Aging is a universal human experience which refers to progressive changes during the life span that often, but not always reduces an individual’s viability. An analysis based on global demographic estimates undertaken by the “Population Division of the Department of Economic and Social Affairs of the United Nations (UN) Secretariat” has provided percentage distribution by age and in different geographic locations (Shrestha, 2000). Based on this survey, the life expectancy at birth in South Central Asia in the year 2000 for both sexes was shown as sixty-four years (males 63.1 years and females 64.9 years). In North America, however, a higher life expectancy at birth was reported for both sexes in 2000, viz., 77.6 years (males 74.4 years and females 80.7 years). In South Central Asia in contrast, the definition of an aged person was similar to that reported elsewhere (Indira, 1999) and this was a person aged over 60 years.

As age advances a number of physical and mental changes occur very often, though they are not inevitable. While there are different ways of categorizing the changes, the following categorization directly indicates how the changes would impact health. There are three main categories of changes: [1] changes in the indicators of general health (this would include pulmonary functions, anthropometric measurements, muscle power and endurance), [2] changes in neurological variables (including autonomic variables, measures of gait and balance, memory and audiometric measurements of hearing, and [3] changes in measures which have a psychological basis (for e.g., the mental state and quality of sleep). Each of these changes has been detailed below:
1.1 CHANGES IN THE INDICATORS OF GENERAL HEALTH:

1.1.1 Changes in the respiratory system: Many structural and functional changes have been reported to occur with aging, which influence the lung and chest wall function, gas exchange, and ventilatory control (Johnson, 2003). The most dominant changes include a stiffening of the chest wall (Rizzato & Marazzini, 1970; Morris, Koski, & Johnson, 1971), an apparent loss of respiratory muscle strength (Black & Hyatt, 1969), and a loss of elastic recoil of the lung tissue (Islam, 1980). Age associated changes in the respiratory system which may alter gas exchange include loss of elastic recoil (as mentioned above), a decreased surface area of the lung (Thurlbeck, 1980), decreased pulmonary capillary blood volume (Crapo, Morris, & Gardner, 1982), increased dead space ventilation (Martin, Das, & Young, 1979) and decreased distensibility of the pulmonary arterial vasculature (Reeves, Dempsey, & Grover, 1989). Whether the healthy elderly adult has an altered ventilatory control at rest remains controversial (Rubin, Tack, & Cherniak, 1982). However, till now most studies examined the adequacy of ventilatory response to exercise in later life and found it quite similar to that of young adults i.e., arterial PO$_2$ remains similar to the resting value and CO$_2$ elimination is reduced below resting values (Johnson & Dempsey, 1991).

1.1.2 Anthropometric measurements: The link between obesity, in particular central adiposity and hypertension and hyperlipidemia is well established. While average central adiposity as indicated by the waist-hip-ratio, continues to increase with increasing age, the average body mass index does not change much after the age of 65 years.
1.1.3 **Muscle strength** increases through childhood, adolescence, peaks in the mid twenties, declines moderately until the age of fifty after which a greater decrement is seen (Larson, 1982). By contrast, after the age of sixty, muscle mass declines each year by 0.5 percent and one percent in men and women respectively.

1.2 **CHANGES IN NEUROLOGICAL MEASURES:**

1.2.1 **Autonomic nervous system:** In humans the effects of aging have been better studied in relation to the sympathetic nervous system. Sympathetic neural activity may be measured in a number of ways such as by the measurements of plasma nor-adrenaline, assessment of nor-adrenaline spill-over, and direct recordings of either muscle or skin sympathetic nerve activity in peripheral nerves using microneurographic techniques. In older people plasma nor-adrenaline levels are higher, but this is not due to impaired clearance. There is an increase in muscle sympathetic nerve activity, but the increase is not generalized as nor-adrenalin spill-over studies indicate a preferential rise in sympathetic outflow to the heart. The reasons for both the increase and the differential changes are not clear. They are unlikely to result from impaired baroreflexes alone and may reflect impaired sensitivity of target organs to the effects of nor-adrenaline, resulting from mechanisms ranging from reduced sensitivity of the adrenoceptors to impairment of post receptor signal induction. Thus, a variety of changes at neural and non-neural sites may reduce sensitivity to sympathetic stimulation in older people. This is supported by the fact that spectral analysis of the heart rhythm of older subjects (i.e., 60-75 yrs) indicated reduced spectral power at all frequencies, including the
low frequency band associated with sympathetic nervous system influence on the heart (Esler, 1995).

1.2.2 Balance, Gait and Mobility

1.2.2.1 Balance: In the absence of age-associated diseases known to impair balance, only modest balance decrements can be demonstrated between 70 and 80 plus years (Wolfson, Whipple, & Derby, 1992). By contrast, in a study of nursing home subjects with recurring falls, half of the subjects had profound deficits of their postural responses as well as impaired gait and lower extremity strength compared to the controls (Wolfson, Whipple, Amerman, & Kleinberg, 1986). Balance may be defined in terms of measurable components which are needed to perform daily activities. For these purposes balance is divided into the following five components along with their measures: (1) standing (sway); (2) ability to use sensory input (loss of balance with limited sensory input); (3) limits of stability (functional base of support); (4) response to external perturbations (loss of balance); and (5) stance with a narrowed base of support (single stance time).

These five categories reflect qualitatively different components but in reality, movement is integrated and often requires more than one component. Coming to each of the components, there is a three percent difference in the antero-posterior sway amplitude of older subjects (average age 76 years ± 5 years) and younger subjects (average age 35 years ± 12 yrs) (Wolfson, Whipple, & Derby, 1992). The sway differences between old and young people increases when visual input or tactile–proprioceptive input is blocked or inaccurate. This suggests
that in older people processing of sensory information into a postural response requires additional input, i.e., visual or tactile–proprioceptive feedback in addition to vestibular input. Standing requires the body mass to be vertically aligned over a support zone (this is the limit of stability in each foot). The functional base of support is a measure of this zone of stability in the antero-posterior plane. It is measured using a forced platform to ascertain the percentage of foot length used to uphold body weight with forward and backward body leaning. The functional base of support is relatively stable until sixty years of age, following which it decreases to forty percent of foot length at the age of eighty years (King, Judge, & Wolfson, 1994). The responses to destabilizing forces are different in old and young subjects, with older people showing more losses of balance than young people. Finally the one legged stance is necessary for turning and leaning used in routine activities. The ability to maintain the one legged stance for a period of time is unchanged from the twenties to the fifties, decreases to twenty-two seconds during the sixties to fourteen seconds during the seventies (Bohannon, Larkin, Cook, Gear, & Singer, 1984).

1.2.2.2 Gait: The gait velocity remains relatively constant until sixty years and thereafter slows by fifteen percent per decade. A decrease in walking speed is accompanied by diminished stride length and single support time (i.e., one foot on the ground) and increased double support time (i.e., both feet on the ground) (Murray, Kory, & Clarkson, 1969; Imms & Edholm, 1979). These decrements indicate a significant but modest decrease in these quantitative indices of gait. It is also interesting to note that the walking speed varies with the level of activity. A
study of nursing home residents demonstrated a strong correlation between abnormal gait (stride length, walking speed, quantitative assessment) and the occurrence of falls (Wolfson, Whipple, Amerman, & Tobin, 1990).

1.2.3 Memory: Cognitive psychology has conceptualized human memory both in terms of systems and processes (Shanks, 1997). A systems-based concept of memory described five forms of memory, given below (Tulving, 1993). The five forms are: (i) procedural memory referring to memory for skills; (ii) perceptual representation of systems involved in the identification of objects and underlying the phenomenon of perceptual ‘priming’; (iii) semantic memory concerning acquisition and use of general knowledge; (iv) short term memory involving retrieval of information from consciousness and (v) episodic memory which refers to memory for personal events encoded in a special temporospatial context. This ordering of memory systems corresponds to their presumed developmental sequence in both a phylogenetic and an ontogenetic sense. Procedural memory is thought of as the earliest system to develop, while, episodic memory is thought to be the latest. Another way of subdividing human memory is the distinction between explicit and implicit memory (Graf & Schacter, 1985). In this view, explicit memory involves conscious recollection of information, an example being episodic memory. In contrast, implicit memory does not require deliberate retrieval of an episode, an example being perceptual priming. The systems-oriented view of memory as well as explicit and implicit memory has been mentioned above. According to the process-oriented view, differences of the type between explicit and
implicit memory may be explained by the different processes which individuals use while performing different memory tasks. This may be data driven processing versus conceptually driven processing; conscious recollection versus familiarity. Each of the five forms of memory according to the ‘systems-view’ will be discussed below with a special emphasis on the changes which occur with age.

1.2.3.1 *Procedural memory* underlies acquisition of skills and those aspects of knowledge which are not directly accessible to consciousness, but whose presence is indirectly shown by action, e.g., walking or cycling. It is commonly believed that procedural memory is largely unaffected by age, especially when contrasted with explicit memory (Light & LaVoie, 1993). However, age deficits have been reported in partial word identification (Hashtroudi, Chrosniak, & Schwartz, 1991), the pursuit rotor task (Ruch, 1934) and in learning to read inverted sentences (Mochvitch, Winocur, & McLachlan 1986).

1.2.3.2 *Perceptual representation system of memory*: In the perceptual representation system of memory, the emphasis is on physical characteristics of the item. For example, in word stem completion, subjects are required to complete a word stem (e.g., TRU_ _) with the first word that comes to mind, e.g., truck or trunk. In contrast, tests based on concepts rather than perceptual representations rely on the semantic meaning of the items. An example of this is the question “Which small blood vessel supplies oxygen and nutrients to cell tissue?” Understanding the concept and semantic meaning would elicit a correct response (i.e., ‘capillaries’). In a recent meta-analysis of the literature, LaVoie & Light (1994) evaluated age differences on a number of perceptually based priming tests.
and concluded that there were small, but statistically reliable age differences in this class of tests.

1.2.3.3 Semantic memory or generic memory refers to our general knowledge of the world. It includes meanings about words, concepts and symbols, their association as well as rules for using these concepts and symbols. The information is stored without reference to the temporal and spatial context present at the time of its storage. Semantic memory also involves knowledge of ones’ own memory proficiency and processes. In general, age differences in semantic memory tasks tend to be negligible. With respect to changes in semantic memory with age, it is unlikely that age related deficits in accessing semantic memory information are because of an actual loss of representations of the names or words, as they are stable across the adult life span. Instead, age deficits in retrieving semantic information may be related to problems in accessing lexical information rapidly.

1.2.3.4 Short Term memory: Short term memory is of two types: primary memory and working memory. For both of them the items which are to be remembered reside in consciousness. However, they differ in one aspect. In primary memory, the items are kept passively, whereas items in working memory are manipulated in some way (Baddeley, 1986). The digit span test of the Wechsler Adult Intelligence Scale provides an example of this. Forward digit span requires individuals to recall a series of digits in the same order as they were presented. Hence, subjects need only to rehearse the items passively and this task is a measure of primary memory. In contrast, backward digit span requires subjects to recall a series of digits in the reverse order. Hence, individuals have not only to
remember the digits, they also have to manipulate them, i.e., arrange them in reverse order. Hence, this task is an index of working memory. Evidence regarding the existence of age-associated performance decrements in primary memory is mixed. For example, there is a report showing that primary memory abilities decline across the adult’s life span (Botwinick & Storandt, 1974). However, it has also been found that the ability to store information temporarily is not affected by aging (Craik & Rabinowitz, 1984). In contrast to this debate about age-related changes in primary memory, it is generally accepted that when the material to be remembered has to be manipulated in some way (i.e., working memory) there are substantial age differences in functioning.

1.2.3.5 Episodic memory: Episodic memory involves retrieval of information which is acquired in a particular place at a particular time. Episodic memory draws on a wide network of brain structures, which include the hippocampal formation and related cortical structures, diencephalon, anterior cingulate gyrus, precuneus, prefrontal cortex, and cerebellum (Cabeza, Grady, & Nyberg, 1997). Hence, the susceptibility of episodic memory to aging may be due to the fact that changes at multiple sites in a large distributed network are capable of disrupting performance. It is important to note that age associated episodic memory deficits appear to be equally large in traditional laboratory-based tasks (e.g., word recall, paired-associate learning) and tasks that approximate more closely the memory demands of every day life (e.g., face recognition, text recall).
1.2.4 Hearing: Presbyacusis is the term used to describe the clinical manifestations of aging of the auditory system, characterized by bilaterally symmetrical loss of hearing in older people. Presbyacusis may begin insidiously; usually the higher frequencies are involved first. However, with progression the frequency of the upper range of human speech are affected particularly interfering with consonant discrimination (Gulya, 2003).

Four types of presbyacusis have been identified. These are: sensory, neural, metabolic and mechanical. Sensory presbyacusis is defined audiometrically by a bilaterally symmetric, abruptly dropping, pure-tone threshold curve with excellent speech discrimination. Audiometrically, neural presbyacusis manifests as a loss of speech discrimination out of proportion to the loss of pure-tone threshold. In metabolic presbyacusis the audiogram typically has a flat configuration and speech discrimination scores remain normal until the pure-tone threshold exceeds 50 dB. Conductive presbyacusis, also called as cochlear presbyacusis describes a downward-sloping threshold curve associated with speech discrimination scores that are inversely proportional to the steepness of the slope of the curve. Although pure forms of the four types of presbyacusis are described above, various combinations can occur and result in differing audiometric configurations.
1.3 CHANGES IN MEASURES WHICH HAVE A PSYCHOLOGICAL BASIS:

1.3.1 Depression: In 1996, Beckman cited fifteen prevalence studies of depression in the primary care of people over the age of 55 years. For depressive illness the weighted average was 1.7 percent (range 0.4 – 10.2). In older people depression and physical illness may occur together. It is also interesting that some biological changes associated with aging are similar to those seen in depression. Hence both normal aging and depression are associated with decreased brain concentration of serotonin and dopamine, nor-adrenaline and their metabolites and increased monoamine oxidase B activity (Veith & Raskind, 1988).

1.3.2 Insomnia: Sleep disturbance is one of the most common problems encountered by a geriatrician. Although many sleep disorders are encountered in older people, the most common complaint likely to be seen will be insomnia. Numerous physiological factors operate to reduce the depth, quality, and length of nocturnal sleep in older people. These normal age-associated changes include: loss of deep (stages 3 and 4) sleep; an increased proportion of total sleep spent in Stage 1 (transitional) sleep; and increased frequency of brief arousals lasting less than 15 seconds. Rapid eye movement sleep may change only minimally with age. It has been suggested that the pattern for elderly people to become sleepy earlier in the evening and awaken during the night may actually reflect an age associated change in what may be termed a “phase advance” of the circadian sleep-wake cycle. It is also relevant to note that the prevalence of specific sleep disorders such
as sleep apnea increases with age and also many medical illnesses which disturb sleep are more common in aged populations. These factors combine to predispose an elderly person to insomnia.

In the paragraphs mentioned above, changes in the number of variables which occur in the human life span and especially in aging, have been given. These variables are the pulmonary functions, anthropometric measures, muscle strength, gait and balance, memory, hearing, mental state and the quality of sleep. The variables listed above were selected as they form part of a battery for the short term measurement of the rate of human aging (Comfort, 1969). In recent years, there has been a concept of successful or healthy aging, where successful aging has three main components. These are: (i) a low probability of disease and disease related disability, (ii) a high capacity for cognitive and physical functioning and (iii) an active engagement with life including interpersonal relations and productive activities.

According to gerontological experts, the health care and self-care strategies likely to be affected in facilitating the transition from usual to successful aging are interdisciplinary approaches that include behavioral, biomedical, nutritional and other interventions (Committee on a National Research Agenda on Aging, 1991). There have been attempts to study the effects of behavioral and lifestyle interventions in aging. These will be described below:

Transcendental meditation (TM) is a widespread technique, as over a million individuals have learnt the TM program over the past forty years. (Schneider, Alexander, Salerno, Robinson, Fields, & Nidich, 2002). The beneficial
effects of practicing TM on the physiological and cognitive correlates of aging have been described. With respect to the physiological correlates, long term (i.e., over five years meditation experience) TM practitioners had a mean biological age twelve years younger than their mean chronological age based on indices, such as, auditory discrimination, near-point vision accommodation and systolic blood pressure (Wallace, Dillbeck, Jacobe, & Harrington, 1982). Also, TM appears to produce long term changes in cognitive functions which appear to be opposite in direction to those associated with aging (Schneider, 2002). These TM induced changes include enhanced short term and long term memory and organization of memory evidenced in learning tasks, incremental gains in fluid intelligence over a two-four year period, improved perceptual flexibility, and an increased perceptual motor speed. In addition the TM program was shown to have beneficial effects on chronic diseases and health patterns associated with aging.

Tai Chi Chuan (TCC) is an ancient Chinese martial art which involves an integration of mind and body in slow circular movements and changes in the center of gravity. The joint proprioception and balance control during weight shifting were compared for four groups (Tsang & Hui-Chuan, 2004). These were (i) experienced elderly Tai Chi practitioners, (ii) experienced elderly golfers, (iii) healthy elderly subjects and (iv) young university students. Both experienced Tai Chi practitioners and golfers had better knee joint proprioception and limits of stability when compared to elderly control subjects. Also, these measures were comparable to those of young students. The effects of TCC have also been studied on autonomic nervous system modulation in older adults (Lu & Kuo, 2003).
Twenty Tai Chi practitioners and twenty controls were compared with respect to the stationary state spectral heart rate variability (HRV) measures and the changes in HRV measures that were studied after classical TCC practice. The results showed that the short term effect of the TCC was to enhance the vagal modulation and tilt the sympathovagal balance towards decreased sympathetic modulation. In yet another study (Li, Fisher, Harmer, Irbe, Tearse, & Weimer, 2004), the effectiveness of Tai Chi on self rated sleep quality and day time sleepiness was evaluated in older adults. Tai Chi participants reported improvements in specific aspects of sleep such as sleep quality, sleep onset latency, sleep duration, sleep efficiency and sleep disturbance. Hence a six month, low to moderate intensity Tai Chi program appeared to be an effective non-pharmacological approach for sleep disturbances.

In the studies on TM and TCC mentioned above, each study examined a different variable. This was not the case in another study which determined the psychological, behavioral, cognitive and cardio-respiratory changes with up to fourteen months of aerobic exercise training in older persons (Blumenthal, Emery, Madden, Coleman, Riddle, Schniebolk, Cobb, Sullivan, & Higginbotham, 1991; Blumenthal, Emery, Madden, Schniebolk, Riddle, Cobb, Higginbotham, & Coleman, 1991). For the first four months of the study, 101 older men and women were randomly assigned to one of three conditions viz., aerobic exercise, yoga and a wait-list control group. After four months, all subjects completed four months of aerobic exercise and they were then given the option of an additional six months of aerobic exercise. Assessments were made initially, after four months, after eight
months and at the end of fourteen months. The assessments included the peak oxygen consumption, carbon dioxide elimination, end-tidal gas concentrations, questionnaires for anxiety, depression and overall mood, motor function, memory as well as range of tests for perception and motor functions. The results showed that there was a 10-15 percent improvement in peak oxygen consumption after four months of aerobic exercise and 1-6 percent improvement in aerobic power with additional exercise training. With respect to the psychological, behavioral and cognitive changes, there were relatively few improvements in cognitive performance associated with aerobic exercise although subjects who maintained their exercise participation for fourteen months experienced improvements in some psychiatric symptoms. The most important points to be noted in this study were that no details have been given of what the yoga practices involved. The second important point is that although a range of variables were measured, apart from the assessments of different aspects on memory and depression, the variables were indicators of levels of functioning but not of the rate of aging, as has been mentioned above (Comfort, 1969).

Hence the present prospective, single blind, randomized control trial was designed to evaluate the effects of two complimentary ancient Indian sciences viz., Yoga and Ayurveda in older persons.

In the present study a comprehensive battery of tests was designed which included different variables taken from the standard battery and which came under three broad categories: (i) General health measures, (ii) Neurological variables and (iii) Psychological measures.