There are four basic interactions in nature; namely, Electromagnetic, Weak, Strong and Gravitational interactions. There has been attempts to unify all four interactions in a consistent manner. The theory obtained by unifying electromagnetic and weak interaction is known as electroweak theory and the mediators of this force are massless photons, massive W and Z bosons. When one combines electroweak interaction with strong interaction, the resulting theory is known as grand unified theory. Here in addition to photon, W and Z bosons, there are additional particles called gluons for mediating strong interactions and, probably superheavy X and Y gauge bosons at a grand unification scale. Since such a theory does not include gravitation, there were attempts to consider some new symmetry which will automatically include gravitation. Consequently, a theory has been developed which incorporates all four interactions and it is known as supergravity. It not only unifies all four basic interactions, but also answers many unexplained things in grand unified theories. Supergravity however is nonrenormalizable and one wants a finite quantum theory of gravity. It is possible to achieve this by the construction of a new kind of theory, known as superstring theory. We shall study some aspects of these theories to get some understanding of ultimate unification.
The thesis is organized as follows. In Chapter 1, we shall give an overview of electroweak unification, grand unified theory, supersymmetry, supergravity, string theories and conformal invariant field theories which focus the background of our work later.

In Chapter 2, we shall extend the supergravity model to SO(10) gauge symmetry. We find that there can be a hierarchical structure with intermediate mass scale for SO(10) symmetry breaking, along with a tree level weak symmetry breaking caused by a Polonyi type potential in a manner parallel to SU(5) symmetry breaking.

In Chapter 3, we shall consider a supergravity model of the grand unified gauge group SO(10), which breaks to $SU(3)_C \times SU(2)_L \times U(1)_R \times U(1)_{B-L}$ ($\equiv G_{3211}$) at a mass scale of $10^{15}$ GeV. The low energy breaking of the gauge group $G_{3211}$ to $SU(3)_C \times U(1)_Q$ is induced by supergravity. The conventional picture of SO(10) grand unification theory is to consider an intermediate scale above the weak scale. In the present picture, we shall however use a single stage symmetry breaking for the SO(10) group, with one extra $U(1)$ symmetry which may correspond to an extra neutral gauge boson at 500 GeV or more. We shall note that such a picture is consistent with present phenomenology.

In Chapter 4, we shall start with the gauge group $SU(3)_C \times SU(2)_L \times U(1)_R \times U(1)_N$ ($\equiv G_{3211}$), which is a rank 5
subgroup of $E_6$. We shall include chiral fermion condensate terms in the effective four dimensional Lagrangian derived from superstrings and discuss how this condensation can be responsible for weak symmetry breaking at a scale of 100 GeV. One experimental effect of the above will be the nonobservation of light higgs scalars of the Salam-Weinberg model, although the other results of the same remain unchanged.

It has been observed that multiple intermediate scales may arise in gauge groups $SO(10)$, $E_6$ or $E_8$. The group $E_8$ is important enough to consider as string theories naturally incorporate $E_8 \times E_8$. It has been shown that superstring theories are anomaly free if the gauge group is $E_8 \times E_8$ or $SO(32)$. Also the group $E_8 \times E_8'$ is phenomenologically very promising. In Chapter 5, we shall consider the gauge breaking of supergravity based $E_8$ grand unified gauge group to $E_6$ in the zeroth order of supergravity at Planck mass scale $M$ and $E_6$ to $SO(10)$ at a scale $\mathcal{F}M$, where $\mathcal{F}$ is a small supergravity expansion parameter of the order of $10^{-4}$. Then we shall see that the subsequent breaking of $SO(10)$ to $SU(5)$, $SU(5)$ to $G_{\text{std}} (SU(3)_C \times SU(2)_L \times U(1)_Y$ and $G_{\text{std}}$ to $G_{\text{LE}} (\equiv SU(3)_C \times U(1)_{Q})$ occur at scales, $\mathcal{F}M$, $\mathcal{F}^2M$ and $\mathcal{F}^3M$ respectively with local supersymmetry breaking at the weak scale in the visible sector.
In Chapter 6, we shall calculate a six point amplitude involving two bosons and four fermions in open ten dimensional superstring theory. We shall explicitly use the ideas of bosonization lattice, cocycles, covariant spin fields and superconformal techniques. This is an abstract exercise in the context that superstring theory may yield ultimate unification for all the forces of nature.

In Chapter 7, we shall summarize the results and discuss about the outlook with the context of our findings and otherwise.