INTRODUCTION

CHAPTER I

Water is most vital resource for all kinds of life on this planet earth. It is adversely affected by both qualitatively and quantitatively by all kinds of human activities on land, in air or in water. Increasing industrialization, urbanization and developmental activities and cosequent pollution of water has brought variable water crises. Disposal of various kinds of wastewater into water resources creates a serious problem of water pollution. Today most of the rivers of the world receive millions of liters of sewage, domestic waste, industrial and agricultural effluents containing substances varying in characteristics from simple nutrients to highly toxic substances. The fate of ground water is also same in most of the areas. Water is not only responsible for life but also for total well balanced ecosystem. Water is no longer remains 'free good'. Availability of clean water is going to become the greatest constraint for development tomorrow.

Water is an important requirement for human life and it is called as nature's free gift to human race. It is available in various forms such as river, lake, streams etc. The importance of water in human life is so much that the development of any city of the world has practically taken place near some source of water supply. It may also further be noted that water is available in solid, liquid and gas forms. The occurrence of water in all these three forms is basically important for human beings for comfort, luxury and various other necessities of life.

The use of water by man, plant and animal is universal. As a matter of fact every living soul requires water for its survival and it is essential for the life, health and sanitation. Approximately 97.2% water lies in ocean as salt water, while 2.15% in frozen ice form and remaining 0.65% remains as fresh water either on surface or as ground water (Santra, 2004). The demand for fresh water has increased day by day and will increase with the rapid growth of population, agriculture and industry. Because water is principal raw material for food production and for many other uses outside the home and on the farm. As a

result the fresh water reserve depletes day by day too. The requirement of clean water per person is about 5 billion cu.m. only for drinking purpose (Santra , 2004).

The status of river water is very much useful as it determines the physiological life cycle of plants, animals and humans. Now a day's direct use of river water for drinking purpose bear significant problem because of the environmental hazards, which are associated with the development of the region (Barik and Patel, 2004). Freshwater resources all over the world are threatened not only by over exploitation and poor management but also by ecological degradation. The main source of freshwater pollution can be attributed to discharge of untreated waste, dumping of industrial effluent and run-off from agricultural fields. Industrial growth, urbanization and the increasing use of synthetic organic substances have serious and adverse impacts on freshwater bodies. It is a generally accepted fact that the developed countries suffer from problems of chemical discharge into the water sources.

Rivers play a significant role because they serve the purpose of various human activities such as bathing, disposal of sewage, irrigation, electricity generation, industrial production and disposal of industrial waste etc. During the process of cultural evolution, natural resources have been brutally exploited by man. The loss in agriculture, gain in industrialization and population explosion has stressed the natural resources (Singh and Gupta, 2004). Due to increasing industrialization, urbanization and other developmental activities most of the Indian rivers have become polluted. The study of water quality of different rivers in India by Athappan *et al.*,(1982), Chattopaddyay *et al.*,(1984), Dhar *et al.*,(1989), Datar and Vashishtha(1992), have shown remarkable pollution level of river water.

Water has been one of the most important strategic natural resource for man kind trough out the history. However, the worlds water resources are under pressure and in danger because of potential pollution and contamination risk due

to over use and misuse of resource. People strive to sustain their lives in under inappropriate environmental conditions. Streams are clean water resources among all water resources. Clean water resources are more prone to the pollution as compared to spring water. Water pollution reduces the number of species and destroys the balance of life in streams and is evidenced by the biological indices of community diversity. Water pollution disturbs normal use of water for irrigation, agriculture, industries, public water supply and aquatic life. Water quality has great influence on the ability of organisms to exist and to grow in the stream, pond or lake (Pawar and Mane, 2006). It is well known that pollution of water causes adverse effect in aquatic biota. The quality of water is threatened by the activities of local inhabitants by way of waste discharge, washing and agricultural practices.

Industrialization and growing population in selected pockets of a country bring large quantities of industrial wastewater, which find their way into natural water bodies. This has been the case in industrialized waste where the quality of water has continuously deteriorating and all efforts at pollution control have failed to restore original purity of the water. Industrial pollution has made contribution in a big way with ever increasing industrial production. Industrial effluents contain variety of chemicals can be recorded if the concentration of waste is fairly high but lack of effort and will have prevented the recovery of chemicals a workable or economic proposition. The natural aquatic systems are covenant sites for disposal of urban and industrial wastes. Sometimes the extent of pollution is beyond the assimilative capacities, such water renders grossly polluted.

Through rapid developments in science and technologies, entirely new man-made chemicals, pigments, dyes, fibers and metals are produced. For these productions, industries use huge quantities of water for their processes; most of it comes out as waste materials containing variety of compounds and elements. These wastes are continually being disposed in water bodies. Industries produce mainly two types of wastes, biological and non-biological wastes. Biological wastes include materials from living or previously living sources e.g. tannery

industry, while non-biological wastes includes wastes from such industries where no biological system is used in production e.g. petrochemical and fertilizer industries etc. The ultimate disposal of wastewater can only be on land or into water. Before disposal it has to be treated to prevent injury to the aquatic life in the receiving water as natural water courses having certain limits up to which they can accept waste without any injury to aquatic life.

Pollution is a gift of rapid industrial revolution and excessive exploitation of natural resources. Majority of the industries are water based and considerable volume of wastewater emanates from them which generally is charged into watercourses either untreated or inadequately treated causing water pollution (Pandey and Carney, 1998). Studies conducted by the Center for Science and Environment (CSE, 1982) suggests over 70% of available water in India is polluted.

The quality of water is usually determined by its physicochemical characteristics. It is well established that domestic sewage and industrial effluents in to natural water results in changes of water quality and cultural eutrophication. A high level of TDS elevates the density of water and such medium increases osmoregulatory stress on aquatic biota (Verma *et al.*, 1978). High chlorides indicate organic pollution, particularly from domestic sewage (Trivedy *et al.*, 1990).

Some selective methods are available for the analysis of pollutants in water at trace level concentrations. The modern methods used for the analysis of metal pollutants as well as simple and rapid methods for the determination of more commonly occurring pollutants is covered. Water used in industries gets degraded to some degree during processing. The distinction between industrial water and industrial wastewater is often not clear, as the multiple use of water is fairly common practice. However, it is necessary to analyze industrial waste water to determine its suitability for reuse the degree of treatment required prior to its disposal or to diverse suitable measures for the recovery of useful products.

Discharge of untreated industrial effluent into aquatic systems seriously affects the aquatic biota and their production. The fresh waters form a very important media for the production of protein rich pisces, crustaceans and molluscan animals. But the fresh water media are ecologically deteriorating due to the discharge of industrial effluents (Thingran, 1974). The physico chemical characteristics and the impact of tannery effluent on water bodies were analysed by Eye and Lawrence (1971), Kothandaraman *et al.*, (1972) and Guruprasada Rao and Nandakumar (1981), Diwan and Nagabhushnam (1972), De Pledge (1985) and Subramanian *et al.*,(1988) had reported the effect of various toxicants on the rate of oxygen consumption in crustaceans. A little quantum of work is available on the effect of tannery effluent in respiration, survival and proximate variation in fishes (Maruthanayagam, 1996).

Industrial effluent constitutes a major form of pollutants in aquatic ecosystems. The ability of the pollutants to disrupt the biological balance or cause deleterious effect on the concentrations of the contaminant and the physicochemical characteristics of the wastewater. The impairment of water bodies by unrestricted disposal of industrial effluent makes it imperative for short term for adequate and prompt monitoring of the aquatic ecosystem. In the coastal lagoon there is rapid increase in levels of anthropogenic releases of contaminants transported by untreated sewage and industrial and agricultural effluents. Some of these pollutants have been accumulating in the tissues of several bivalve species. The accumulation of these pollutants along with the increase in temperature over the summer resulted in deleterious effects on these species some of that became unsafe for human consumption. Several industries and urban effluents are discharged into river, lakes and other water systems as well as in adjoining fields without any pre-treatments. These effluents carrying toxic substances enter in to the aquatic bodies may rich in rivers affecting aquatic organisms which are important from both ecological and economical point of view (Elumalai *et al.*, 2002).

The dumping of industrial wastewater into an aquatic system can seriously affect the aquatic components. Tannery effluent mixed or run off or contamination of these in adjacent aquatic bodies might seriously threaten the level of food chain (Maruthanayagam, 1996). The physicochemical parameters of the tannery effluent viz. color, odour, pH, electrical conductivity, TSS, TDS, BOD, COD, total hardness, total calcium, total magnesium, chloride, sulfate and total chromium were found to be high that is exceeding the CPCB limits (Mohamed and Sharief, 2004). The effluent from these tanneries from stagnant pools seeps through the land and pollute the drinking water and the ground water on a radius of 6 km. Heavy load of various industrial pollutants in the freshwater aquatic systems pose a serious threat to the health of wild and cultured aquatic animals by affecting their immune system. Integrating biological sensors, complementing the power of analytical methods and identifying pollutants in the parts per million and parts per billion ranges assessed the toxic impact of the tannery effluent. Future integration of higher tropic levels will further characterize these ecotoxicological effects and develop more efficient monitoring techniques for aquatic systems (Mwinyikione *et al.*, 2005).

Amongst the industries leather industry is the fifth single foreign exchange earner in India. Ramsubramanian *et al.*, (2004) have been reported that about 3000 tanneries are located in India and spread across the state of Tamilnadu, West Bengal, Maharashtra, Punjab, Karnataka, Andhra Pradesh, Bihar and Uttar Pradesh. The effluent discharged from tanneries contains high values of pH, electrical conductivity, chlorides, sulfide, sulfate, carbonate, chromium, biological oxygen demand, chemical oxygen demand, oil and dye (Mariappan *et al.*, 2001). The effluent from these tanneries from stagnant pools seeps through the land and pollute the drinking water and the ground water on a radius of 6 km (Paul Bhaskar, 1992).

The tannery industry is growing in diverse proportion at cottage, medium and large-scale sectors particularly in developing countries. It provides employment opportunities to several thousand people and earns considerable

sums via foreign exchange, thereby contributing to the economy. Unfortunately this industry is linked with water pollution. The quantity of water used is voluminous in the tannery unit; it discharges 3000-3200 liters of water per 100 kg of skins and hides processed. The spent water of tanning industry is invariably let off as effluent becoming either stagnant or in most cases confluent with the nearby water bodies. Thus, pollution due to tannery wastes and its control has gained international importance.

Investigations into tanneries in India revealed extensive chromium contamination of soils, surface water and groundwater. The Woburn Childhood Leukemia Study in America studied the elevated incidence of leukemia in children who lived near a site where tannery waste was dumped. The study confirmed "a significantly elevated incidence of childhood leukemia in Woburn" (Bureau of Environmental Health Assessment, 1997). Studies of leather-tannery workers in Sweden and Italy found cancer risks "between 20 per cent and 50 per cent above those expected".

Tanneries consume huge amount of water and only small fraction of it is consumed by the products and lost by evaporation. The rest finds its way into the water courses as wastewater. Pollution potential of these wastes arises from high concentration of organic and inorganic solids, presence of heavy metals, acids or alkalis, oil and other floating substances. The tannery effluent is ranked as high pollutants among all other industrial wastes (Eye and Lawrence, 1971).

Tanning industry is one of the oldest cottage industries in India which has now taken a predominant place in the countries economy (Sastry, 1986). Although tanning industry has been in existence for such a long time, the problem of environmental pollution received serious consideration only in last few years. Considerable damage has been caused to water bodies due to discharge of unmanaged pollutants to tannery wastewater. When untreated

tannery waste is allowed to stagnate, it gives rise to odour nuisance, unsightly appearance besides creating ground and surface water pollution. With the addition of number of tanning units and absence of scientific methods of disposal of liquid waste, a problem of environmental pollution is likely to increase further in coming years. The increasing demand of cleaner environment, especially in the context of increasing populations, requires immediate measures for the control of pollution from tanneries by one or the other method (Sastry, 1986). Therefore, it becomes utmost necessary to treat the wastewater for the abatement of pollution in order to keep the environment clean. But before any treatment is given to the wastewater, the information about tannery, such as chemicals used, process duration, number and weight of hides processed, characteristics of different streams and combined effluent must be known.

Leather business stands at second rank and in India Kanpur, Madras, Mumbai and Calcutta cities are famous for production of leather industries. In Maharashtra Mumbai and Kolhapur are famous for the production of leather and its value-added goods. Kolhapur is well known for Kolhapuri Chappals. In the city maximum tanneries are situated at southern side of bank of wastewater drain called Jayanti nalla. Initially Jayanti nalla was a clean water stream, which flows through the center of the city to meet finally to Panchganga river. The nalla originates from the well known Lake Kalamba, a fresh water lake supplying water to citizens for drinking purpose. The nalla water becomes highly polluted due to addition of a number of pollutants from the tannery and some other small scale industries together with sewage.

Leather production involves tanning, is chemical process converting the semi soluble proteins called the collagen present in the animal skin into tough, flexible, insoluble and highly durable leather. Tanning is of two types, one is vegetable tanning and other is chrome tanning. Control of environmental pollution can be successfully implemented by precise, periodic and fast

monitoring of pollutants. Among the several characteristic parameters of effluent, chemical oxygen demand (COD) is one of the major pollution parameter, which is a measure of the degree of pollution.

Chromium is major source of environmental pollution discharged in to the environment through the disposal of waste from industries, like leather tanning. In an environment chromium occurs mainly in the trivalent and hexavalent forms. The hexavalent chromium is more toxic compound than those of trivalent chromium (Bartlett, 1991).

Many tanning units in India are situated along the banks of rivers where the concentration of hexavalent chromium has been frequently exceeded the permissible limits for the discharge wastewater from a tannery unit into the receiving stream (Khwaja *et al.*, 2001). Chromium has been shown to affect humoral and cell-mediated immunity by decreasing levels of antibody (Arunkumar *et al.*, 2000) and splenic plaque-forming cell number (Prabakaran *et al.*,2006), by reducing proliferation of splenic lymphocytes and increase the susceptibility to bacterial infection in fish (Khangarot *et al.*, 1999; Prabakaran *et al.*, 2006). Aquatic animals and their immune system may also represent an important scientific tool in the monitoring of environmental quality, particularly immunotoxic environmental pollution.

Although leather producers like to tout their products as "biodegradable" and "eco-friendly", the process of tanning stabilizes the collagen or protein fibers so that they actually *stop* biodegrading. Many chemicals are used during the tanning process for removing hair and for liming, deliming, tanning and curing. These chemicals include trivalent chromium sulfate, which can cause irritation to the eyes, skin and respiratory tract, is harmful if swallowed or inhaled and is known to have carcinogenic effects; sodium sulfide, which is fatal if swallowed or inhaled and burns the skin on contact. Other chemicals that are used in the tanning process include arsenic, which is a known carcinogen that may be fatal if

swallowed, inhaled or touched; cyanide, which is a sharpening agent that can be fatal if inhaled, ingested or touched; ammonium sulfate. It is an irritant that may cause nausea, abdominal pain and vomiting; sulfuric acid, which can be fatal if ingested because it is extremely corrosive, highly toxic and possibly carcinogenic, and aniline dyes, which can be toxic if ingested. Prolonged exposure to aniline dyes can also lead to convulsions, coma and death. In addition to the toxic substances mentioned above, tannery effluent also contains large amounts of other pollutants, such as protein, hair, salt, lime sludge and acids.

Heavy metals are considered to be serious contaminants of aquatic systems due to extended biological half life, inherent toxic nature at low concentration and high rate of bioaccumulation (Baby and Menon, 1986). Amongst the pollutants insecticides are considered hazardous because of their ability to kill or immobilize fresh water estuarine and marine organisms at extremely low concentrations (Eisler, 1969). Heavy metals and their salts constitute a very important group of anthropogenic environmental pollutants. These chemicals exert toxic effects on aquatic organisms at tissue, cellular and molecular levels. Because of the heavy tannery pollutants they are not suitable for cultivation and hence the income generated by the people of this area has been completely lost. The industrial pollutants are known to contaminate the abiotic components of the ecosystem and also pose threat to the sustenance of plant and animal kingdoms on the earth. The quantity, quality and toxicity of pollutants vary with the type of industries, so the pollution profile of different industrial polluting agent is variable. Tanning industries along with other inorganic constituents contain appreciable amount of heavy metals, which pollute water.

Many toxic heavy metals like chromium, nickel, zinc, copper, cadmium, arsenic etc. are associated with heavy metal industries. Short-term toxicity of these metals was of major concern previously but slow accumulation of these metals in the physiological system of living beings through food chain (Grimji Pushpa, 1993). Their inherent chemical stability and non biodegradability has

given way to greater interest in their long term consequences since ecological terms disturbed behavior, impaired physiology or induced sterility can have more or less the same ultimate effect on population or organism (Tarzwell, 1971). Heavy load of various industrial pollutants in the freshwater aquatic systems pose a serious threat to the health of wild and cultured aquatic animals by affecting their immune system. The leather-tanning industry is one of the major polluters of freshwater bodies of many developing countries including India (Tare *et al.*, 2003). The Indian leather industries are significant in terms of export and employment opportunities for people of economically weaker sections (Tare *et al.*, 2003; Naidu, 2000). There is more than 1900 chrome leather tanning factories in India most of which are located near major riverbanks (Khwaja *et al.*, 2001).

The homeostatic systems of aquatic animals like molluscs, crustaceans and fishes are continuously adapted to normal demands of the aquatic environment and challenged or stressed by aquatic pollution. Additional stress may result from anthropogenic habitat alterations by pollutants. When affected by various stresses, aquatic animals respond to biochemical and physiological stress reactions called secondary stress responses (Mazeaud *et al.*, 1977). Physiological and biological responses in poikilotherms aid them to adapt a range of environmental factors. Body components are reported to be affected by water pollution (Palanichamy *et al.*, 1986; Sastry and Suneeta, 1983; Ram and Satyanesan 1984; Kumar *et al.*, 1993).

Levels of contaminants in the aquatic environment are increasing as a consequence of anthropogenic activities and resulting diminishing water quality reflects the status of aquatic resources. For this reason, there is an increasing need to develop methods for the identification, estimation, comparative assessment and management of risk posed by chemical pollutants discharged into the aquatic environment. Therefore, measuring of the biological effect of pollutants is essential for assessing the quality of the aquatic environment.

The flat low land, moderate climate, rich natural resources of the water bodies provide an excellent ecosystem as breeding ground for the aquatic animals. Bioaccumulation should be regarded as a hazard criterion itself during acute and chronic toxicity testing, since as soon as xenobiotics enter the body, the process of biotransformation and elimination determines their fate. Hence, assessment of chemicals in biota may be a prerequisite for testing the adverse effects of xenobiotics on the ecosystem (Franke *et al.* 1994). Biomarkers, also termed as stress indicators, are used as an alarming signal for pollutant exposure in the organism. Besides the chemical analysis of pollutant burden in the biota, there is another kind of strategy that tracks alterations in the metabolism produced by the accumulation of pollutants in the cells. The interest of such approach is that cells are placed in the interface between molecular events and events at the organism level. Changes in cells anticipate and reflect the possible consequence at higher levels of biological organization.

Animals used for the experiment were bivalve, *Lamellidens marginalis.* The bivalve molluscs immediately respond to any toxic substances in the medium by closing the valve and this would minimize the respiratory rate. Marine mussel (*Mytilus edulis*, a bivalve mollusc) increasingly used as environmental sentinels in pollution biomonitoring (Moore, 1991). Exposure to an extended period shows the real physiological response of the animal to the presence of toxic substances of the medium. Such physiological response of benthic organisms like fresh water mussel could be used as an index to measure the level of aquatic pollution (Mohan and Hameed, 1991). Among aquatic organisms, mussels such as freshwater bivalves are excellent biomonitors for bioaccumulation studies because they are sedentary, filter large amounts of water and live buried in sand (Jacomini *et al.*, 2006).

Shellfishes are the second largest group after arthropods in animal kingdom includes a soft bodied animals usually protected by a shell. The fresh water shellfishes constitute an important part of the ecosystem. Their participation in mankind has made them significant partners in the ecological

communities. These animals' serves as a food for many other aquatic animals like fishes, aquatic birds, human etc. The nutritive and medicinal value of shellfish has been recognized from time immemorial. Shellfish is an excellent source of protein for human diet and it is highly digestible. They are known to reduce serum cholesterol level and also to prevent excessive platelet aggregation. Therefore, shellfishes must be considered as integral part for overall development of human health and wealth. So their importance can not be neglected. The molluscs have specific ecological adaptations in aquatic ecosystems. They are on primary stages of food chains and influence the organization and functioning of ecosystems (Almar *et al.*, 1927). Moreover, they live attached or sessile and are not subject to rapid mitigation and they serve as natural monitors of water quality associated with specific area (Cairns and Dickson, 1976).

The *Lamellidens spp.* is fat free and its curry is used for faster growth, sound health. The shell powder of *Lamellidens spp* mixing with honey is used for the remedy of giddiness, nervousness and dehydration. Soup prepared from *Lamellidens spp.* is used to cure cardiac elements and blood pressures. Shellfish is generally a favored item of low-income groups of rural area. Aquatic birds and some carnivorous fishes consume most of the shellfishes.

Incorporation of toxic compound or their metabolites in lower organisms, as well as in the tissues of fishes have been recorded to cause serious morphological alterations in vital tissues of organisms even at very low levels (Chakraburthy and Konar, 1974; Mathur *et al.*, 1981). A respiration, the vital phenomenon of life and the rate of oxygen consumption depends upon the metabolic activities and thus it has its own importance in the physiological study. Any change in the rate of oxygen consumption is an indication of stress and altered metabolic rates. Gills are most important vital organs in all aquatic animals including bivalves, fishes, crabs, prawns, which serves the most important functions like respiration and osmoregulation. They being continuously bathed in the surrounding water are most vulnerable organs to the various

aquatic pollutants (Roberts, 1978). It leads to alterations in the normal respiratory surface and would lower down the diffusing capacity of gases through the gill (Skidmore and Tovell, 1972). Since gills have a key position of these animals having a key role in the transport of oxygen for the metabolic activities, they offer a favorable material for the studies on effects of toxic pollutants on respiration. The toxicity of any chemical alters the physiological state of the animals, thereby impairing the various metabolic activities. However, to have clear understanding as to how these chemicals cause injury to the tissues, it is essential to have studies on the histological changes that took place in gill tissues in response to industrial effluents.

Histology is the branch of biology concerned with the composition and structure of plant and animal tissues in relation to their specialized functions. Its aim is to determine how tissues are organized at all structural levels, from cells and intercellular substances to organs. Histologists examine extremely thin slices of human tissue under microscopes, using dye to increase the contrast between cellular components. The toxicity of any chemicals alters the physiological state of the animals, thereby impairing the various metabolic activities. However to have a clear understanding as to how these chemicals cause injury to the tissues, it is essential to have a few studies on the histopathological changes that took place in the tissues of animals which are affected by the chemical exposure due to industrial wastewater discharge. In the present Investigation histopathological changes in the gills, hepatopancreas of a bivalve, *Lamellidens marginalis* exposed to different concentrations of tannery wastewater to different exposure period have been studied.

Biochemical constituents and enzymes have been explored, as potential biomarkers for a variety of organisms. They are the first detectable quantifiable responses to environmental changes and can serve as markers for both exposure and effect in organisms. The significant role of adenosine triphosphate in controlling high-energy metabolic transformations and ion movements in living tissues are well known. ATPase is hence involved in physiological process and

their inhibition by xenobiotics may produce significant toxic effect in the cell. Environmental and chemical stress can interfere with physiological and biochemical functions such as growth, development, reproduction and circulatory systems in aquatic animals. Protein and cholesterol are two important components of maturing oocytes are transported to the gonads via blood (Kaur. and Kaur, 2006). Under positive caloric balance a significant proportion of the food energy intake is stored as either glycogen or fat. However, in many tissues, even under fed conditions, fatty acids are oxidized in preference to glucose but particularly under conditions of caloric deficit or starvation. The purpose is to spare glucose for those tissues that require it under all conditions. Acid phoaphtase plays a vital role in the autolytic degradation of tissues and dissociation of dead cells. It acts as a good indicator of environmental stress condition of the biological system (Verma *et al.,* 1980; Murti *et al.,* 1984). Alkaline phophtase splits various phosphorous esters at alkaline pH, mediates membrane transport and involved in glycogen synthesis (Gupta and Rao, 1974). Enzymes play an important role at the junction between the carbohydrate and protein metabolism by interconnecting strategic compounds viz. ketoglutarate, pyruvate and oxaloacetate on one hand and alanine asparate and glutamate on other hand. A close relationship exists between the mitochondria intensity and transaminases level (Baimtenico, 1974., Suhasini *et al.*, 1979) and any modification in the organization of mitochondria might alter the enzyme associated with it. Lactate dehydrogenase is present in most of the animal tissues and is involved in the interconversion of lactic acid to pyruvic acid that acts as a pivotal enzyme between glycolytic pathway and tricarboxylic acid cycle. Decreased activity of lactate dehydrogense towards the formation of lactate in animal tissues proves the role of glycolysis in this organ is more likely to supply precursor for biosynthetic process like gluconeogenesis rather than to provide pyruvate for oxidation of NADH (Walton and Cowey, 1982).

Toxicity of a substance refers to its capacity to cause adverse effects on living organisms and the term is more commonly used to compare the impact of two or more substances. Toxicological impact may bring physiological,

biochemical or pathological alterations in organisms. In other words toxicity may inflict signs or symptoms of illness varying from simple local effects to complex disorders resulting in the mortality of organisms. The intoxication of toxicants includes a sequence of events, which starts with the exposure of a substance to an organism. Subsequently the toxic substances are absorbed in various routes followed by their distribution within the body of organisms thus causing an internal exposure. Today both developed and developing countries face ecological and toxicological problems due to indiscriminate release of pollutants into the environment. Toxicity is nothing but a chemical's potency to cause an adverse impact on living organisms and is dose and duration dependent. To evaluate the toxic impact of various pollutants, a number of bioassay procedures have been put to use in the laboratory and are useful to assess the toxic impact of the pollutant on living organisms under the standard conditions. Toxicity of various chemicals is under the influence of a number of factors like duration of exposure and concentration of chemicals, species, nature of toxicant, environmental factors.

Static bioassay methods are usually applied for determining toxicity of industrial effluents to various aquatic organisms under laboratory conditions. LC_{50} values are representing the concentration of the test material at which 50 % of the test animals die on specific period of exposure is determined. These toxicity tests are necessary to predict the safe contaminant concentration in the environment (Johnson and Bargman, 1983). The industrial effluent changes physiological, biological, histological, hematological and behavioral changes in aquatic organisms and result in death is made use of an essential detectable response to the action of the toxicant in short term toxicity bioassay and is widely used method in water quality management.

Acute toxicity test method may be categorized according to the length of exposure, test situation, criteria of effect and test of organism. In aquatic toxicity, the best index for pollution stress is survival that is measured by acute toxicity. Acute toxicity test are one of the many tools available to the toxicologist which

provide a quick, relatively inexpensive and reproducible estimate of the toxic effects of a test chemical or toxicant. They are an indispensable first look method. The test deals with determination of median lethal response or median tolerance limit (TLM) where 50% of the organism shows death with respect to time. In terrestrial animals the dose of pollutant is administered by inhalation, ingestion, injection or irradiation and hence is often referred to as lethal concentration LC_{50} value or effective concentration EC_{50} value.

In sublethal toxicity studies, much attention is paid to physiological and biochemical responses, especially changes in blood and organs, development of tumors and reproductive effects. In chronic toxicity test all the population except the controls is exposed continuously to the chemical for a period of sufficiently long time. Certain factors such as salinity, temperature, molt as well as reproductive stages cast light under mechanism of metal uptake by aquatic animals. Sublethal toxicity studies are becoming very important and sensible tools for evaluation of impact of pollutant on aquatic life for determination of lower 'no effect' concentration of a pollutant. In aquatic environment organisms usually face relatively low pollutant concentration but over a long duration such as chronic exposure to sublethal metal concentration can induce an acclimation process.

There are fragmentary reports on the study of toxicity of tannery effluent in molluscan species. Therefore, present study reports the effect of tannery effluent on biochemical constituents of freshwater bivalve, *Lamellidens marginalis* as it has great economic importance and high food value. The study deals with the acute and sublethal toxicity changes in biochemical parameters like protein, glycogen, cholesterol and lactic acid as well as enzymes like acid phophtase, alkaline phosphtase, glutamate oxaloacetic transaminase, glutamate pyruvate transaminase, lactate dehydrogenase and adenosene triphosphtase. A histological alteration studied by light microscopy and accumulation of metals in the bivalve, *Lamellidens marginalis* was also conducted by Atomic Absorption Spectrophotometer. This type of study will help in of environmental monitoring.

The present study is presented in five chapters. The first chapter gives a detailed introduction of the topic. The second chapter gives detailed materials and methods used in the investigation. The third chapter deals with detailed observation of all parameters studied. The fourth chapter deals with discussion of all parameters studied and their correlation with the work carried out by other investigators. The fifth chapter deals with the summary and precise conclusions. The dissertation also gives a detailed bibliography of the references, which are directly and indirectly referred for the correlation of the present investigation.