A growing cell follows either of the two developmental pathways - 1) vegetative pathway and 2) meiotic pathway. The events of the yeast cell cycle occur in a reproducible temporal order viz., duplication of the nuclear plaque, the segregation of the nuclear plaques to opposite poles of the nuclear membrane, the initiation of DNA synthesis, emergence of bud, DNA replication, chromosome segregation, nuclear division, cytokinesis and cell wall separation (Hartwell 1976). The production of two viable cells at cell division is possible only when these events occur in the proper sequence. Now, the question is "How is this order achieved?" The second question which arises is "What is the cause of the switch from equational division to reductional division of the nucleus"? It is of interest to study the factors underlying the shift from mitosis to meiosis and also to single out the factors specific for meiosis and/or recombination. In the present studies we have attempted to probe into these questions using yeast as our experimental material.

The baker's yeast *Saccharomyces cerevisiae* belongs to the family *Saccharomycetaceae* of the order *Endomycetales*. This yeast is one of the ascosporogenous group which forms ascospores after meiosis. The most widely accepted definition of yeasts is that they
are fungi in which unicellular form is predominant. In *S. cerevisiae*, the vegetative reproduction is by budding. Sexual reproduction involves the process of meiosis resulting in the formation of four haploid ascospores. A few yeasts, such as *Schizosaccharomyces octosporous* and members of the genera *Nematospora* and *Coccidiascus* resemble higher ascomycetes in regularly producing a maximum of eight ascospores per ascus (Powell 1969).

The unicellular habit of yeast like that of bacteria and the presence of a well defined nucleus similar to that of eukaryotes makes this organism to appear like the link between prokaryotes and the higher eukaryotes. The somatic division "mitosis" ends in the formation of bud which gets separated from the mother cell after cytokinesis and the formation of cell wall. Sometimes 2 to 3 buds remain attached to the mother cell forming short "chains". The mitotic cell cycle of yeast has been widely analysed by the use of different cell cycle mutations.

Yeasts propagate sexually by producing ascospores which are the end product of meiosis. In some fungi, including yeast, the conversion from mitosis to meiosis can be manipulated by changing the environment. Whatever its nature, the developmental switch from mitotic to meiotic division is very effectively protected from error, probably because the conversion includes very many integral steps. No example has been reported of meiotic division being displaced morphologically, spatially or temporally in eukaryotes. Occasionally, however, a particular consequence of meiosis such as recombination or chromosome reduction can be achieved by non-meiotic means.
Since meiosis is considered to have arisen as a deviation from the pattern of normal mitotic division, the study of factors underlying the shift from mitosis to meiosis is of particular interest. In higher plants, the matter is complex because of the unknown interactions between meiocytes and the surrounding tissues. When sporogenous tissue is isolated from anther before the onset of meiosis, the cells do not enter into meiosis but continue to divide mitotically in tissue culture. In most lower organisms, the occurrence of meiosis results from preceding developments, such as fusion of nuclei or germination of the zygote. However, in a limited number of microorganisms e.g. baker's yeast, meiosis is directly induced by changes in the environmental conditions. The yeast, *S. cerevisiae* offers an excellent experimental material in that it is a unicellular organism and its generation time is very short, so it can be handled as easily as bacteria although it is an eukaryote. Another advantage of this material is that it exists in diploid as well as haploid forms and the haploids are also very stable. Sporulation can be induced at will simply by transferring the cells to nitrogen free acetate medium. Sporulation results in ascospores which form haploid colonies on germination. Diploid can easily be obtained by mating two haploids of opposite mating types 'a' and 'a'. As haploids can be easily obtained from diploid and that they are stable, even the minutest recessive mutation can be detected, whereas recessive mutations can only be detected in higher eukaryotes when they come in homozygous state. So this difficulty can be overcome in yeast.
subsequent distribution of the recombined chromosomes to the four daughter nuclei after meiosis. With very few exceptions, the results obtained from genetic studies of yeast are in accord with the predictions of tetrad analysis theory.

The only drawback with this material is its asynchronous growth. Mainly in cell biological experiments, asynchrony poses a major problem which has been dealt with to a certain extent by many workers by selecting out cells of the same size and age by density gradient centrifugation. For our meiotic studies, we have attempted to eliminate this problem by using the early batch of meiotic products as the probe for monitoring the developmental sequence of meiosis.

The developmental stages of the cell cycle are divided into G1, S (DNA synthetic period), G2 and M (mitosis or meiosis). The mitotic cell cycle of *S. cerevisiae* has an initiation point in G1 phase, termed 'start' (Shilo et al 1978). Stationary phase cells arrest prior to start and may stay viable in this situation for long periods of time. This is the natural resting stage. When a diploid cell reaches start point, it has two alternatives- to remain in the stationary phase or to undergo mitosis or meiosis. Both the divisional processes are initiated at the same point. Initiation of meiosis is closely related to the parallel event of mitosis. There is indication that initiation of meiosis occurs in G1, at or prior to the mitotic start (Shilo et al 1978). Under special circumstances cells that have initiated mitosis may
continue as meiotic cells utilizing the early functions of mitosis like 'start'. Conversely, meiotic cells can revert to mitosis on transferring the cells to rich medium before commitment to meiosis has occurred.

There is little evidence as to the period over which commitment to meiotic development becomes irreversible. Stern and Hotta (1969) have shown in lily that cells normally proceeding towards meiosis could be induced to revert to mitosis, provided leptotene had not been initiated. The reversion occurred in spite of its having been preceded by the prolonged DNA replication, a characteristic of meiosis. Pattern of meiosis can be affected by events occurring before the premeiotic S (Simchen et al 1972). Meiotic readiness is distinct from meiotic commitment. Perhaps this illustrates why separate cellular changes constitute readiness for and those that mark an irrevocable commitment to meiosis. In yeast, only after the initiation of recombination events, the cells get committed to meiotic division (Esposito and Esposito 1974).

Thus there are two landmarks in the meiotic pathway—
1) readiness and 2) commitment. Readiness is a prolonged phase in which the cells are able to sporulate in water upon transfer from sporulation medium, but in vegetative medium they revert to mitosis. A short stage follows this approximately at the time of meiotic prophase, and is characterised by the inability of the cells to grow vegetatively or to sporulate when transferred to vegetative medium. Next comes commitment which is evident by the ability of the cells to sporulate upon transfer to vegetative medium. Throughout the
premeiotic DNA synthesis period, the cells retain their ability to revert to mitosis. According to Stern and Hotta, premeiotic DNA synthesis is characteristic and necessary for meiotic cells but not sufficient to commit the cells to meiosis (Simchen et al 1972). The meiotic cycle includes DNA replication (Croes 1966), genetic recombination, first and second nuclear division and spore wall formation (Moens and Rapport 1971). Premeiotic DNA synthesis and commitment to intragenic recombination (gene conversion) are initiated before cells become committed to meiosis (Sherman and Roman 1963; Simchen et al 1972). Commitment to intragenic and intergenic recombination occurs before commitment to meiotic chromosome disjunction. The meiotic programme can thus be charted out with the two landmarks of meiosis—readiness (R) and commitment (C) as in the diagram below. The initial phase of G1 of yeast cell cycle houses the 'start' signal. The initiation and synthesis of premeiotic DNA was related with these two major events and it was found that premeiotic DNA synthesis is initiated before the cells become ready for meiosis (Das 1980). After its initiation, the DNA synthesis reaches a peak sometime after readiness. A lull follows this spurt of activity which in turn is followed by another smaller peak of activity. This second period of maximal activity is presumed to be occurring before the cells become committed to meiosis, and it is thought to carry significance to meiotic recombination process (Das 1980).
The mitotic and meiotic cycles differ from each other in the duration of their DNA synthetic period (or S phase). The prolonged duration of the S phase in premeiotic cell cycle may be of particular importance to the understanding of meiosis. Bennett, Chapman and Riley (1971) reported that in wheat, the premeiotic S-phase lasts for at least 8 h as compared to 3-5 h of the premitotic one. In spermatocytes of Triturus the premeiotic S-phase is about 3 times as long as the premitotic S-phase (Callan 1972). The same is the case for mouse spermatocytes (Kofman-Alfaro and Chandley 1970) and for Coprinus lagopus (Lu and Jeng 1975). Esposito and Esposito (1974) reported the distinctiveness of premitotic and premeiotic S-phase in S. cerevisiae. Premeiotic DNA synthesis in yeast differs from premitotic DNA synthesis in the source of precursor nucleotides (Simchen et al 1972). The premeiotic S-phase appears to be prolonged due to a much reduced number of initiation points in the meiotic nucleus. Another speculation is that the special pattern of chromosome folding in meiosis requires the presence of special proteins for which a prolonged S-phase is essential (Stern and Hotta 1973). Since special pattern of chromosome folding is essential for meiotic crossing over, we may say that premeiotic S-phase metabolism includes activities that are immediately or subsequently involved in crossing over. In lilies, a distinctive feature of premeiotic S-phase demonstrated by Hotta and Stern (1971) is that approximately 0.3% of the total DNA is replicated as late as zygotene and chromosome pairing fails in the absence of this replication (Stern & Hotta 1967, 1973).
Meiotic recombination in yeast can be assessed among the meiotic products (ascospores) by analysing the genetic constitution of the colonies that are produced by these spores. Studies show that yeast cells become committed to recombination during the premeiotic DNA replication (Esposito and Esposito 1974), but the recombination events get completed after the replication at meiotic prophase (Simchen et al 1973). Thus meiotic recombination is a long process which includes early events like recombination commitment during the premeiotic DNA replication and late events at meiotic prophase when the process is completed. Hence inhibition of premeiotic DNA replication might affect meiotic recombination thus projecting on the events in replication that are relevant to recombination. Although recombination does occur during mitosis, its frequency is much higher in the meiotic cell cycle. Genetic data indicate that there are approximately 150 gene conversion events per meiosis in yeast and that 75 of them are accompanied by reciprocal exchange between homologs (Hurst et al 1972).

In yeast, 150 temperature sensitive cell division cycle (cdc) mutants all derived from strain A364A (α) have been isolated and characterised (Hartwell 1967, Hartwell et al 1973). These mutants are recessive and fall into 35 nuclear cistrons. Mutations in different cistrons produce different cellular and nuclear morphologies at restrictive temperature but those in the same cistron produce essentially the same morphology. The products of these genes seem to function individually in a discrete step of the cell cycle and they define collectively a large number of
different steps. The uniform morphology attained at the restrictive temperature by all cells of an asynchronous population is called "terminal phenotype", which is characteristic of a block in one and only one step of the cell cycle. Execution point is that discrete point in the cell cycle after which, the remainder of the cycle can be carried out to completion even at restrictive temperature.

The cdc mutants represent functions that are indispensable for the mitotic cell cycle. It is of interest to find out if these functions are also required for meiosis and if yes, then in what stages? It has been established by the use of meiotic and sporulation specific mutants which do not affect vegetative growth, that certain meiotic functions are not required during mitosis. These events might be specific for meiosis but there must be some functions in mitosis and meiosis which are fundamentally similar, because the same gene products have been found to mediate these functions in both mitosis and meiosis. 13 out of 20 cdc genes that were tested were found to be essential for meiosis and sporulation (Simchen 1974). These genes include mutants which show defects in plaque duplication, plaque separation, initiation of DNA synthesis, DNA synthesis, medial and late nuclear division of the mitotic cell cycle. The stage of arrest of these mutants in meiosis has not yet been investigated. In case of cdc genes which have been shown to have function in meiosis, the questions have been asked that in this: programming calendar- 1) when does that gene product function?
2) Does the gene product function independent of other cdc gene products which also show their effect on programming?

3) Whether all alterations or perturbations of meiotic programming have their influence on recombination?

4) What is the possible significance of commitment period in meiosis as well as recombination?

In the present studies we have attempted to find solutions for these questions as far as possible. We have used three temperature sensitive cdc mutants viz. cdc 7 (DNA initiation), cdc8 (DNA replication) and cdc 15 (late nuclear division) and two double cdc diploids in the combination of cdc7 and cdc15 and cdc8 and cdc15, to observe their interaction, and also their effect on meiosis and recombination. Besides nuclear division (mitosis or meiosis) a parallel event of bud emergence and cytokinesis runs in a periodic clock of one cycle time. Normally there is a synchrony between bud emergence and nuclear migration so that at the end of division, two cells each with one nucleus are formed. In course of study we isolated a clone (strain SNM 75) in which an impairment of cellular division resulted in the development of filamentous condition. It is reported that such impairment may result either from the temporary inhibition (frequently reversible) of some reaction essential to the completion of cellular division or from a hereditary block in a reaction essential to this process (Nickerson and Mankowski 1953). Thus filamentous yeast strain is a suitable material for analysis of single steps in the chain of metabolic
reaction comprising the mechanism of cell division. *Candida albicans* which is also filamentous, does not sporulate which poses difficulty in the genetic analysis of filamentous nature (Nickerson and Chung 1954). This difficulty is overcome in our strain SNM 75 which forms ascospores which are normal meiotic products. In the following text we have attempted to analyse mutants defective in the process of cell division viz., DNA initiation, DNA replication, late nuclear division and cell wall separation.