EFFECT OF RADIATION ON TISSUES WITH SPECIAL EMPHASIS ON ITS CARCINOGENIC EFFECTS

THESIS

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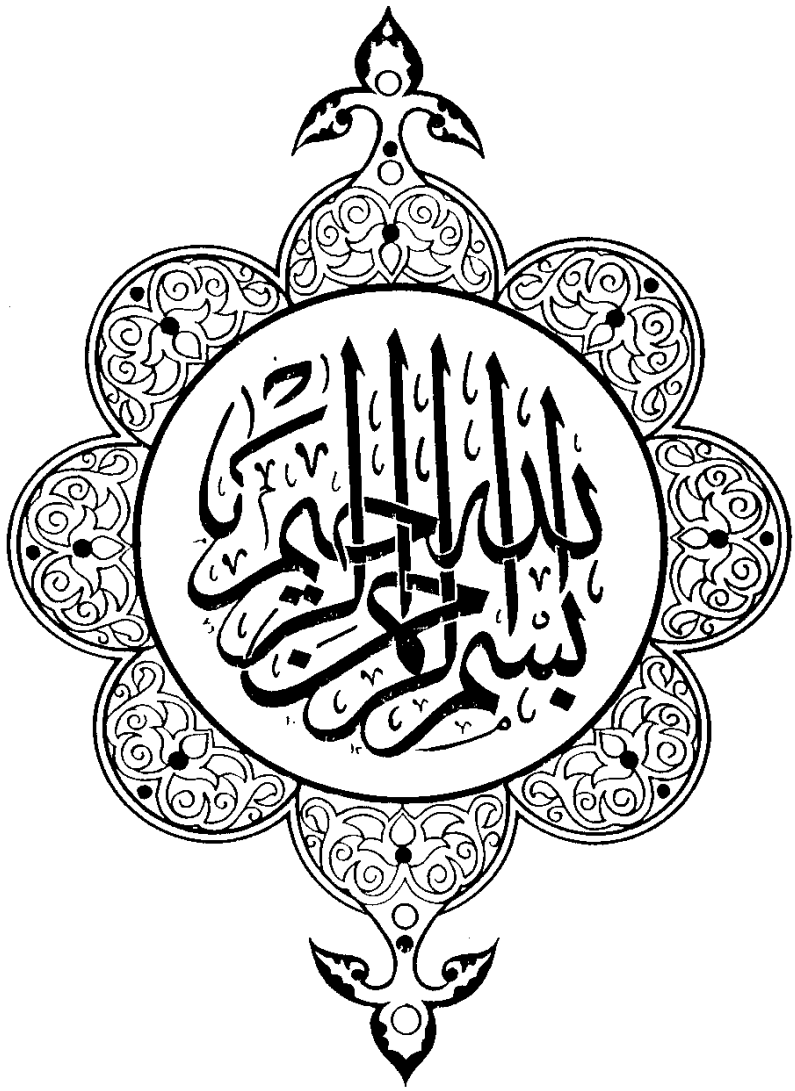

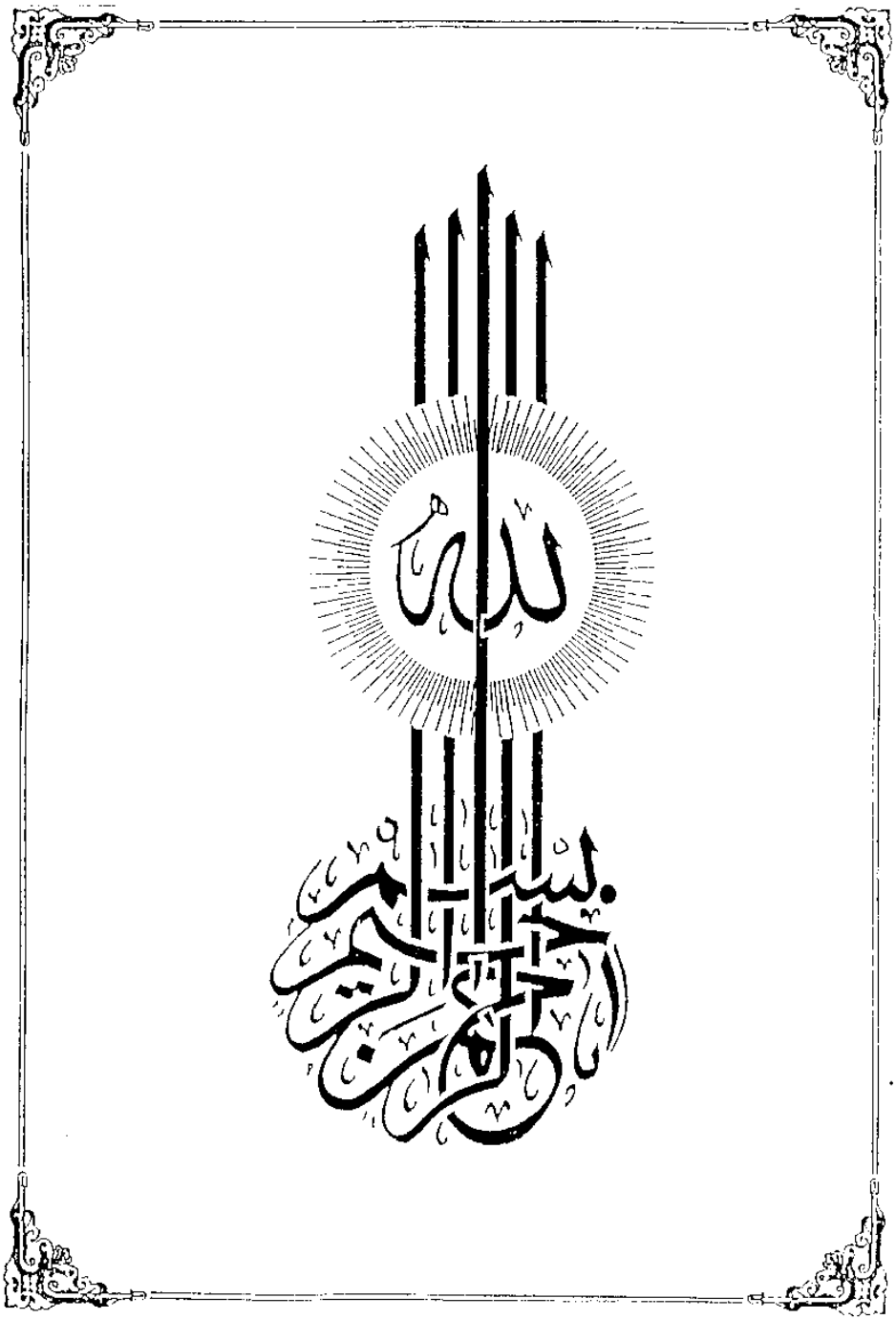

GRATITUDE

To Prof. Dr. Talaat Mahmoud El-Deeb for his kind supervision, remarkable ideas, generous advice, for his patience in reviewing the work, for his great assistance and encouragement during preparation and completion of this work.

To my Family

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INTRODUCTION

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There is no proven body of fact that establishes an increase in human cancer after low doses of x-ray or gamma radiation such as those received environmentally, occupa tionally, or from medical diagnostic procedures; that is, radiation levels below about 10 rad (0.1 Gy) (Webster, ~~et al~~, 1959).

During the past few years, several widely publicized reports concerning the carcinogenic effects of the low level radiation have appeared. These reports have claimed that significant increases in cancer mortality have been observed in human populations after exposure to low doses of x-rays or gamma rays of the order of 1 rad (0.01 Gy), (Modan, ~~B.~~ et al, 1974). The cancer risks from low doses are much greater than those estimated by study groups on the basis of high dose observations assuming proportionality between risk and dose (Caldwell, et al 1980).

Recent years have also produced unqualified assertions concerning the carcinogenic effect of radiation at the lowest levels, including natural back-ground radiation.

Stewart et al, (1956) drew attention to the fact that a greater proportion of mothers of children who

died of leukaemia or some other type of malignant disease, in comparison with mothers of children without malignant disease who were still surviving, reported that their abdomens had been x-rayed during the time the child was in utero, and the same observation has continued to be made on subsequent groups of children who died of malignant disease over the years 1953 - 1967 (Stewart and Kneale, 1968). Moreover, the excess history of irradiation given by the mothers of affected children was greater when the beam had been directed at the abdomen during the relevant period than when it had been directed to any other part of the body or at any other period in her life.

UNSCEAR, (1977), provides that exposure to ionizing radiations in amounts that are unsufficient to cause macroscopic tissue damage increases the risk of cancer in practically every organ, that the increase in risk is approximately proportional to the dose received down to doses of the order of 1 Gy (rad), that the increase varies with age, being greater in childhood and late middle age than in young adult life, that the risk of developing leukaemia attributable to irradiation is 10 to 20 per 1000 000 persons per cGy (rad) whole body exposure within 20 years.

An overwhelming amount of data has been accumulated that show there is no safe level of exposure and that there is no dose of radiation so low that the risk of malignancy is zero (Morgan et al, 1978).

Whether natural or man made, all radiation is dangerous. There is no safe amount of radioactive material or dose of radiation. Any exposure at all constitutes a serious gamble with the mechanism of life (Caldicott et al, 1978).

REVIEW OF LITERATURE$

RADIATION AND CANCER

Radiation is defined as the process of emission of energy by atoms and the transmission of this energy through space.

The meaning of ionization is understood if the structure of the atom is recalled. An atom consists of a central positively charged nucleus (proton) surrounded by negatively charged particles (electrons). The number of electrons equals the number of the positive charges of the nucleus. There is attraction between the electrons and the nucleus because they are of opposite charges. If an electron attains an extra energy that enables it to overcome that attraction and leaves the atom, we are left with an ion (positively charged because of loss of negative charge). Such energy is called ionizing agent. X-rays and gamma rays are among the ionizing radiations. The biological effects of such rays are due to ionization. Radiation is of two forms: (1) waves (electromagnetic radiation, (2) particles (corpuscular radiation).

a- Particulate:

These consist of α-particles, B-particles, neutrons and protons. α-particles are rapidly moving nuclei of helium atoms which are emitted spontaneously by radioactive

elements such as radium and thorium or are produced by the bombardment of the elements of helium and boron by neutrons (Bianchi et al, 1980).

B-particles are rapidly moving electrons carrying either a negative or a positive charge. They are emitted naturally from many radioactive elements and can also be produced by passing high tension currents through cathode ray tubes. Neutrons are electrically neutral particles which are present in all atoms other than hydrogen, (J.R. Tighe, 1981). They can be generated in atomic pills from such elements as uranium. Since these particles are electrically neutral they can penetrate the electron cloud of an atom relatively easily and reach its neucleus. The alteration of the neucleus of certain elements which result from this penetration leads to the emission of active ionizing radiations. Protons are the positively charged nuclei of hydrogen atoms which can be accelerated to very high velocities in a cyclotron. α-particles and protons are relatively large and have little penetrating power. B-particles, being smaller penetrate tissues to a greater through still limited distance (up to two millimetres of tissue).

Electromagnetic radiation :

Energy in the form of electromagnetic radiation is produced when an orbiting extra nuclear electron passes to a lower orbit. The wave length of this radiation depends on the energy released, large changes in energy producing very short wave length y-rays and smaller changes produced ultraviolet light. X-rays have a slightly longer wave length than y-rays. Laser radiation consists of narrow beams of monochromatic light (Curtis, 1979).

The penetrating power of electromagnetic radiation depends on its wave length. Hence ultraviolet light has very little penetrating power, where as y-rays and x-rays are much more penetrating. Particulate forms of radiation including α-rays and B-rays have very little power of penetration (J.R. Tighe, 1981).

Ionizing radiations form part of the normal environment in small and usually harmless amounts. They come in part from the sun (solar or cosmic radiations), in part from traces of radioactive elements incorporated in the soil and manufactured articles such as bricks. They will also emanate from human bodies themselves - radioactive carbon, for example, exists in bone and its presence there has been used in recent years to estimate

the age of those found archaeologically.

X-rays and y-rays are the forms of ionizing radiation which are most used in clinical practice.

Seeds sometimes inserted by surgeons are sources of x-rays and y-rays. The amount of radiation used in x-ray diagnosis is much less than is used in radiotherapy (Fagos, 1976).

Units used in radiology :

Roentgen (r) is the amount of x-rays or gamma rays that produces 1 electrostatic unit of charge in 1 c.c of air at normal temperature and pressure mercury.

Rep (Roentgen-equivalent physical) is the quantity of any ionizing radiation from which the tissue will absorb 98 ergs/gm of tissue, (previously 98 ergs/gm)

Rad is absorbed dose of 100 ergs/gm of tissue, it is independent of type of irriadiation.

RBE (relative biological effectiveness) is a term that expresses the ability of a given type of radiation