5.1 Growth rate

In the present experimental study, it has been observed that the magnetic field had a pronounced effect on the development of tail regeneration in *Hemidactylus brooki*. The initial phases of the tail regeneration showed less effect, but when the regeneration progressed, the effect was magnified. From the data, it could be summarized that the south and the north pole of the ceramic magnet had an inhibitory effect on the regeneration.

The results show that magnetic field has no significant influence on wound healing phase of tail regeneration. Although a slight decrease in number of days was noted for the completion of wound healing under the north pole when compare with that of control lizards (Table 1, Fig. 1).

During the last several years many experimental and clinical studies demonstrated that magnetic fields promote or delay healing of wounds and ununited bone fractures (Liepa and Slutskii, 1974; Basset *et al.*, 1974; Smith and Nagel, 1983; Haupt, 1984; Wahlstrom, 1984; Satter *et al.*, 1999, Guerkov *et al.*, 2001; Kotani *et al.*, 2002; Zborowski *et al.*, 2003; Icaro *et al.*, 2006; Sakai *et al.*, 2006; Selvamurugan *et al.*, 2007). Significant beneficial stimulation in wound healing process in mammals treated with pulsed electromagnetic fields has also been reported (Ottani, 1988; Vodovnik and Karba, 1992; Aaron and Ciombor, 1993; Patino *et al.*, 1996;
Adam et al., 1998; Joshua et al., 2004. Scardino et al., 1998 showed that a significant increase in the rate of wound contraction was found in dogs treated with magnetic fields. But Cockshutt et al., 1984 and Nursal et al., 2006 failed to show any effect of the magnetic field on wound healing, which later found that the main differences were in the frequency and the duration of the treatment. The present experimental data regarding wound healing during regeneration showed no significant effects of magnetic fields (Table 1, Fig.1). The activity of neutrophils and acid phosphatase which are known to be associated with phagocytic function during wound healing phase of reptilian regeneration (Hiradhar et al., 1979; Thomas et al., 1980) was not found to be changed in the lizards exposed to magnetic fields when compared to the control (Tables 20 and 24; Figs. 20 and 24).

In the blastemal phase, a number of cell types readily revert to move embryonic stage under conditions of trauma and start dividing. Mitotic activity occurs in the cells beneath the apical cap (Shah and Chakko, 1968a). In the present investigation, it was observed that a considerable acceleration of blastemal and differentiation phases in lizards exposed to north pole, when compared to control and south pole exposed animals (Table 1, Fig. 1). North pole seemed to stimulate the process of early phases of regeneration while south pole seemed to have an inhibitory effect. The opposite response to north and south
poles may be due to the opposite direction of the gradient vector as observed in Fiddler crab regeneration (Lee and Weis, 1980).

A multihormonal mechanism (growth hormone, thyroxin, melatonin, insulin, catecholamines, prolactin and corticosteroids) has been suggested for vertebrate regeneration (Vethamany–Globus and Liversage, 1973a, b; Shah and Hiradhar, 1978; Ramachandran and Ndukuba, 1991; Anoop Kumar and Pilo, 1994; Kurup et al., 1995; Pilo and Anoop Kumar (1995). A number of possible mechanisms can be involved in effects of magnetic field on regenerating system. Inhibitory and stimulatory effects of magnetism on hormones like insulin (Sutter et al., 1987); thyroxin (Katola et al., 1982); melatonin (Lerchl et al., 1991; Yaga et al., 1993; adrenalin and noradrenalin (Sankarnarayan et al., 1984) have been reported.

A significant quantitative difference of protein and free amino acids, during different phases of reptilian tail regeneration has been observed by Shah et al., (1977b; 1979). According to Lebowitz and Singer (1970) only 40 % of the protein synthesis in the regenerating amphibian limb is nerve dependant however, denervation did not alter the rate of transport of aminoacids for protein synthesis (Singer and Ilan, 1977). Studies on the influence of magnetic field on nervous system have revealed that it plays some role in neuronal activities (Abdullakhozhdaeva et al., 1986; Cordeiro et al., 1989; Blackman et al., 1993; Sakamoto et al., 1993; Rosen, 1994; Kim et al., 2002;
Crowe et al., 2003). Neuronal activity, one of the indispensable factors during regeneration can be influenced by magnetic fields.

After the 30th day, the regenerate of lizard exposed to south pole showed an acceleration of growth than the north pole. When the relative weight of the regenerate on 80th day (Table 5, Fig. 5), in north and south poles of the magnetic fields showed no much differences. But the lizards exposed to magnetic fields showed a significant reduction in the growth of the regenerate, when compared to that of control. The percentage of tail replacement was 56.69 and 69.08 in north and south poles respectively (Table 4, Fig. 4).

Extremely weak industrial-frequency magnetic field on the regeneration rate of the planarian showed an inhibition rather than activation (Lednev et al., 2005). Landesman and Douglas (1990) observed an abnormal limb regeneration of newt exposed to pulsed electromagnetic field. Rapyan et al., 1985 reported the impairment of connective tissue under constant magnetic field. Magnetic fields are also known to influence chondrocyte differentiation and collagen alignment (Coimbor et al., 2002, Torbet and Ronziere (1984). Presently observed poor development of structural elements of the regenerate in both magnetic poles could be due to the impairment of various regeneration mechanisms caused by the magnetic field.
Bioelectricity has been found to play an important role in regeneration (Becker, 1961; Borgens et al., 1977a; Smith and Pillai, 1981; Borgens and Raymond, 1985). Smith (1981) has studied the role of electrode position in the electrical induction of limb regeneration in subadult rats. The application of a 0.2 µA current to the limb stumps of adult frogs (*Rana pipiens*) caused partial regeneration if the current was cathodal (distally negative). The application of anodal current (distally positive) caused extensive destruction of the limb stump (Borgens et al., 1977b). These effects of the oppositely directed current were related to the effects of north and south poles of magnetic fields on regeneration of Fiddler crabs (Lee and Weis, 1980). A similar involvement of bioelectric current in lizard regenerative mechanism could also be considered in the present study.

From the present study, it became evident that wound healing phase of regeneration was not influenced by the magnetic field. However the later phases *viz.*, blastema, differentiation and growth were gradually affected by the magnetic field. The inhibitory effect of the regenerate could be due to the effect of magnetic fields on cell proliferation, metabolic machinery, neuroendocrine activity and various bioelectrical functions.
5.2 Metabolites

Developmental processes such as regeneration, wherein large scale restoration of lost tissues occurs, presumably raise the energy demands of the organism. It is logical to believe that regenerative activity might evoke alterations of metabolites locally and from distant organs. The results of the present study show that the magnetic field has a significant effect on the metabolites of the regenerating lizard, *Hemidactylus brooki*. The pattern of fluctuation of metabolites during the different phases of regeneration in control and experimental lizards was more or less similar.

5.2.1 Carbohydrate

Importance of glycogen as a major energy yielder for metabolic activities in animal tissues during development has been well recognized. Tassava (1969) while studying amphibian regeneration reported that energy derived from sources other than the stump tissue increases the survival chance and regenerative capacity of an animal. Shah et al., (1977b) have reported alteration of blood glucose and glycogen content of the liver and thigh muscle and broken tail tissues of the stump in *Hemidactylus flaviviridis* during wound healing phase. Similar reports on hepatic glycogen during wound healing phase of amphibian limb regeneration are available from the work of Procaccini et al., (1973).
In the present study in all sets of experiments, it could be noted that depletion of glycogen from the tail (Table 6, Fig. 6) and liver (Table 7, Fig. 7) and the parallel rise in the blood glucose level (Table 8, Fig. 8) from the preautotomy value may primarily be for meeting the stress condition in the initial stages and the energy demands of the wounded tissues for the repair.

During the blastemal phase, blood glucose concentration showed a drastic decrease from its previously elevated level, whereas the liver glycogen content remain more or less to that of the wound healing period in all the three sets of experiments. Remarkably low level of glycogen was observed in the blastemal phases. From the data it is summarized that there is no much mobilization of the metabolite from liver during blastemal phase than wound healing phase. But reduction of blood glucose level indicates the possibility of blood glucose being utilized by the blastemal cells. According to Shah et al., (1977b), the fall in the blood glucose level during this period could possibly due to the utilization of glucose molecule to the hexosemonophosphate (HMP) shunt which is significantly associated with synthesis of nucleotides and lipids in the regenerating lacertilian tail. Considerable paucity of glycogen in the blastema may be due to lack of its synthesis (Shah and Hiradhar, 1974). Whatever little glycogen could be detected was possibly due to the phagocytic properties of wound epithelium and the scattered glycogen droplets in
the extracellular spaces among the blastemal cells (Singer and Salpeter, 1961; Norman and Smith, 1967).

During the differentiation of the tail regenerate, the glucose concentration in the blood maintain near to the preautotomy value. But in the liver, the glycogen content showed an increase during the differentiation phase from the blastemal phase in experimental and control animals. The present observation indicates that the differentiating tissues of the tail regenerate are using glucose and the synthesis of glycogen also occurs in the regenerate. At this phase increased vascularity of the differentiating regenerate and glycogen synthesis was reported in the regenerating tail tissues of lizards (Shah and Hiradhar, 1974).

As the regenerating lizards attains its growth phase, the levels of blood glucose, tail and liver glycogen showed a tendency to reach almost the respective preautotomy values. However the glycogen content in the regenerating tail of the lizard exposed to north pole revealed a higher level of glycogen content as compared to that of the lizards exposed to south pole (Table 6, Fig. 6). The present study on rate of growth, it has been observed that north pole stimulate the early phases and it has an inhibitory role in the growth phase. But the south pole shows an acceleration of growth phase, compared to north pole (Table 2, Fig. 2).
The observed different levels of glycogen in tail and liver and blood glucose in lizard exposed to magnetic field probably due to the differential effects of magnetic fields on carbohydrate metabolism. The above said magnetic effects may be due to the fact that during magnetic exposure, magnetic flux could have inhibited or stimulated the enzyme machinery (Haberditzl, 1967; Gorczynska and Wegrzynowicz, 1989; Kefuss et al., 1997; Pashovkina and Akaev, 2000; Lohmann et al., 2000). Magnetic field is also believed to affect the absorption of glucose, synthesis of glycogen and various hormones concerned with carbohydrate metabolism (Madar et al., 1979; Shakula and Chernyakov, 1981; Tomashevskaya, 1981; Galka and Krolikovska, 1982; Sankarnarayan et al., 1984; Sutter et al., 1987; Gorcynska and Wegrzynowicz, 1991). Such possibility in the present contest cannot be ruled out.

5.2.2 Lipid

Total lipid contents of the tail regenerate and liver showed no drastic differences in the experimental and control lizards during different phases of regeneration (Tables 9 & 10, Figs. 9 & 10). The total weight of the abdominal fat body and its lipid content studied by Licht (1967) during the process of regeneration did not show any fluctuations in the initial phases of regeneration, but during the early differentiation phase it was found that its lipid content had seen
decreased. Kinarivala et al., (1978) has studied hepatic lipids and glycerides in relation to the regenerative process in Mabuya. An increased synthesis of lipids in the differentiating tail regenerate and a decreased content of the abdominal adipose tissues during tail regeneration has been reported in house lizard, *Hemidactylus flaviviridis* (Shah and Hiradhar, 1977; Shah et al., 1977 b).

Magnetic field is believed to affect the metabolism of lipids in animals, such as increase in serum cholesterol (Todorov and Draganov (1973); changes in lipid composition of rat liver (Chernysheva (1987); various magnetic effects on lipid membranes (Speyer and Sripada (1987); Carl et al., (1991); Rosen (1993); Sinerick et al., (1994); Alexander (2001) and Thomas et al., 2002). It is observed that during growth phase, total lipid content of the liver was significantly lower in the lizard exposed to magnetic fields. Similar observation has also been made in mice (Satheesan and Muraleedhara kurup, 1994).

The presently observed reduced rate of growth of the regenerate in the lizards exposed to north and south poles of ceramic magnet could be correlated with differential effects of magnetic fields on carbohydrate and lipid metabolism.
5.3 Haematology

The result of the present study shows that the magnetic field has a profound but differential effect on the haematology of the regenerating lizard, *Hemidactylus brooki*.

Various mechanisms have been evolved by animals to combat to an injury as part of adaptive changes in animals could reasonably be expected to entail noticeable changes in the composition of blood, which is endowed to perform a variety of functions. Reptiles and mammals have been found to respond haematologically to stress (Meints *et al.*, 1975; Steplewski and Vogel, 1986). Andrew (1959) reported that haemapoietic function in lizards is performed by the spleen and bone marrow. Studies on immunity and classification of reptilian blood cells have been carried out by various workers (Saint Girons, 1970; Duguy, 1970; Cohen, 1971; Coe, 1972; Cooper, 1973; Cuchens and Clem, 1979).

In the present study, it is revealed that the total RBC count is decreased during wound healing phase of the regenerating lizard and a corresponding decrease in haemoglobin content is also seen in control animals (Tables 12 & 13, Figs. 12 & 13). This indicates a low O₂ supply in the lizard during this phase. As such the O₂ affinity of the blood of lizards is low (Pough, 1969) and the increased energy demands during activity in most reptiles are met primarily by anaerobic metabolism (Bennet and Dawson, 1972; Bennet and Licht,
1972). Low RBC and haemoglobin contents are clearcut evidence of exhibiting a predominantly anaerobic mode of metabolism. However the mean cell haemoglobin concentration (MCHC) has shown an increased level during the wound healing stage in the animal exposed to magnetic field. Eventhough the PCV values shows no much difference in wound healing phase, it showed a drastic reduction in all sets of regenerating lizards from preautotomy value. During the blastemal formation, RBC counts, haemoglobin content, PCV and MCHC values showed a tendency to reach the preautotomy period.

A remarkable rise in the total RBC counts, haemoglobin content and MCHC values during wound healing, blastema, differentiation and growth phases in lizards exposed to magnetic field has been noted. The experimental results mentioned above can be described under the light of many magnetic effects reported on haematology.

Chen Issac and Subratha (1984) reported a retardation of blood flow by an intensive magnetic field and if this retardation in the blood flow continues, the O₂ supply will decrease in the body tissue and the body will produce more RBC to meet the inadequate O₂ supply.

Studies support the fact that magnetic fields affect the function and structure of haemoglobin (Atef et al., 1995); on increase in iron content (Aristarkov and Piruzyan, 1974); on disturbed blood circulation (Trausch-Treml and Scherer, 1989) and on reduced microcirculation (Ichioka et al., 1998).
In the light of above observations it may be concluded that the present increased level of blood parameters observed in the lizards exposed to magnetic field could be correlated with the influence of magnetic field on vascular system.

While examining the total leucocyte count of the different stages of the regenerating lizards, it was found that the highest total WBC counts were observed in the wound healing phase. Afterwards, the total leucocyte count gradually decreased in blastema and differentiation phases and attains its normal level at the growth phase in control. A similar pattern of fluctuations in total leucocyte count was noted in experimental lizards. Magnetic field do not exhibited any prominent changes during wound healing, blastema and differentiation phases (Table 15, Fig. 15), whereas during the growth phase, the long term exposure showed a significant increase in count. The increased total leucocyte count level in the wound healing phase will be to act against infections in the wound site and to remove and clean the cell debris from the wound sites (Ward, 1980). Electromagnetic and ceramic magnetic fields have showed an increase in total leucocyte count in guinea pig, rats and humans (Barnothy et al., 1956; Mitropolski, 1973; Kartsovnik and Faitel, 1974).

The differential leucocyte count in the normal lizards revealed that lymphocytes are the most abundant leucocytes followed by eosinophils, neutrophils, monocytes and basophils. In the present
observation, different leucocyte number varies from the normal count during different phases of regeneration (Tables 16 - 20, Figs. 16 - 20).

Healing of a wound is the product of an integrated response of several cell types of blood to injury. Schilling (1968) has emphasized the importance of haemostatic mechanisms in wound healing. To make good, the loss of blood immediately following autotomy of the tail, the haemopoetic activity of the spleen and bone marrow are geared up (Hiradhar et al., 1979). Stress is known to cause discharge of lymphocytes from haemopoetic organs (Pickford et al., 1971). Circulating lymphocytes are significantly immunosensitive as they are antigen reactive (Wilson, 1971). Significance of lymphocytes in immune reactions in lizards has been very well understood (Wetherall and Turner, 1972).

A remarkable threefold increase in the total leucocyte count in control and experimental lizards noted in the wound healing phase could be correlated with the systemic response for the healing of the exposed surface of the autotomised tail stump. The lymphocyte population of blood largely contributes this increase. Hence it is not amazing to find involvement of lymphocyte in immune reactions, which are found to occur subsequent to tail anatomy.

The increased lymphocyte count from the wound healing phase was found to decrease in all groups of lizards as the regeneration progressed. However, during differentiation and growth phases the
lizards exposed to north pole and south poles showed a significant increase with the control. This can be considered as the effect of magnetic field effects on haemapoetic tissues of lizards.

The long term exposure of magnetic field on rabbit and guinea pigs showed a marked increase in WBC. This increase was caused solely by an augmentation of lymphocytes count (Gruszecki, 1962, 1964). The proliferation and stimulation of human and rat lymphocytes was also noted under magnetic field (Rosenthal and Obe, 1989; Scarfi, et al., 1999; Zmyslony et al., 2000; Jolanta et al., 2001; Jajte et al., 2001). Hence the observed increase in the lymphocyte count in the experimental animals is apparently a circulatory response to magnetic field.

A decrease in the neutrophil and eosinophil count during the wound healing phase is quite understandable since the early inflammatory response to injury is dominated by accumulation of polymorphonuclear leucocytes at the site of damage (Schilling, 1968). A large number of polymorphonuclear leucocytes in the mouse skin scab (Tarin and Croft, 1970) and in the injured liver of rat (Shah et al., 1974) have been reported. The only well designated function of neutrophilic leucocytes is that of phagocytosis to combat infection (Simpson and Ross, 1972). The eosinophilic leucocytes can also act as phagocytes although to a lesser extent than neutrophils (Vaughn, 1953). Similar pattern of neutrophil and eosinophil count was
observed in experimental and control groups of lizards (Table 19 and 20; Fig. 19 and 20). Although a stimulatory and inhibitory effect of static magnetic field on neutrophil and eosinophil of mammals has been reported (Savula et al., 1981; Gorczynska and Eleonora, 1987; Biju and Thomas, 1999) but no significant magnetic effects were observed in these cells during wound healing.

Once the blastema is formed, the neutrophil count in all groups of lizards is more or less comparable to that observed in animals with normal tail. Slightly higher count of neutrophil during blastemal phase observed in the present study can be related with the restoration of the depleted count of neutrophils.

Data on differential WBC count during the regenerative phases showed that the monocytes and basophils populations are lower than the preautotomy level. The lizard exposed to magnetic field showed no significant variation during the different phases of regeneration. An inhibitory effect of static magnetic field on monocytes and basophils of mammals has been reported (Kartsovnik and Faitel, 1974; Gorczynska and Eleonora, 1987). Such inhibitory magnetic field effects were not observed in the present study.

From the present study it become evident that static magnetic field has inhibitory and stimulatory effects on the haematological parameters of the regenerating lizards. Magnetic field effects were
seems to be prominent during differentiation and growth phases of tail regeneration.

### 5.4 Ascorbic acid

Ascorbic acid is an important molecule which can exercise significant influence on biological activities and hence has been studied in relation to regeneration (Shah *et al*., 1971; Hiradhar *et al*., 1981). The levels of ascorbic acid in tail, liver and kidney showed a fluctuation during the various phases of regeneration in all groups of lizards. The magnetic effect seems to be effective from growth phase.

It has been suggested that ascorbic acid plays a very important role in the healing of wounds (Bartlett *et al*., 1942 a, b). When mammals with partial vitamin C deficiency were wounded, mobilization of ascorbic acid from the other tissues and organs to the site of the wound was noticed during the wound healing (Gould, 1963). Ascorbic acid is known to be linked with lipid and carbohydrate metabolism (Banerjee and Ghosh, 1947; Banerjee and Ganguli, 1962). From the study of the Kreb’s cycle enzymes and ascorbic acid in scorbatic guinea pigs, Banerjee *et al*., (1959) concluded that ascorbic acid is essential for proper functioning of the Krebs’s cycle. Ascorbic acid plays an important role in the energy transfer mechanisms by its transformation into its free radical-monodehydroascorbic acid, which is a more powerful electron donor.
than ascorbic acid (Chinoy, 1978). The ascorbic acid level in tail during wound healing showed a two fold increase from the normal value in all groups of lizards (Table 21, Fig. 21). Wound healing in lizards exposed to magnetic field did not show any significant differences from the control. Relationships of high level of ascorbic acid to accumulation of fibroblasts and leucocytes and the synthesis of mucopolysaccharides and collagen at the wound healing site has been reported (Gould, 1963; Chiltz et al., 1977). The results obtained presently are in agreement with the above observations.

With a completion of healing and onset of blastemic phase, considerable fall in tail ascorbic acid was observed in control and experimental lizards (Table 21, Fig. 21). Blastema is characterized by active cell division, cell proliferation and anaerobic environment. These conditions are not conducive to collagen fibrillogenesis (Ross 1968; Shah et al., 1971). Thus, an overall requirement of ascorbic acid during this phase is lower compared to that during wound healing.

The metabolic activities during differentiation phase are at peak. Laying down of connective tissue matrix and collagen fibres; incorporation of aminoacids for protein synthesis and high level of cAMP is a prominent feature of the differentiating phase. Ascorbate is an enzyme cofactor and antioxidant that stimulates the transcription, translation, and posttranslational processing of collagen in connective
tissue cells (Franceschi, 1992; Peter and Masanori 2002). It has been reported that collagen building and aminoacid synthesis is greatly influenced by ascorbic acid intake in animals (Gould, 1963). Involvement of ascorbic acid in maintaining high levels of cAMP in animal tissues has been well established by several workers (Lewin, 1974; Van Wyk and Kotze, 1975; Tisdale, 1975). Ascorbic acid is also considered as a source of electron energy for animal metabolism (Chinoy, 1969).

During differentiation phase of regenerating tail, a fourfold increase in ascorbic acid content from the preautotomy value has been noticed in experimental and control lizards. The observed high level of ascorbic acid could be correlated with the formation and maintenance of macromolecules during the process of differentiation.

A fall in the level of ascorbic acid soon after the differentiation phase indicates the role of ascorbic acid in the promotion of differentiation rather than growth. The observed significant low levels of ascorbic acid during the growth phase of lizards exposed to both magnetic fields with the control may be due to the long term effect of magnetic exposure. Inhibitory effect of magnetic field on ascorbic acid oxidase, free radical and plasma vitamin C level has been reported (Ghole et al., 1986; Gonet, 1991; Kashkalda et al., 1995; Issa et al., 2001).
Ascorbic acid is mobilized from liver and kidney which are known to be site for storage and synthesis respectively during wound healing in animals. (Grollman and Lehninger, 1957; Roy and Guha, 1958; Candlish and Chandra, 1967; Hiradhar et al., 1981).

Ascorbic acid level of liver and kidney showed slightly higher value than the preautotomy value during different phases of regeneration. But no significant differences in the levels of ascorbic acids were observed between experimental and control lizards (Table 22 and 23. Figs. 22 and 23). This observed change in levels suggests a gearing up of synthetic machinery residing in distant organs in the event of increased demands for the vitamin during the process of different stages of regeneration.

Gonet, (1991) and Shust and Kostinik, (1975) has reported that magnetic field significantly decrease the mammalian liver ascorbic acid content. Ascorbic acid synthesis, distribution and metabolism were found to be controlled by hormones (Stubbs et al., 1967; De Nicola et al., 1968; Dieter, 1969; Sreelethka kumari et al., 1994). As magnetic field influences endocrine system (Madar et al., 1979; Katola et al., 1982; Sankarnarayan et al., 1984; Sutter et al., 1987; Gorczynska and Wegrzynowicz, 1991; Anna-Laitl-Kobierska et al., 2000), this may be a plausible explanation for the general trend of decreased levels of ascorbic acid observed in tail, liver and kidney.
5.5 Acid and Alkaline phosphatases

The changes in acid and alkaline phosphatase activities associated with regeneration in animals suggest that these enzymes are intimately involved in the processes of growth and repair. The present study indicates that the regenerating lizard, *Hemidactylus brooki*, exposed to different poles of magnetic fields showed a similar trend of alterations in the levels of acid and alkaline phosphatases activities during different phases of regeneration and the effect was more pronounced during the later phases of regeneration.

Production of lysozymal enzymes such as acid phosphatase represents one of the first steps in repair process (Raekallio, 1960). Acid phosphatase is known to be involved in phagocytic activity and mucopolysaccharide synthesis during regeneration of appendages in amphibians and reptiles (Singer and Salpeter, 1961; Miller and Wolfe, 1968; Thomas et al., 1980). Such activities are apparently affected in event of unavailability of an optimum concentration of acid phosphatase. In the present study, the acid phosphatase activity during wound healing phase in control and experimental lizards showed an increase (Table 24, Fig. 24) as compared to the preautotomy level. The slight differences in the mean values of acid phosphatase activity observed in the wound healing of control and experimental lizards
could be correlated with the observed differences in the time taken to
attain the wound healing (Table 1).

Blastema is a mass of undifferentiated mesenchymatous cells
that are actively engaged in cellular division and proliferation. Such
activities should certainly demand greater synthesis of
macromolecules such as proteins and acid phosphatases is known to
be involved in protein synthesis (Pearse, 1968). It has been also
reported that increase in concentration of nucleic acids (Shah and
Chakko, 1972); total proteins (Shah et al., 1977b) and free amino
acids (Shah et al., 1979) occur in the blastemal and differentiating
phases of lizard tail regeneration. On comparison, acid phosphatase
activity levels in the blastema and differentiation in all three groups of
lizards do not show any significant differences however, the animal
exposed to north pole showed a tendency of reduction in enzyme
activity compared to control and lizards exposed to south pole. A
significantly low level of acid phosphatase activity was observed
during the growth phase of lizard exposed to north pole of the ceramic
magnet. Thus a correlation between low acid phosphatase activity and
per day rate of growth (Table 3. Fig. 3) during the growth phase is
quite apparent.

Acid phosphatase activity accelerates hydrolysis of phosphate
esters optimally at acidic pH and has been identified with a special
group of cytoplasmic particles, the lysosomes (Duve et al., 1962).
Catalytic activity of alkaline phosphatase is similar to that of acid phosphatase; except that the hydrolysis of phosphate esters takes place optimally at an alkaline pH. Since these phosphatases hydrolyse a variety of phosphate esters, they are termed as non-specific phosphatases. Due to their nonspecificity, it is difficult to ascertain any specific role played by either acid or alkaline phosphatase activity present in a particular tissue or cell. Usually, therefore such an enzyme activity can be correlated only with specific reference to the functions of a particular tissue or cell type.

Some of the important functions ascribed to acid phosphatase activity are:- as the hydrolytic enzyme (Heinrikson, 1969), in the regulation of pyridoxal phosphate requiring enzymes (Andrews and Turner, 1966), involvement in steroid transport, in vitamin, B₆ metabolism (Dipetro and Zengerle, 1967), absorption (Straus, 1964), phosphorylation (Stetten, 1964) and in lipid metabolism(Blank and Snyder, 1970).

In the present study acid phosphatase activity in the liver was found to exhibit a gradual increase from the preautotomy value during wound healing and blastema and attained peak activity at the differentiation phase. A significant reduction in acid phosphatase activity was noted in experimental lizards during differentiation and growth phase. But in kidney, the acid phosphatase activity was not
altered significantly in experimental lizard during different phases of regeneration (Table 26, Fig. 26).

Consideration of biological effects of electromagnetic radiation is particularly important with regard to bone metabolism. Magnetic fields have been applied to the treatment of bone fractures. The acid phosphatase activity was not changed after the treatment with electromagnetic field (Schmitt, 1978). Mice when exposed to intense static magnetic field for short duration showed no significant changes in bone acid phosphatase activity (Papatheofanis and Papatheofanis, 1989), whereas acid phosphatase was found to increase in guinea pigs exposed to static magnetic field (Gorczynska and Wegrzynowicz, 1985). Hence a similar differential effect of magnetic field on acid phosphatase activity in lizard liver and kidney cannot be ruled out.

Alkaline phosphatases are a group of isomers of non-specific enzymes, which hydrolyze monophosphoric acid esters at an alkaline pH of about 10. They have been demonstrated to be involved in differentiation, formation of fibrous proteins, calcification of bone, formation of mucopolysaccharides, forming ground substances (Simkiss, 1964), carbohydrate metabolism (Rosenthal et al., 1960), phosphate transfer in DNA metabolism (Rogers, 1960), passage of metabolite across cell membranes (Simkiss, 1964; Kramer, 1989) and osteoblastic activity (Gutkin et al., 1992; Leung et al., 1993).
In the present study, alkaline phosphatase showed a remarkable decrease in its activity from the preautotomy value during wound healing in control and experimental lizards. This may be due to change of environmental condition in the cells engaged in wound healing, which is probably becomes acidic, thus creating a condition unsuitable for alkaline phosphatase activity.

During blastema and differentiation phase, the alkaline phosphatase activity showed a tremendous increase in its activity in all the three groups of lizards. Rapidly proliferating cells during embryonic development are also known to exhibit high activity of alkaline phosphatase (Abe et al., 1972; Meakawa and Yamana, 1975). Hence the apparent increase in alkaline phosphatase activity could be associated with the laying down of matrix and synthesis of mucopolysaccharides in the tail regenerate.

The electromagnetic field is believed to causes a reduction in cell proliferation and increase in alkaline phosphatase activity in culture cells (Pashovkina and Akaev, 2000; Lohmann et al., 2000). The alkaline enzyme activity which was considerably reduced in the immobilized children, increased significantly after treatment with electromagnetic field (Schmitt, 1978). Studies on mice and guinea pigs exposed to static magnetic field showed no significant changes in alkaline phosphatase activity (Gorczynska and Wegrzynowicz, 1985; Papatheofanis and Papatheofanis, 1989).
A significant increase of alkaline phosphates was observed in lizards exposed to both magnetic fields when compared to control. This indicates that static magnetic field has a stimulatory effect on regenerating lizards.

In the present study alkaline phosphatase activity in the liver and kidney was found to be lower than the preautotomy value during wound healing and blastema. Thereafter it showed a gradual increase during differentiation and growth phase. However a significant increase in their activity were noted in the experimental lizard during growth phase when compared to control (Tables 28, 29. Figs. 28, 29).

Magnetic field has been believed to influence the living system in various ways. Influence of static magnetic field on enzymes is either inhibitory or stimulatory (Gorcynska and Wegrzynowicz, 1985, 1989; Kefuss et al., 1997; Chiu et al., 2007). This effect was found to be altered with the different exposure time or intensity (Haberditzl, 1967). The magnetic field is also found to influence regulation and kinetics of enzyme action (Harkins and Grissom, 1994; Eichwald and Walleczek, 1996; 1998) and via by the indirect effect on hormones (Sankarnarayan et al., 1984 and Sutter et al., 1987).

Hence it is summarized that direct or indirect effect of magnetic fields on acid and alkaline phosphatase activity in the regenerate probably affected the regenerative processes in the lizard.