Biological Perspectives of Ageing

Gerontology:

Gerontology (from Greek: *geron*, "old man" and *logy*, "study of") is the study of the social, psychological and biological aspects of aging (Gorman M. Randel J, et al. 1999). Aging may be defined as a time dependent series of cumulative, progressive, intrinsic, and harmful changes that begin to manifest themselves at reproductive maturity and eventually end in death (Arking, 1999). Primary aging describe those changes that occur over time independent of any specific disease or trauma to the body, where as secondary aging describes disabilities resulting from sufferer disease (Moody, 2002).

Gerontology encompasses the following:

- studying physical, mental, and social changes in people as they age;
- investigating the aging process itself (bio-gerontology);
- investigating the interface of normal aging and age-related disease (geroscience);
- investigating the effects of our aging population on society, including the fiscal effects of pensions, entitlements, life and health insurance, and retirement planning;
- applying the knowledge originating from gerontological studies to the policies and programs, including a macroscopic (i.e. government planning) and microscopic (i.e. running a nursing home) perspective.

Bio-Gerontology:

Bio-gerontology is the study of the biological processes of aging. It is composed of the interdisciplinary research on causes, effects and mechanisms of biological aging in order to get better understanding of human senescence. Bio-gerontologists usually work at research universities or laboratories. Some within bio-gerontology have worked to show that aging is a biological process that we are far from being able to control. The multidisciplinary focus of gerontology and bio-gerontology means that there are a number of subfields. As with bio-gerontology, geriatrics studies the biological causes and effects of aging. Both fields are considered by many scientists to be the most important frontiers in aging research. There is a sub discipline of bio-gerontology that is biomedical gerontology.

Ageing:

The term aging is synonymous with decline, often encompassing a range of situation including deterioration, chronic illness and a failure to thrive.

Aging is defined as a genetic physiological process associated with morphological and functional changes in cellular and extracellular components aggravated by injury throughout life and resulting in a progressive imbalance of the control regulatory systems of the organism, including hormonal, autocrine, neuroendocrine and immune homeostatic mechanisms.

Aging can be defined as the time-related deterioration of the physiological functions necessary for survival and fertility. The characteristics of aging—as distinguished from diseases of aging (such as cancer and heart disease)—affect all the individuals of a species.

Senescence:

Senescence refers to all of the changes that take place in a human body that will finally lead to the death of cells, tissues, and, eventually, the whole body. *Senescence* can be traced back to Latin *senex,* meaning "old." So, *senescence* refers to the state of being old (specifically, to the final stage of the normal life span).

Major difference between Ageing and Senescence are as follows.

AGEING	SENESCENCE
1. Ageing is progressive deterioration in the body of the organisms. There is general decline in metabolic processes.	The terminal irreversible stage of ageing is called senescence. In plants it is characterized by yellowing d leaf fall.
2. It is not essential that ageing starts at the end of reproductive phase.	Senescence (old age) starts at the end of reproductive phase.
3. Ageing leads to senescence.	Senescence leads to death.

Different aspects of aging which are commonly identified by the gerontologists are namely: *chronological, biological, psychological, social or situational and socio-psychological or behavioral.*

Biological Aspects of Ageing:

Biological ageing, often known as senescence (declines of a cell or organism due to ageing) and sometimes functional ageing, refers to biological events occurring across time which progressively impair the physiological system so that the organism becomes less able to withstand disease, ultimately increasing its susceptibility to death. From this perspective, aging process stems from several physiological factors, and is modified throughout the life course by environmental factors (such as nutrition), experience of disease, genetic factors and life stage (Phillips et al. 2010). Biologists regard the normal ageing process as a complex of progressive changes in cellular composition and capacity for growth; in tissue structure and function; in the speed, strength, and endurance of the neuromuscular system; and in the reduction in the capacity to integrate organ systems (Shock, 1951). Parallel to these changes and no doubt related to them is an increasing prevalence of long-term, chronic disease arising from cumulated insults to the organism (Carlson and Stieglitz, 1952).

Biological Perspectives of Ageing Process

Aging is a natural process and an inevitable facet of life. Every one eventually ages despite the best of efforts and care; however, the manner by which you succumb to age is subjective and tends to vary between individuals. There are several factors that influence the way you age. Depending on these factors you may age gracefully and be a sight for sore eyes or you may 'fall from grace' and be a sore sight for all eyes. Factors that influence aging can be categorized as intrinsic (internal) and extrinsic (external) factors.

A. Extrinsic Factors For Aging:

There are several external triggers that influence the way you age. They may be environmental factors or your own lifestyle choices. Let us take a peek-a -boo at a few of them.

i) **Sunlight:** The sun sustains life on earth but over exposure to the sun rays speeds up the Aging process. The free radicals produced by the UV rays damages the DNA in skin cells, impair collagen production, destroy elastin and ruin your skin's ability to regenerate and repair. With time, unappealing changes such as dark spots, dryness and freckles, appear on the skin .The collective harm done by the sun is known as photo damage. Your ability to endure the sun entirely depends on your skintype and the degree of exposure to sunlight. Dark skins, with more melanin, are more sun - tolerant than fair skins; as a result, they tend to age slower.

ii) **Consumption of Alcohol:** It is all very well to enjoy a 'shot on the rocks' but remember that alcohol is an established neurotoxin, which speeds up the normal aging process. Excessive alcohol makes a person more vulnerable to various diseases of the heart and liver, and dehydrates the skin, contributing to a dull and aged look.

iii) **Stress:** Are you the kind of person who worries in a hurry? Beware! A person's ability to handle stress has a great influence on the way he ages. Oodles of energy is required to deal with stress- causing factors and the rate at which this energy is expended controls the quality of Aging.

iv) **Facial Exercises:** A few facial exercises which were initially promoted as anti- dote to Aging are now believed to enhance wrinkles and emphasize facial lines.

v) **Unhealthy Diet:** Look before you eat. If you are on a weight watch just remember that a poor, ill – balanced diet, will rob your skin of its natural sheen. A greasy, jumbo diet can also affect your overall health and usher in premature Aging.

vi) **Pollution:** If you want to stay youthful for a long, long time stay away from the heat and dust! Pollution produces oxidants on the skin surface, which work on the skin cells and destroys them, thereby fast forwarding the aging process.

vii) **Smoking:** Nicotine breaks down skin cells at a faster pace. As a result, long- time smokers develop wrinkles and a sallow, sagging skin. But the good news is that if the smoker 'kicks the butt' the detrimental effects of smoking can be successfully reversed and a visibly improved skin will be there for all to see. Therefore, it is never too late to stop your life from going up in smoke.

B. Intrinsic Factors for Aging:

There are certain factors within you that influence the way you age. You may have little or no control over them.

i) **Genes:** Your genes have a mammoth role to play in the manner and rate at which you age. If you belong to a 'youthful' family, you too would tend to look young despite your age. Several genes have been shown to affect aging. In humans, Hutchinson-Gilford progeria syndrome causes children to age rapidly and to die (usually of heart failure) as early as 12 years. It is caused by a dominant mutant gene, and its symptoms include thin skin with age spots, re-sorbed bone mass, hair loss, and arteriosclerosis.

ii) **Hormones:** Are your hormones all over the place? Just remember that an imbalance in hormones can, without doubt, fast- forward aging.

iii) **Cellular inflammation:** Aging is also characterized by cellular inflammation which ultimately leads to cell death.

iv) **Telomeres:** While discussing genes, it is only appropriate to learn a little about telomeres. They are specialized structures, found at the tail end of chromosomes, that play an undisputed role in cellular Aging. Research has revealed that the size of the telomeres gradually wanes with age. As part of anti aging research, there have been attempts by scientists to reconstruct telomeres. However, studies have shown that such a move could be harmful because the decline of telomeres, with age, is the cell's defense mechanism against old age diseases, such as cancer.

Details of most of the important intrinsic factors for controlling senescence are given below.

Factors leading to Senescence

Senescence can be triggered *e.g.* by oxidative stress, telomere damage/shortening, DNA damage, mitochondrial dysfunction, chromatin disruption, inflammation, epigenetic dysregulation, and oncogene activation.

Oxidative stress

The oxidant/antioxidant imbalance causes a structural damage of macromolecules (DNA, proteins and lipids). Age-related accumulation of damaged macromolecules is one of mechanisms that contribute to the aging processes.

Telomere shortening

Senescence is mostly triggered when the length of the telomere shorten from 5–20 kb to 4–7 kb. The shortening of the telomeres that occurs during normal aging is controlled by the activity of specialized enzyme telomerase. However, the balance between telomere shortening and counteracting by telomerase is disrupted during accelerated senescence as a result of the disease.

DNA damage

Critically short telomeres are recognized as DNA damage, which trigger a DNA damage response (DDR). The DDR arrests cell cycle progression until damages are repaired. However, senescent cells display persistent DDR foci that that are resistant to endogenous DNA repair.

Mitochondrial DNA damage

Mitochondria are intracellular source of oxygen. Functional mitochondria regulates cellular homeostasis through the maintenance of redox balance, which implies a balance between oxygen uptake, ATP production, membrane potential and generation of ROS. Mitochondria that accumulate in senescent cells show increased concentrations of ROS and increased rate of senescent cells in the same tissues, resulting in mitochondrial dysfunction.

Tumour suppressors and cell cycle inhibitors

Today, several suppressors and cell cycle inhibitors are known, *e.g.* p16 (known as cyclin-dependent kinase inhibitor 2A, multiple tumour suppressor 1), p53, p21, p15 ($p15^{INK4b,}$ protein kinase; cyclin-dependent protein serine/threonine kinase inhibitor, multiple tumour suppressor), p27 (cyclin-dependent kinases regulator), ADP-ribosylation factor (ARF), hypophosphorylated retinoblastoma protein. Activation of the tumour suppression pathways p53 and p21 and the p16/retinoblastoma protein pathways occurs during senescence. Activation is triggered by the DNA damage, which may be result of telomeric and non-telomeric DNA damage or oxidative stress.

Concept of Population Ageing:

Population ageing, sometimes referred to as societal ageing, is a process where by a group (such as a country or an ethnic group) experiences the progressive increase in the actual numbers and proportion of older people within its total population. This change brought about largely by socio-economic improvements in health and living standards, progressively reduces mortality and fertility, resulting in increased life expectancy and fewer births, and ultimately, an increase in the older population in relation to younger age groups. Population ageing has long-term implications for governments in terms, for example, of the cost of health and social care for an increasingly important number of older people (Phillips et al. 2010).

According to WHO (2002), population ageing is one of humanity's great triumphs. Throughout the twentieth century and twenty first century, it has become a worldwide phenomena reflected on changing demographic scenario of aged population. Ageing is basically the result of two dimensional demographic transformations which is explained by overall declines in mortality and fertility. So, population ageing is a process whereby a group (a country or an ethnic group) experiences the progressive increase in the absolute numbers and proportion

of older people within its population. Population ageing occurs as the result of a complex interaction between health, mortality and fertility transition, which together change the number of people at each age in a given population (Kinsella and Velkoff, 2001).