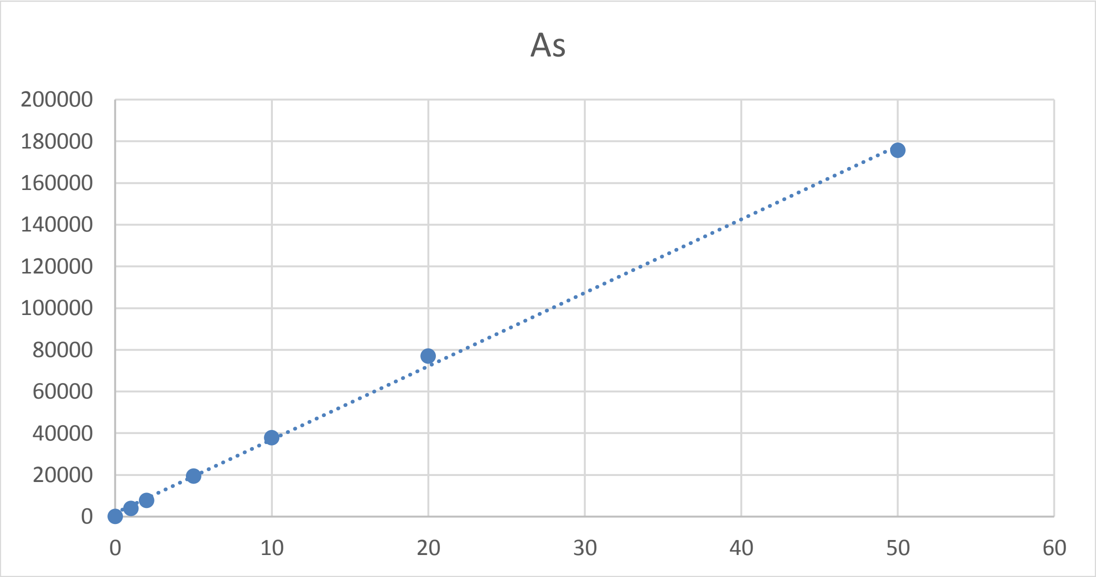
Phone number:

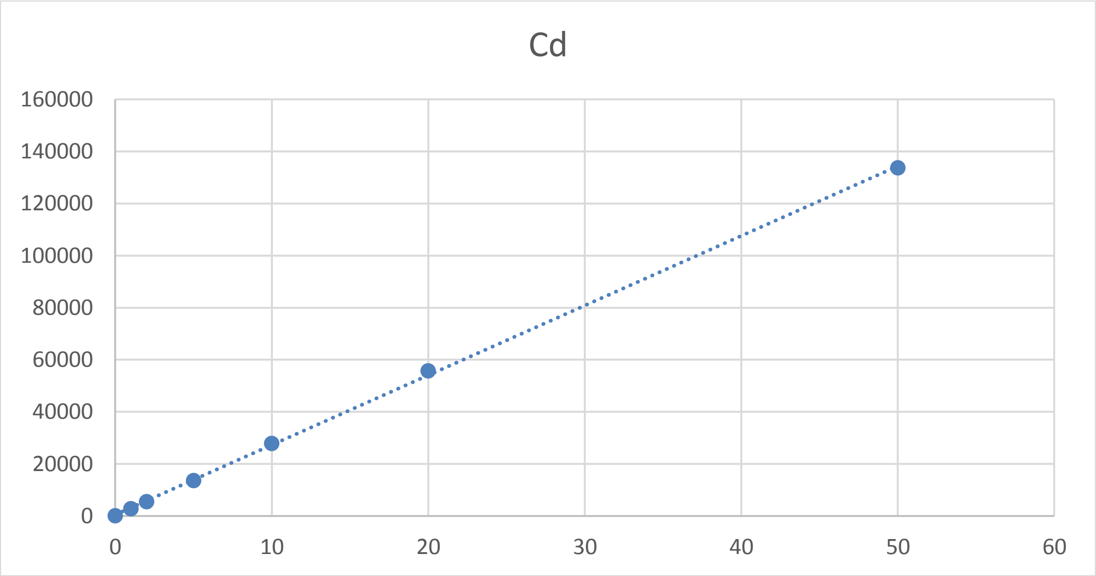
Questions:

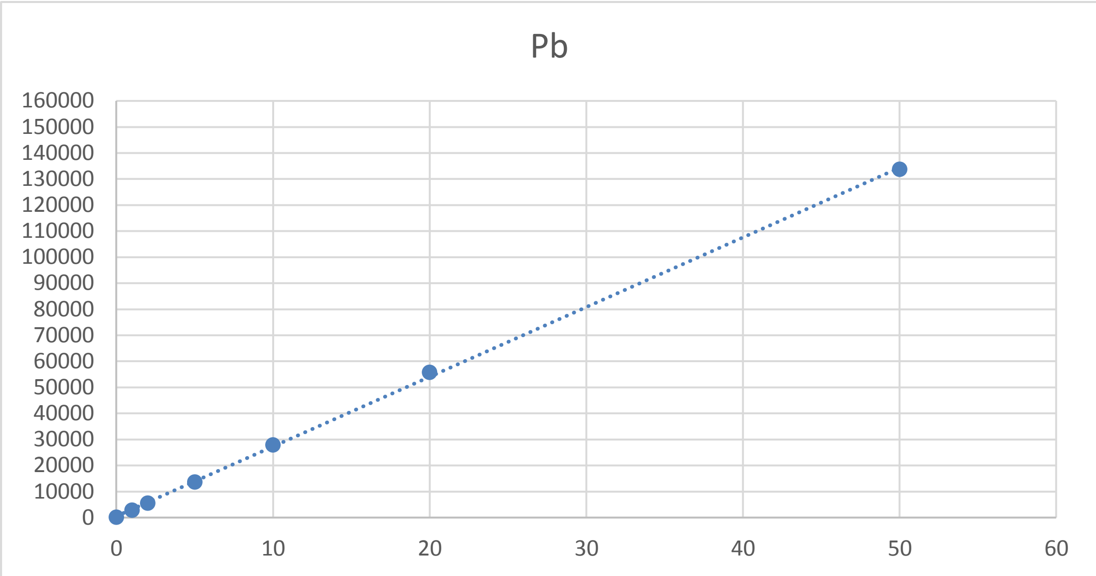
1- Gender: male female
2- Age:
3- Smoking habit: yes no
4- Health status(cancer): intact patient
5- Medical history:
6- Other diseases:
7- Job:
8- If you are cancer patient, what is the case (physician diagnosis)?
9- Type of medication:
10- Blood type:

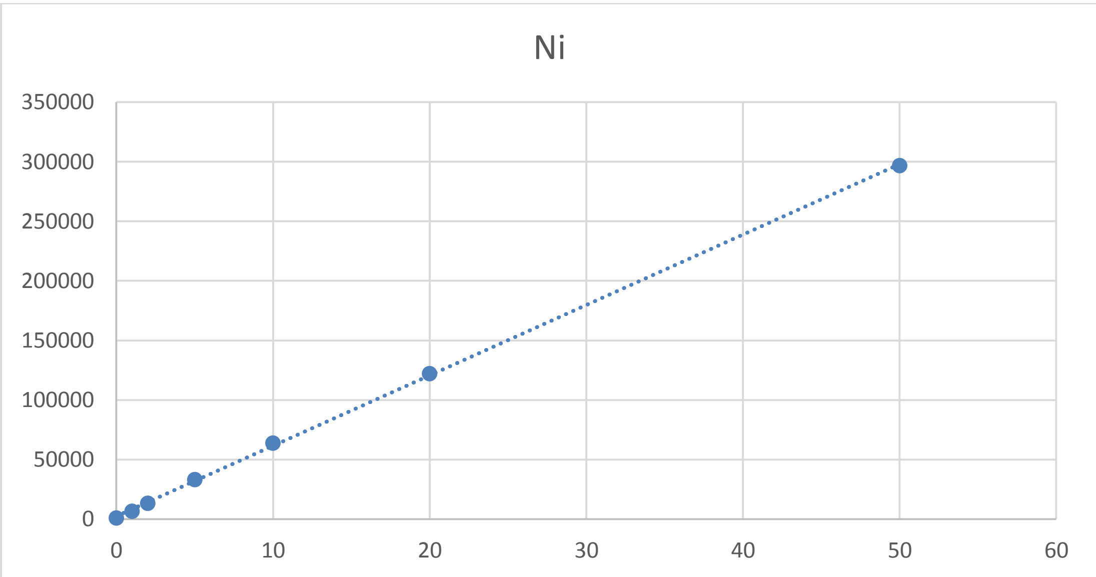
Appendix C: Calibration curves of trace elements (As, Cd, Pb, Ni, Zn, and Mn).

Where the y-axis represents the intensity and the x-axis represents the concentration of the element






Pb
160000
150000
140000
130000
120000
110000
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
0
10
20
30
40
50
60


Ni
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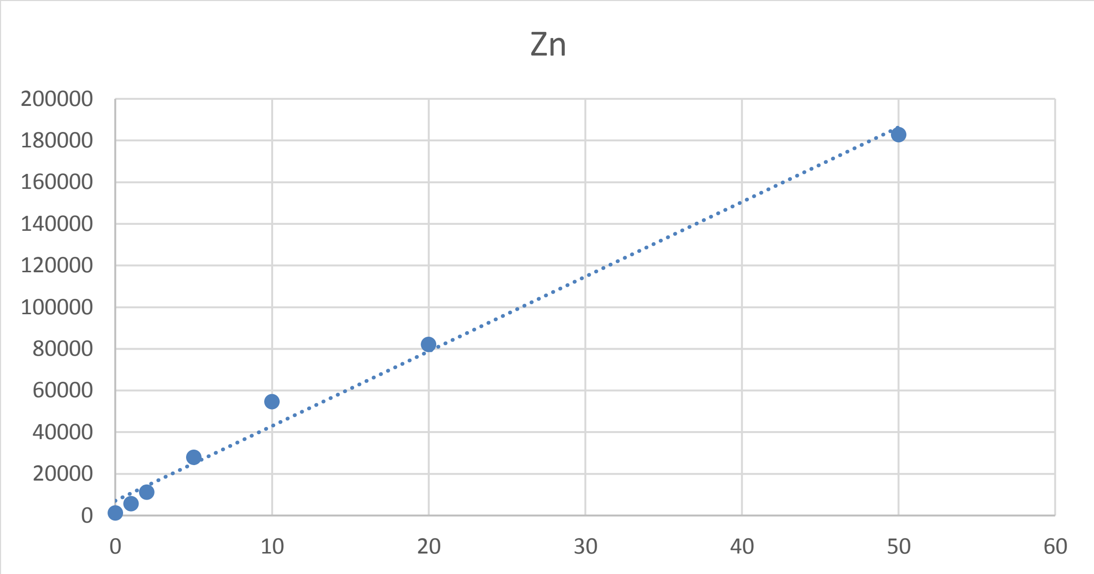
300000
250000
200000
150000
100000
50000
0
0
10
20
30
40
50
60


Zn
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180000
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140000
120000
100000
80000
60000
40000
20000
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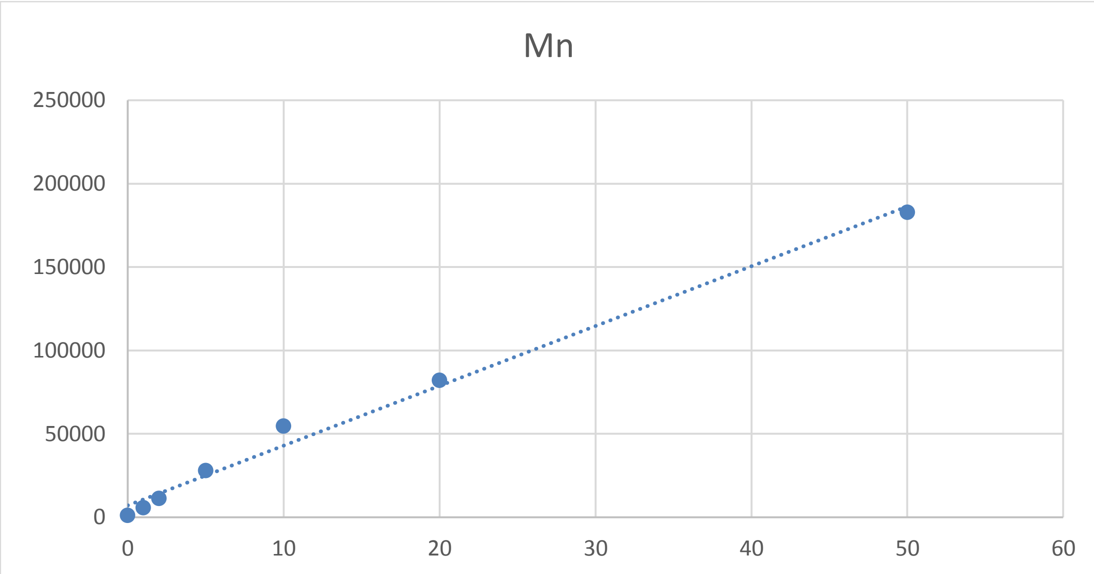
0
10
20
30
40
50
60


Mn
250000
200000
150000
100000
50000
0
0
10
20
30
40
50
60

Appendix D: The demographic characterizations of the human samples.

Table A: The demographic characterizations of the blood samples.

Sample Code	Age	Gender	Smoking Habit	Resident Area	Cancer Type
Cancer Patients					
B1	50	Female	No	Urban	Breast
B2	52	Female	No	Rural	Cervix
B3	68	Female	Yes	Rural	Kidney
B4	50	Female	No	Urban	Breast
B5	70	Female	No	Urban	Colon
B6	52	Female	Yes	Rural	Breast
B7	44	Female	No	Rural	Breast
B8	41	Female	No	Rural	Colon
B9	31	Female	No	Rural	Breast
B10	61	Female	No	Rural	Breast
B11	35	Female	No	Rural	Breast
B12	28	Female	No	Urban	Breast
B13	50	Female	No	Rural	Breast
B14	72	Female	Yes	Rural	Cervix
B15	39	Female	No	Urban	Cervix
B16	25	Female	No	Urban	Cervix
B17	47	Female	No	Urban	Breast
B18	29	Female	Yes	Urban	Breast
B19	18	Female	No	Rural	Cervix
B20	52	Female	Yes	Urban	Breast
B21	56	Female	No	Rural	Cervix

B22	38	Female	No	Urban	Kidney
B23	64	Female	No	Rural	Colon
B24	52	Female	No	Rural	Colon
B25	28	Female	No	Urban	Kidney
B26	65	Male	Yes	Urban	Prostate
B27	66	Male	No	Urban	Kidney
B28	38	Male	Yes	Rural	Colon
B29	67	Male	Yes	Rural	Prostate
B30	43	Male	Yes	Rural	Prostate
B31	67	Male	Yes	Urban	Prostate
B32	48	Male	No	Rural	Kidney
B33	20	Male	Yes	Rural	Kidney
B34	52	Male	No	Rural	Prostate
B35	48	Male	Yes	Urban	Kidney
B36	20	Male	No	Urban	Kidney
B37	72	Male	Yes	Rural	Prostate
B38	63	Male	No	Urban	Colon
B39	45	Male	Yes	Urban	Kidney
B40	52	Male	Yes	Urban	Kidney
B41	74	Male	No	Rural	Prostate
B42	70	Male	Yes	Rural	Prostate
B43	20	Male	No	Rural	Kidney
B44	20	Male	Yes	Rural	Colon
B45	66	Male	No	Rural	Colon
B46	21	Male	No	Urban	Colon
B47	67	Male	Yes	Rural	Colon

B48	26	Male	Yes	Urban	Colon
B49	66	Male	No	Urban	Kidney
B50	38	Male	Yes	Rural	Colon
B51	39	Female	No	Rural	Breast
B52	56	Female	No	Rural	Cervix
B53	35	Female	No	Urban	Kidney
B54	43	Female	No	Rural	Breast
B55	22	Female	No	Rural	Colon
B56	44	Female	No	Rural	Breast
B57	23	Female	No	Rural	Cervix
B58	38	Female	No	Urban	Kidney
B59	21	Female	No	Rural	Colon
B60	18	Female	No	Rural	Colon
B61	32	Male	No	Rural	Kidney
B62	20	Male	No	Rural	Prostate
B63	26	Male	Yes	Urban	Kidney
B64	64	Male	No	Rural	Prostate
B65	48	Male	No	Urban	Colon
B66	49	Male	No	Rural	Prostate
B67	46	Male	No	Rural	Colon
B68	45	Male	Yes	Urban	Kidney
B69	43	Male	No	Rural	Prostate
B70	34	Male	No	Rural	Colon
Healthy group					
B71	42	Female	No	Urban	Healthy
B72	41	Female	No	Urban	Healthy

B73	40	Female	No	Urban	Healthy
B74	65	Female	Yes	Rural	Healthy
B75	18	Female	No	Urban	Healthy
B76	46	Female	No	Urban	Healthy
B77	47	Female	No	Urban	Healthy
B78	48	Female	No	Urban	Healthy
B79	70	Female	No	Rural	Healthy
B80	23	Female	No	Urban	Healthy
B81	57	Female	No	Urban	Healthy
B82	34	Female	No	Urban	Healthy
B83	27	Female	No	Urban	Healthy
B84	38	Female	No	Rural	Healthy
B85	64	Female	No	Urban	Healthy
B86	58	Male	No	Urban	Healthy
B87	59	Male	No	Urban	Healthy
B88	50	Male	No	Urban	Healthy
B89	42	Male	No	Rural	Healthy
B90	42	Male	No	Urban	Healthy
B91	44	Male	No	Urban	Healthy
B92	43	Male	No	Urban	Healthy
B93	34	Male	No	Urban	Healthy
B94	24	Male	Yes	Rural	Healthy
B95	18	Male	No	Urban	Healthy
B96	36	Male	No	Urban	Healthy
B97	28	Male	No	Rural	Healthy

B98	21	Male	No	Rural	Healthy
B99	47	Male	Yes	Urban	Healthy
B100	25	Male	Yes	Rural	Healthy

Table B: Tissue samples classification in age, gender, smoking habit, resident area and cancer type for malignant and benign groups.

Sample No.	Sample Code	Age	Gender	Smoking Habit	Resident Area	Cancer Type
Malignant group						
1	T11	46	Female	No	Rural	Breast
2	T12	41	Female	No	Rural	Breast
3	T13	35	Female	No	Rural	Breast
4	T14	42	Female	No	Rural	Breast
5	T15	48	Female	No	Urban	Breast
6	T16	43	Female	Yes	Urban	Breast
7	T17	52	Female	No	Rural	Cervix
8	T18	67	Female	No	Rural	Cervix
9	T19	68	Female	No	Urban	Cervix
10	T20	67	Female	No	Urban	Cervix
11	T21	56	Male	Yes	Rural	Colon
12	T22	70	Male	Yes	Rural	Colon
13	T23	42	Female	No	urban	Colon
14	T24	54	Male	No	urban	Colon
15	T25	50	Female	No	Urban	Colon
16	T26	51	Female	No	Rural	Colon

17	T27	70	Female	No	Urban	Colon
18	T28	58	Female	No	Rural	Breast
19	T29	53	Female	No	Rural	Cervix
20	T30	58	Female	No	Rural	Cervix
21	T31	47	Male	No	Rural	Kidney
22	T32	69	Male	No	Rural	Kidney
23	T33	39	Male	Yes	Urban	Kidney
24	T34	60	Female	No	Rural	Kidney
25	T35	59	Female	No	Rural	Kidney
26	T36	59	Female	No	Rural	Kidney
27	T37	49	Male	Yes	Urban	Breast
28	T38	36	Male	Yes	Urban	Prostate
29	T39	17	Male	No	Rural	Prostate
30	T40	73	Male	No	Rural	Prostate
Benign group						
31	T1	50	Female	No	Rural	Cervix
32	T2	40	Female	No	Urban	Kidney
33	T3	55	Female	No	Rural	Cervix
34	T4	37	Female	No	Rural	Cervix
35	T5	17	Female	No	Urban	Breast
36	T6	35	Male	Yes	Urban	Colon
37	T7	54	Male	No	Urban	Kidney
38	T8	32	Male	No	Urban	Colon
39	T9	24	Male	No	Rural	Prostate
40	T10	50	Female	No	Rural	Cervix

الخلاصة

اصبح التحقيق في آثار التلوث الإشعاعي والتلوث السام ، فضلاً عن المعدلات المرتفعة لمرضى السرطان في جميع أنحاء العالم وفي العراق على وجه الخصوص ، أمرًا حيويًا ، لا سيما بالنظر إلى الوضع الذي كان فيه العراق ولا يزال عرضة لعواقب التلوث الناجمة عن الصراعات والحروب. تناولت الدراسة عينات بيولوجية بشرية من الدم الكامل والأنسجة من خمسة أنواع من السرطانات (الثدي ، وعنق الرحم ، والكلى ، والقولون ، والبروستات) لتقييم مستويات التلوث الإشعاعي والسام في محافظة كربلاء. وتضمنت مجموعتين ، واحدة لمرضى السرطان والأخرى لأصحاء. تم قياس القواعد النيتروجينية الموجودة في الحمض النووي البشري ، الأدينين ، والسايتوسين (C) ، والجوانين (G) ، والثايمين (T) ، ودراسة تأثرها سواء التلف أو التغيير بسبب الإصابة بالسرطان باستخدام أطياف رامان من مصدر الليزر ومقارنتها بالعينات الصحية.

تم تطبيق كاشف المسار النووي الصلب (CR-39) مع أنظمة TASLImage ™ للكشف عنعن تركيزات بواعث ألفا في العينات تركيز الرادون (C_{Rn}) ، تركيز الرادون داخل العينة ($C_{Rn}^{s,ac}$) تركيز الراديوم ($C_{Ra}^{s,ac}$) والجرعة الفعالة السنوية (E)، وتركيز اليورانيوم U بوحدات (*ppm*). تمت مقارنة قيم بواعث ألفا المتمثلة في الرادون واليورانيوم ، في عينات المجموعات الصحية والمرضى وعينات الدم والأنسجة ، ثم تمت مقارنتها مع تغير الجنس والعمر والتدخين وموقع السكن الريفي أو الحضري ، وكذلك نوع السرطان. كان تركيز الرادون واليورانيوم في عينات دم مرضى السرطان 7.631 ± 1.238 (*Bg / Kg*) و 0.615 ± 0.099 (*ppm*) على التوالي ، بينما في عينات الأنسجة كان 7.385 ± 0.838 (*Bg / Kg*) و 0.595 ± 0.211 (ppm) على التوالي.

أظهرت المقارنات الإحصائية قيمًا معنوية تم أخذها في الاعتبار بين مرضى السرطان والأشخاص الأصحاء في تراكيز كل من الرادون واليورانيوم لكل من عينات الدم والأنسجة ، كما أن قيم الرادون واليورانيوم كانت متشابهة بين الدم والأنسجة لعينات المرضى ، مع وجود تباين بين قيم الرادون واليورانيوم وزيادة طفيفة جدا في الدم. بناءً على تركيزات الرادون واليورانيوم المدروسة تحت تأثير الجنس في عينات الدم والأنسجة ، كانت القيم أعلى قليلاً للذكور ، والتي كانت متوافقة مع النسب الأعلى للمدخنين في عينات الدم والمنطقة السكنية بالنسبة لعينات الأنسجة. لم يكن لعامل العمر تغيرًا إحصائيًا يؤخذ في الاعتبار ، على الرغم من أن أعلى التراكيز في الدم والأنسجة كانت في حدود 51-60 عامًا. بالنسبة للسرطان الذي يصيب كلا الجنسين ، كان هناك زيادة في تركيز الرادون واليورانيوم لسرطان الكلى في عينات الدم والأنسجة.

تم حساب تراكيز العناصر السامة الرصاص (Pb) والكادميوم (Cd) والزرنيخ (As) والعناصر الأساسية في الجسم مثل المنغنيز(Mn) والنيكل (Ni) والزنك (Zn) باستخدام جهاز البلازما مزدوجة الحث المقترنة بمقياس مطياف الكتلة (ICP-MS). بينما كان تراكيز العناصر النزرة السامة الرصاص (Pb) والكادميوم (Cd) والزرنيخ (As) في عينات الدم (5.699 ± 1.410 و 0.314 ± 0.0433 و 0.309 ± 0.0423) جزء في المليون. في عينات الأنسجة ، وجد أن هذه التراكيز هي (3.199 ± 1.291 ، 0.12171 ± 0.007 ، و 0.187 + 0.027) جزء في المليون على التوالي والتي كانت اعلى من المسموح به عالميا . بينما تراكيز العناصر النزرة الأساسية المنغنيز (Mn) والنيكل (Ni) والزنك (Zn) في عينات الدم كان على النحو التالي (4.964 ± 1.245 ، 0.798 ± 0.158 ، و 155.281 ± 20.537) جزء في المليون وفي عينات الأنسجة ، على النحو التالي (0.182 ± 0.037 ، 0.141 ± 0.009 و 4.318 ± 0.764) جزء في المليون).

فيما يتعلق بالعناصر النزرة السامة ، كانت تراكيز الرصاص أعلى من تركيز الزرنيخ والكادميوم في عينات الدم والأنسجة. من ناحية أخرى ، احتل تركيز الزنك قيمة أعلى فيما يتعلق بالمنغنيز والنيكل لدى المرضى والأشخاص الأصحاء في عينات الدم والأنسجة ، وكانت تراكيز الزرنيخ في عينات الدم أعلى عند الرجال ، بينما كان الرصاص والكادميوم أعلى عند الإناث. كانت قيم الرصاص والزرنيخ أعلى بين المدخنين ، بينما زاد تركيز الرصاص والكادميوم بين سكان المدينة. من حيث العناصر الأساسية ، كان لدى الرجال مستويات أعلى من المنغنيز ، في حين أن النساء لديهن مستويات أعلى من الزنك والنيكل. لم يكن للتدخين أي تأثير على تغيير تركيزات العناصر الأساسية ، حتى بعد الأخذ في الاعتبار أن مرضى الأنسجة الذين يقيمون في جانب المدينة لديهم مستويات أعلى من المنغنيز والزنك. في المقابل ، احتوت الأنسجة السرطانية لسكان الريف على مستويات أعلى من النيكل. بشكل عام كانت نسب العناصر السامة من الزرنيخ والرصاص والكادميوم أعلى من المسموح به عالمياً في كل من عينات الدم والأنسجة ، كما أعطت عينات الأنسجة الأفضلية عند الكشف عن تراكيز العناصر السامة الرصاص والزرنيخ والكادميوم مقارنة باستخدام عينات الدم. بينما كان استخدام عينات الدم الكامل أفضل من الأنسجة عند الكشف عن تراكيز العناصر الأساسية في الجسم وهي المنغنيز والنيكل والزنك.

أظهر فحص القواعد النيتروجينية (DNA) باستخدام مطياف Raman لمواقع الروابط الكيميائية تغيرًا في مواضع جميع الروابط في (A) Adenine و (C) Cytosine و (G) Guanine ، ولكن في (Thymine (T) الروابط في الموقع (cm^{-1}) 642 بقيت على حالها. ومع ذلك ، لم تتأثر المواقع (cm^{-1}) 1239 و(cm^{-1}) 1208 تقريبًا في معظم العينات.

جامعة كربلاء

كلية العلوم

قسم الفيزياء

دراسة تركيز اليورانيوم والرادون والعناصر النزرة في العينات البيولوجية لمرضى السرطان

أطروحة مقدمة الى مجلس كلية العلوم / جامعة كربلاء وهي جزء من متطلبات نيل درجة الدكتوراه في علوم الفيزياء

من قبل

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١٤٤٤ هـ **٢٠٢٢ م**