RESEARCH BASED DEVELOPMENT OF REMEDIAL INTERVENTIONS FOR MAKING UP THE IDENTIFIED DEFICIENCIES IN LABORATORY SKILLS IN BIOLOGY AT +2 LEVEL.

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INTRODUCTION

Several studies in literature have shown that students at the school level have difficulties with respect to the acquisition of specific skills and sub-skills in practicals. (Refer-Identification and diagnosis of difficulties in acquiring laboratory skills in Biology at higher secondary level (XII standard). Several other studies have shown that difficulties in attaining a concept/skill is mainly due to problems of information processing, problems in language components, problems of cognition (and meta-cognitive components as well), problems of social and emotional nature, failure on the part of the teacher to understand learner and the learner characteristics, problems in handling pictures and symbols etc. Other researches have revealed that mere help at home either by family members or tutors do not rectify the difficulties; infact, teachers have to be trained properly and adequately during pre-service and in-service training programs. It has been concluded that only a qualitative improvement of teacher training programmes alone can enhance the performance level of children.

If we look at the educational scenario, we still do not have sufficient scientific and technical manpower. Universities have become totally isolated from national research laboratories and industries and this has turned the universities exclusively into places for the creation of teachers alone – university research is purely academic and purely esoteric. Modern courses of education have led to mushrooming of business administration and computer literate individuals; and science with an applied aspect has been relegated to the background. Our strong base of scientific and technical manpower is slowly getting eroded. Universities need to be restructured to meet the needs of employers. A survey conducted in UK showed that core competencies had a much higher priority ranking than knowledge of a specific course content.

Science education should actually address the need of overall development of well-rounded personalities who can be assets to an organised society. Specifically, science education should aim at producing students who can acquire, update and communicate knowledge. The current course and institutional structure is too rigidly

discipline – based, wasteful of human resources, lacking in efficient avenues for development of new areas, and not geared to developing the attributes mentioned above.

Science education in schools across the world according to a report is becoming more and more irrelevant and there is a decline in involvement at senior secondary and higher levels. Students find science difficult as well as boring. How can this scenario be changed?

Science in India is taught as a body of complete knowledge with answers to all the questions that are worth asking. There is almost complete absence of experimentation by children in the classroom. Principles take precedence over practice and products are given more importance than the processes of science. Students graduate from universities, with a lot of information but with little ability to apply their learning to solve the real life problems that affect them, their society and their environment. It is our experience that methods of science can be used to solve life's problems. It has been found that school children especially girls find school science unfriendly. Though the present study is not oriented to gender sensitivity, it is worthwhile to note that girls face more educational handicaps than boys – this being especially so in science. With equality being a constitutional right, this disparity should not be very wide and affect the educational scenario as a whole by displacing the gender balance. With this background, it cannot be that teachers do not encourage girls in science classes. May be girls from a certain socio-economic background alone get demotivated to study science in schools. Mukherjee and Varma (2001) are of the view that there is a need to study this problem in depth and come up with a school science curriculum. Reasons enumerated for this impasse in science education are science is not child-centered (one of the prime targets we are set about modifying in the present project); science is artificial and does not arise from the daily lives of children; science methods and processes do not provide motivation to the natural curiosity of children (this also is being attended to by providing more visuals and graphics and brain teasers); lack of depth in curricular content (this is being remedied by providing an exhaustive glossary of key-words and instructional materials); and lastly lack of experimentation, investigation, analysis and the framing and testing of hypothesis (this is being remedied by project works pertaining to the different

practicals which in turn will also help in information processing and other psycho-motor functions). Brainteasers and brainstorming sessions are to be provided for augmenting skills of discussion, analysis and argumentation. There is an urgent need to change the main-stream curriculum and tailor them to suit a genre of students with higher IQ and technical minds. The curriculum has to be modified in a way that makes it interesting and also relevant to their daily lives and concerns as citizens of the future. The million dollar question is as to how to orient science education to equip students for life itself (this was practised in the ancient ages whenever gurus taught life skills to children in the Brahmacharya *ashram*; education was relevant then). Science education curriculum has to make real lives (of our future generations) more meaningful. (A poser here would be a study of the Tsunami tragedy on Dec. 28th 2004. How many of the people affected have the basic skills to survive in those devastated conditions? A cave man/paleolithic man would have had more life skills than us given the same situation. People are depending on the government to transport, feed and clothe them. Where are we heading? Where are the basic life skills gone? We have forgotten them at the portals of a technological future which we have already entered). Some of these concerns are addressed by UNESCO's project 2000+ "Scientific and technological literacy (STC) for all". This initiative recognises the growing need for a scientifically and technologically literate society and emphasises the creation of educational programmes (both formal and non-formal) that empower all, so that they are able to satisfy their basic needs and be productive in an increasingly technological society.

While conventional science teaching starts from the demands of the discipline "there should be a unit on electric current and circuits" "we have to teach the chemical composition of water"; STL based science (UNESCO pattern) starts from real-life problems, with a social dimension – " why are there so many power cuts?" "why has my well gone dry?". There is science and technology in every aspect of life, in what we think, speak and do. Moreover, science has to be made more meaningful to the common man through science education.

Srivastava (2001) says that Jawaharlal Nehru's original idea was to develop national laboratories in close collaboration with universities. World War II and acquisition of independence brought the effectiveness and ability of our scientists to

the fore. World War II also brought about the emergence of giant government laboratories in the west and these were later on merged with the universities. In India laboratories were developed independent of universities and continue to remain independent. But no thought was given to where young scientists would come from. Bhabha recognized that national labs had been built at the cost of universities from which good people (their most valuable asset) had been drawn. Senior scientists on advisory bodies to the government are to blame for this situation. Development of national laboratories and universities should have been complementary but has become lopsided. Science education at all levels can strengthen these national laboratories.

LITERATURE REVIEW

Science education should prepare our present generation to be active and creative participants of a democratic society because in a democratic society, many public decisions involve considerations relevant to scientific knowledge. When the present generation is faced with new social problems in the future, they should recognize scientific implications of the problem, be able to seek out appropriate scientific facts and theories, and use these in arriving at a decision.

Pre-test and post-test tools have been avoided here as it is found that test achievement in school does not always indicate later ability to use the knowledge and skills in similar and new situations. Our greatest scientists have not always been our highest scoring students in school courses, and many of our highest scoring students have rapidly forgotten their classroom knowledge or been totally unable to use this knowledge in later relevant situations. Teacher made tests generally highlighted isolated knowledge of some sort, memory of facts, terminology, methodology, conventions of science rather than ability to use this knowledge systematically or creatively in an analytical or evaluative context.

We have introduced a number of time-tested activities and tests as remedial measures for the difficult skills. Here questions involving general skills and understandings which the students would retain and be able to use later have been given. With tests of this sort, one can still not guarantee that the students who score well in the test will be able to use these skills in such situations later. However, it seems reasonable to assume that this will be a better predictor of high-level later performance on similar tasks than would a test of memorised facts and principles. Test writing helps us sharpen our own objectives (Grobmann, 1966).

It has been reported that in South East Asia school biology should deliberately aim at helping the pupils to recognize that there are connections between biology

science and human welfare and that only some of these connections have been bridged (Basnayake and Cruz, 1966).

The education coat has to be cut according to the cloth of manpower requirements. Mass general education leads to mass unemployment. Policy decisions should emphasize upon the role of education in manpower or human resource formation in the economic or occupation sense. Educational policy has to be steered between the demands of pure economics and of pure culture in India as in South East Asia. Therefore, each country should develop its own materials for biology/science education in the light of its own problems and its own concepts of what the proper balance should be between such things as 'scientific method' and facts and between 'pure biology' and 'applied biology'. The last word on the content of a universal biology has not yet been spoken.

Films are indispensable and valuable in the dispensation of biological instructions and in scientific observation. We have tried to incorporate filming of important experimental procedures to enhance specific skills. Cinematographic projection enables a repertoire of observations which leads to accurate observation. The filmed protocols of biological processes are sufficient for the experts who do not need a commentary (Ledvinka, 1966). It is more important to him to know the technical data of the pictures. This direct transmission and transformation of biological knowledge through cinematographic pictures has a proven scientific value and has been acclaimed as a type of scientific work, published by the film. As a result in biology, the film can play an increasing part in international scientific co-operation. Films are illustrations with large details and repeated scenes which make for better understanding. It does away with incorrect interpretation that occurs during verbal description. (Films may also be prepared with animated diagrams or schematic colour drawings that make those parts of the process that cannot be seen with the naked eye more understandable). Biological films are more purposeful in that they are a method of scientific research, a means of observation, registration and evaluation of processes and a method of scientific communication or instruction. Films can be an effective

part of post-graduate education in Biology. They can do away with schematic handling of subject matter. Films can be used at any time and anywhere for study and analytical use. It can be reused many times over, it can be produced in many copies and used as mass means of communication. It is good for demonstration and evaluation of slow and undiscussible processes, it perfects observation, permits objective analysis, eliminates subjective and emotional reaction and guides the audience towards scientific observation. It permits repetition of processes that cannot be repeated. World Library of Science films (Brussels) and the International Science film association present information on biological films.

According to Ledvinka (1966), we can use biology films in higher scientific technological instruction or information for courses in biological disciplines, as a program on the development of biological science. Other films can serve for demonstration purposes in biological laboratories or experimental procedures while didactive biology films can demonstrate and illustrate lectures on biology.

The aim of science education according to the secondary education commission (1952-53) is not directed to produce scientists but to give a basic understanding and application of scientific phenomena. The commission was not clear in its policy so far as the teaching at school stage was concerned. All India Council for Secondary Education has already stressed time and again the importance of preparing instructional materials and hence this venture. The planning group on education gave high priority to the development of science education laying emphasis on development of scientific attitudes and skills as it is found that the teaching of science in schools is far from satisfactory and recommended various measures which have appeared in the IV five-year plan.

According to the National Policy on Education (1986), Science education will be strengthened so as to develop in the child well-defined abilities and values such as the spirit of inquiry, creativity, objectivity, the courage to question and an aesthetic sensibility. Science education programmes will be designed to enable the learner to

acquire problem-solving and decision-making skills and to discover the relationship of science with health, agriculture, industry and other aspects of daily life. It was also emphasised that every effort will be made to extend science education to the vast numbers who have remained outside the pale of formal education. However nothing concrete has been achieved so far. There is an intense need to integrate various experiences and form an overall strategy of school science educational development and to formulate a clear-cut consistent and effective science educational policy and a national consensus on a programme of implementation.

The American Association for the Advancement of Science (AAAS) rejects the idea that science is only a collection of facts. They hold that the major goal of science is to develop a child's skill in using the processes of science. A report on a study of class VII students understanding of science and their process skills in relation to ability to apply science in daily life reveals that the overall performance of the students in science application ability, science understanding and science process skills are not so good. The study revealed that there is a relation between science application ability and science understanding and the latter is the base using which students can apply science in daily life. So provision should be made in science curriculum and teaching so that students are thorough with the scientific terms, facts, concepts etc., along with the variety of ways in which some of them can be applied in daily life. An effort in this direction has been made in the present work by presenting glossary of keywords or scientific terms. Another finding of the same work is that the performance of rural students is not good when compared to urban students in their science application ability. And it has been suggested by them that in order to improve their application ability, provision should be made in the rural area for life science exhibition, quizzes, field work, projects etc., with a thrust on daily life application. An effort in this direction also has been made by quizzes in the difficult areas and through suggestion of projects/activities in difficult content areas.

Potting and Waldron (2002) report that many students are at risk of failure in their college courses not because of a deficiency in ability or intelligence but because they lack the fundamental skills required to learn the material presented in their classes. In their opinion, students who have trouble learning science often lack fundamental skills in note-taking, study-practices and exam-taking that are essential for learning and achieving satisfactory grades (taken into account here is the methodology using a general questionnaire). Personality culture and previous learning experiences also contribute to academic success and failure. Our goal is to teach all students who need the basic skills of learning and help students build the awareness and personal characteristics to be enthusiastic and successful learners. These authors have reported that the attributes associated with good learners consist of 2 groups of practical skills such as note-taking, reading, writing and exam-taking and the personal characteristics that make the learning process fulfilling and efficient including such traits as confidence, independence and logical thought processes. Both practical skills and personality characteristics have been taken into account while doing this project. It has also been concluded by these workers that discussing key-activities and strategies for successful learning with these students and providing a non-threatening environment in which they can try out new activities can reverse the negative sequence of events and train these students into fine learners. The remedial measures suggested in this project are in the form of exercises to enhance learning skills.

Laboratory work is a form of co-operative learning (this form of learning is as old as Socrates – who engaged his disciples in group questioning and argument to develop their philosophical ideas). Lab courses were first established by Dewey in 1916 to foster creativity and co-operation among students. In co-operative learning goals are achieved by most or all group members. Also, co-operative groups produced higher quality product and discussions. The value of co-operative learning as an educational tool lies in both its effective and cognitive impacts.

It has been reported several times that laboratory manuals are time savers. The teacher is freed from the preparation of directions for each laboratory period. He need

not use class time for giving directions. Pupil time is saved because the directions have been worked out so carefully that positive results can be obtained without finishing. And if a manual with record forms is used, pupils need spend little time organising and reporting data. Keeping this in mind, efforts are made in this project to provide remedial measures for the difficult practicals in the form of revised and updated instructional material.

Chelini (2001) assessed and compared the achievement of class VII students in respect of basic understandings and skills based on a content analysis of the textual experts and opinions of experts in the non-language subjects. The study revealed that the highest number of concepts acquired by any student was 39 (out of 63) in science, 28 (out of 38) in mathematics and 30 (out of 41) in social studies. That is to say that majority of the students who enter the secondary stage are found deficient in more than one of the basic understandings and skills needed in science, mathematics and social studies.

It is difficult to answer the question – which one of the strategies/methods of teaching is the most effective? No clear-cut answer has become available. For e.g., Aranha (1988) showed the utility of mastery learning approach for slow learners. They gained in scores on final tests along with strong academic motivation and self-concept habits. Gurumurthy (1990) found the guided – discovery approach superior to the instructed performance one when it came to the development of cognitive abilities and practical skills. Goel and Agbesi (1990) reported that the acquisition of psychomotor skills favoured the group, which followed the individual laboratory method rather than the lecturer demonstration method. Shishta (1990) found that the treatment/intervention comprising the blended strategies of different modes of teaching given to the experimental group brought about significant differences in achievement in biology in comparison to the control group. In sum, it appears difficult to give a verdict on the superiority of any method of teaching – for the long term studies based on some sort of theory (say instruction) are required. A combination of all methods has therefore been suggested here as remedial interventions.

Pandit (1989) identified eight major laboratory skills in chemistry in their individual hierarchical order. The study revealed a significant relationship between the ability to learn content in chemistry and the ability to acquire cognitive and manipulative skills.

There is a growing need to emphasise mastery level of learning. The MLL approach implies a calculated effort to include those minimum, essential and common competencies that all children must master. If minimum essential facilities and help are given to schools and teachers and if continuous feedback, academic guidance and remedial work are given to the learner, it should be possible for most children to reach the mastery level of achievement in basic competencies at the primary stage. Minimum levels of learning can, perhaps, be specified in a variety of ways. For instance, MLL can be stated as expected learning outcomes defined as observable terminal behaviour. One can also state the MLLs in terms of learning competencies expected to be mastered by every child by the end of a particular class or stage of education of the various alternatives available. The committee has chosen to state the MLLs in terms of terminal competencies. Each competency can be further defined in terms of sub-competencies or while specifying the content inputs. MLLs serve as performance objectives and goals and ensures learning up to mastery level by every child in the class.

When an individual possesses a capability to perform a task with a high order of proficiency it is a skill. As a capability, skill is extremely difficult to distinguish from the traditional meaning of ability (Laves 1987). Broadly defined ,skills are the abilities to deal effectively with the demands and challenges of every day life. These are a person's ability to maintain a state of mental well-being and to demonstrate the same in adaptive and positive behaviour while interacting with others or his/her environment (UNESCO, 2001) .WHO has defined life skills as the abilities for adaptive and positive behaviour that enable individuals to deal effectively, with the demands and challenges of everyday life (WHO, 1997). In skill development the emphasis is more on 'what to do' and 'how to do'. There are strategies viz., curricular

approach, co-curricular approach, teacher counseling and peer education, which can help students to develop skills in other disciplines (Saroj Yadav, 2002). Can these self-same strategies be applied for developing lab skills?

Andy Priggot puts teaching and learning at the center of designing your own laboratory or prep room. Good laboratory design in schools involves the science department from the outset, so ensuring that teaching and learning is central to the design process. In countries outside India, all available material guidance on building and filling out laboratories and prep rooms is made available through the project website and a CD. These are same to every secondary school in the UK. Perhaps this could be considered as a means of enhancing lab skills.

Rediess (1989) has suggested a five to six week base unit with expanded laboratory activities to overcome deficiencies in the student's background in chemistry. Each topic was covered from several approaches to increase the interest and broach individual learning styles. A pre-test and a post-test were given to assess the impact of the module on learning.

Evidences showed that students retained the information much longer, and used it on other units and understood chemistry's relevance to their lives. Students learned use of laboratory equipment and were able to apply what they learned to unfamiliar problems. Overall grades improved following the study. (It is to be thought out/worked out whether we can suggest a module with expanded laboratory activities with respect to skills where deficiencies are seen).

Lichel (1993) designed an experimental unit concerning the biological effects of dams on rivers to replace previously taught one on basic ecological concepts (e.g., populations, communities and ecosystems). Two classes were taught in an experimental manner and two in a traditional manner. The experimental unit was designed to provide more laboratory instruction than the traditional approach to provide a cohesive theme for teaching of ecology and to bring local relevancy to the

student's education. Students taught the experimental way learnt as much as those taught in the traditional manner and infact learned more.

Webster (1993) measured students understanding of cell biology using pre-test, post-test along with an evaluation survey. As a result of the application of this unit, the students demonstrated progressively high scores as well as a desire to complete each task.

Fisher (1996) used the constructivist approach to teach the structure and function of plants to seventh grade students. He included a combination of various teaching and learning strategies with a focus on "hands – on" activities. The students made concept maps, wrote in journals and dissected frames as part of this unit. He used a focus group of different levels of students and found that all students showed significant improvement in their understanding of the structure and function of plant after the teaching of this unit.

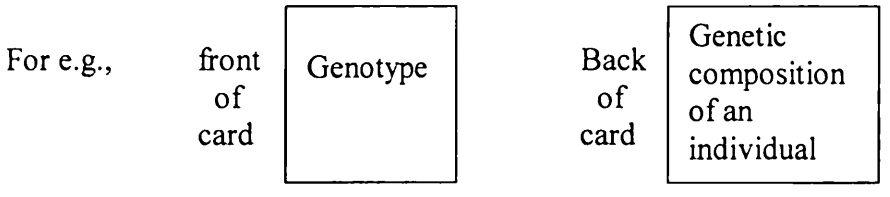
Hoekwater (1996) designed a plant unit in plant anatomy and physiology. Here students took on the role of plant researchers and conducted controlled experiments. He used a pre-test to measure students prior knowledge and at the conclusion of the unit, a post-test to measure student's understanding of key concepts. To measure how well students followed the scientific method and recorded their results, he evaluated their research reports. Using a written survey, he assessed student's attitude towards the research project. The results from these assessment tools indicated that this method of teaching is educationally effective and helps to increase student's interest in class (Projects have been planned for the difficult experiments of the present project as well – a pre-test and post-test also could be planned for each project to test previous knowledge and understanding of key-concepts).

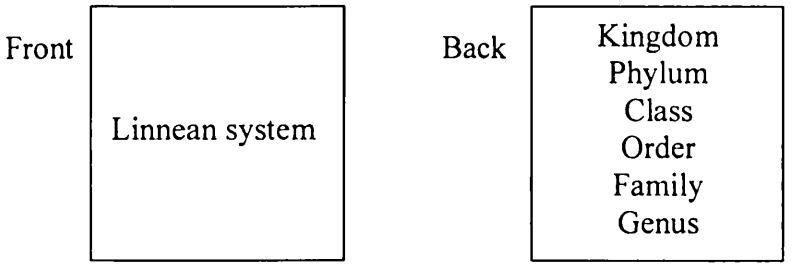
Some authors suggest a pre-lab preparation for each experiment in order to improve lab-skills. It is always done preceding the lab. Without a complete pre-lab,

students will not do the lab. It includes title, purpose and hypothesis, materials list, flow chart and data tables. It includes content update also.

Making up mnemonics memory technique has been recorded to be fine as well as beneficial. For example, if you need to remember the 12 cranial nerves, take the first letter of each nerve and makeup a sentence where each word begins with the first letter of each nerve. It is also reported that reorganizing lab material in meaningful ways can help biology students in a number of respects. There is an information organisation strategy, which acts as memory triggers especially for visual learners. Some good strategies for visual learners are flash cards, running concept lists, matrices, concept maps and hierarchical organization.

Flash cards are used to organise information such as terms and definitions people and their contributions (used for doing research), lists identifying characteristics and structures.





In a running concept here, all words and explanations are put on one piece of paper and can be used to organise information about people, terms and concepts.

e.g.,

Mendel	Laws of inheritance.
Gene flow	Transmission of genes between populations.
Mutation	Accidental alteration of genetic material.

Matrices are used to show comparisons between 2 or more concepts or how concepts are similar and different.

e.g., immature and mature ecosystem.

	Immature	**Mature**
Plant size	Small.	Large.
Species diversity	Low.	High.
Trophic level	Mostly producers.	Mixture of all.

Concept maps are used to organise supporting information related to one topic. In biology, concept maps help to organise large chunks of related information. Hierarchial organisers show super-ordinate and sub-ordinate relationships.

Mnemonics are verbal devices to help recall a series of facts e.g., to remember the types of bacterial flagella, we use a word LAMP.

L – Lophotrichous

A – Amphitrichous

M – Monotrichous

P – Peritrichous

It has been mentioned that flash cards can be used for slide identification and lab classes. Pre-lab should include preparing for each lab by reading the procedure before class, preparing abbreviated lab procedures and writing out shortened step-by-step version of what you will be doing for the next lab, eliminating all extraneous words and explanations.

Muskingen college instructors conduct midterm and final exam where cell types are to be identified when shown on OHP. Quizzes covering previous laboratory are also taken.

Process-based teaching of science has been of important concern to all who were connected with the teaching of science at primary level. Several aspects of process based science teaching were discussed by Goel (1987, 1988).

Construction and standardization of achievements or diagnostic tests started quite late in the field of science education. It was first attempted by the SCERT (1971) of Andhra Pradesh followed by Rawat (1976), Sali (1977), Khandewale (1981), Gadkari (1982), Ansari (1984), Verma (1986) and Banmalidas (1987). Of these Rawat (1976) and Verma (1986) constructed diagnostic tests, while the rest constructed and standardised achievement tests. All these tests were constructed in physics, chemistry or general science but not in biology. The sample of these studies varied from 250 to as many as 6130 (Sali, 1977). For performance, researchers measured it though percentages, statistics, 2' – scores, t – scores and reliability was measured by different reliability co-efficients. In the separate study, Sethia (1972) also diagnosed a few low SES students and conducted remedial teaching.

Radha (1984) has studied the personality characteristics of science teachers. The problems faced by teachers or students while teaching or conducting science practicals seem to be a matter of interest for the NCERT or UGC but not Ph.D. level researchers since all the three studies conducted in this area-Rajput *et al.*, (1978), Muddu (1978) and Singhal (1983) were financed projects. Needless to say, the findings were highly disappointing. Teaching science without practicals or laboratories, teachers, teaching subjects other than the one they are qualified and appointed for weak expression and strictly confining themselves to the syllabus were some of the problems exposed through these studies. Mishra (1977) identified a sizable number (23.38%) as educationally backward in science and mathematics and diagnosed inferior intellectual potential as the cause of their backwardness.

Chand (1984) found the effects of the personalised system of instruction and Bloom's mastery learning strategy on the retention of high school children in the science stream while Bhadwal (1984) studied the effect of an interim test on the performance and test anxiety of high school children following programmed instruction material in general science. Vaidya (1974 & 1979) studied the problem

solving behaviour of students through psychological test, SES scale and a few problems and extracted ten factors related to student's problem – solving behaviour.

Many researchers have picked up a method or strategy or a package and compared it with the traditional teaching through a parallel group design and have come out with the finding that their method was more effective than the traditional method. Of course, without strictly defining the traditional method. For e.g., Muddul (1978) found motion pictures, Sivadasan (1981) found science kits and the tutorial system; Sastry (1982) found educative toys. Adinarayan (1984) found instructional packages; Desai (1986) and Kalachary (1987) found programmed learning and Pillai (1987) found Gagne's conditions of learning more effective than the traditional methods of teaching science. Dighal (1985) discovered that two or three methods when combined gave better results than any one in isolation. According to the 5th zonal survey (Gangulee & Vashista) science education should direct its attention

(i) to improve the existing procedures of science instruction and
(ii) to establishing new and verified procedures for teaching science.

According to these researchers, computer and computer-based learning ground system are gaining all over the country.

Vardhini (1983) concluded that for achievement of different instructional objectives systematically validated multimedia strategy can be implemented at school level without having to spend too much money or time.

Krishnamal (1983) developed a multimedia package for teaching a course on audio-visual education including programmed slides, programmed print material, non-projected visual aids, self-instructional material with manuals for practical exercises, self-evaluating unit-tests, feed back etc., and found it quite effective.

Arranging field trips, choreographing chemical reactions have been suggested. For e.g., if the difficult skill is explanation one can choreograph the reaction $CuSO_4$ and KOH in the form of impersonated molecules. One can add a page on how to prepare chart and materials to be used. For the descriptive skill, a classroom chart which is pictorial/and also self-depending or regular remedial type were taken.

Science education is one of the important core areas mentioned in the National policy on education, 1986. The ten core areas are – The history of India's freedom movement; the constitutional obligations, the content essential to nurture national identity, India's common cultural heritage, egalitarianism, democracy and secularism, equality of sexes, protection of the environment, removal of social barriers, observance of the small family norm and inculcation of scientific temper.

In order to ensure access to the education of a comparable standard to all learners irrespective of caste, creed, location or sex, the concept of the minimum levels of learning (MLLs) has emerged as one of the basic concerns. An effort to conserve quality with equity, keeping in view the developmental needs of learners from all sections of society including the disadvantaged and deprived ones, the drop-outs and the working children and girls, has generated a need for identifying certain essential levels of learning for each stage of school education. These are called minimum levels of learning and are expected to be achieved by one and all. Since the MLLs provide a sense of direction of a certain amount of accountability, these are considered to be an effective tool for programme formulation for school improvement. One of the important ways of stating MLLs is in the terms of competencies. MLLs are envisaged as learning outcomes to be achieved at the end of a particular stage. Each learning outcome has several skills and the marshalling and sequencing of skills representing learning outcomes is to be done in such a way that it involves in a balanced manner the analytic – synthetic processes. Moreover, 'learning' is to be understood in the broader sense of 'skill' 'quality', 'attitude' and 'value' too. That way the term would embrace all the cognitive, psychomotor and affective area learning outcomes of education. Learning outcome is related to skill in

a broad sense and MLL is to improve school curriculum and school curriculum has to aim at enabling measures to acquire knowledge, develop understanding and inoculate skills, positive attitudes, values and habits conducive to the all round development of their personality (Curriculum designers could hardly afford to overlook the emotional dimensions of the child's life during the school period and the importance of emotional maturity in the life of a person. What do the curriculum developers do in this regard?)

The NCF stresses that activities related to health should get a prominent place at primary stage so that children acquire necessary skills, attitudes and habits to keep themselves healthy and participate in games and sports suitable for their age. Skills have been mentioned at every step of the elementary and secondary stages of education in the NCF. Science and technology mentioned in NCF emphasizes the development of manipulative skills which are required in day-to-day life situations. Also it has been mentioned that practical activities to be chosen should have relevance for future life through acquisition of skills and values.

In addition to academic skills, social skills and civic competencies may be developed to help them grow and participate effectively in day-to-day life.

Gay Beauchamp (2004) says that in the main, both researchers and classroom practitioners have the same aim; to improve the quality of teaching and learning available to pupils in the classroom. According to him, ICT should remain a supporting friend who is there when needed and who can also help to motivate both pupils and teachers away from the essential investigative nature of science learning. Science education should be an opportunity for first thinking. An attempt has been made in the present project that computers help in the process of science education (apart from helping to model concepts, provide variety and diversity of tasks, record results and help with assessment).

According to Ganguli and Vashista (1991), the competence of science teachers is manifested when they are in a position to reach out to different children by creating a rich multi-dimensional environment for them to learn. He also mentions that there are tangible as well as intangible outcomes of science teaching and education such as scientific knowledge and problem solving are easy to measure with the help of paper-pencil tests, others resist measurement. Dubey (1992) attempted to measure scientific temper and concluded that whereas all groups of students showed scientific temper, significant differences were observed between male and female science teachers. Ghosh (1989) showed that whereas scientific aptitude was related to scientific attitude there were no such significant differences in respect of sex, socio-economic status and place of work among the various groups. Kumar (1991) showed that the development of scientific attitude depended upon their perception of science teaching and nature of learning experiences. Malviya (1991) examined attitude towards science and interest in science. The study showed that high scores on attitudes towards science favour higher scientific interest. Further, with minor differences here and there, age, sex, profession and socio-economic status have no effect on attitude towards science.

Phalachandra (1989) found a positive relationship between concept-based achievement in chemistry and environment. Sex differences in achievement favouring boys existed. Parent's qualifications, sex and place of birth (urban area) contribute substantially to achievement. Darchingpuii (1989) confirmed Kar (1990) in principle and added socio-economic status, type of school attended, family facility (opportunity structure), scientific attitude and finally that problem solving favoured achievement in science.

STATEMENT OF THE PROBLEM:

The aim of the present study was to reidentify and recircumscribe the difficult skills in lab situation, to retest content knowledge of skills and to correlate performance in theory and practicals on the present available sample of 16 DMS students. As this is a continuation project of STP – I (Title: **Identification and Diagnosis of difficulties in acquiring laboratory skills in Biology at higher secondary level – XIIth Standard**) and since the very same sample of students is not available, therefore it was decided to check whether there is any homogeneity in pattern of results of all the three schools taken earlier. A graph was plotted between major skills and difficulty level in that particular skill for all the three schools (Refer graphs 3.1 and 3.2). It was found that there indeed was an uniformity in pattern (please refer table no. 3.1 and graphs 3.1 and 3.2). Graphs 3.1 and 3.2 shows a lot of similarity in the type of difficulties faced by students and in the percentage of obtained scores in the 3 schools viz., all the 3 have maximum difficulties pertaining to skill numbers 6, 7 and 8 (there is dip in graph 3.2 near skills 6, 7 & 8). Few ($\leq$ 30%)have difficulties in skills 3 and 5. It is sufficient therefore, if the 8 experiments are repeated only on DMS sample as DMS is closer, experiments are the same in DMS (whereas the practicals in 2004 for the previous two schools Mahajana's and JSS are different and therefore cannot be repeated to a point of accuracy in these schools with respect to the STP-1). This remedial intervention project is being done in 2005, thereby bringing change in the previous sample type and number (there is a different set of students this year) and the results of the former project sample cannot be applied to the present student sample for remedial interventions. The 8 practicals of STP-1 are being readministered (through tools such as check-lists, scoring sheets, diagnostic tests and mental aptitude tests) on the present batch of std. XII students of DMS alone in order to maintain sample accuracy and constancy as precisely as possible thereby arriving at remedial measures and other modifications and improvements. After re-identifying the difficult skills it was planned to find out probable reasons for the difficulties experienced by students and suggest remedial measures in the form of easy to do exercises/activities for students in the classroom viz.,

1. Crosswords on difficult practicals including important key words.
2. Word search activities in different practicals/skills.
3. To bring out quizzes which have to be answered within a limited time.
4. To suggest easy-to-do activities in the form of mini-science projects.
5. To prepare instructional material for the difficult skills of practicals based on reasons identified
6. To bring out these remedial measures in the form of a CD which could be used by the students themselves at the beginning of the practicals.
7. Preparation of flash cards for improving the memory
8. Development of visuals and glossary.

Lastly, it was also planned to administer the remedial measures to present sample of 19 students and to see whether they improve their performance.

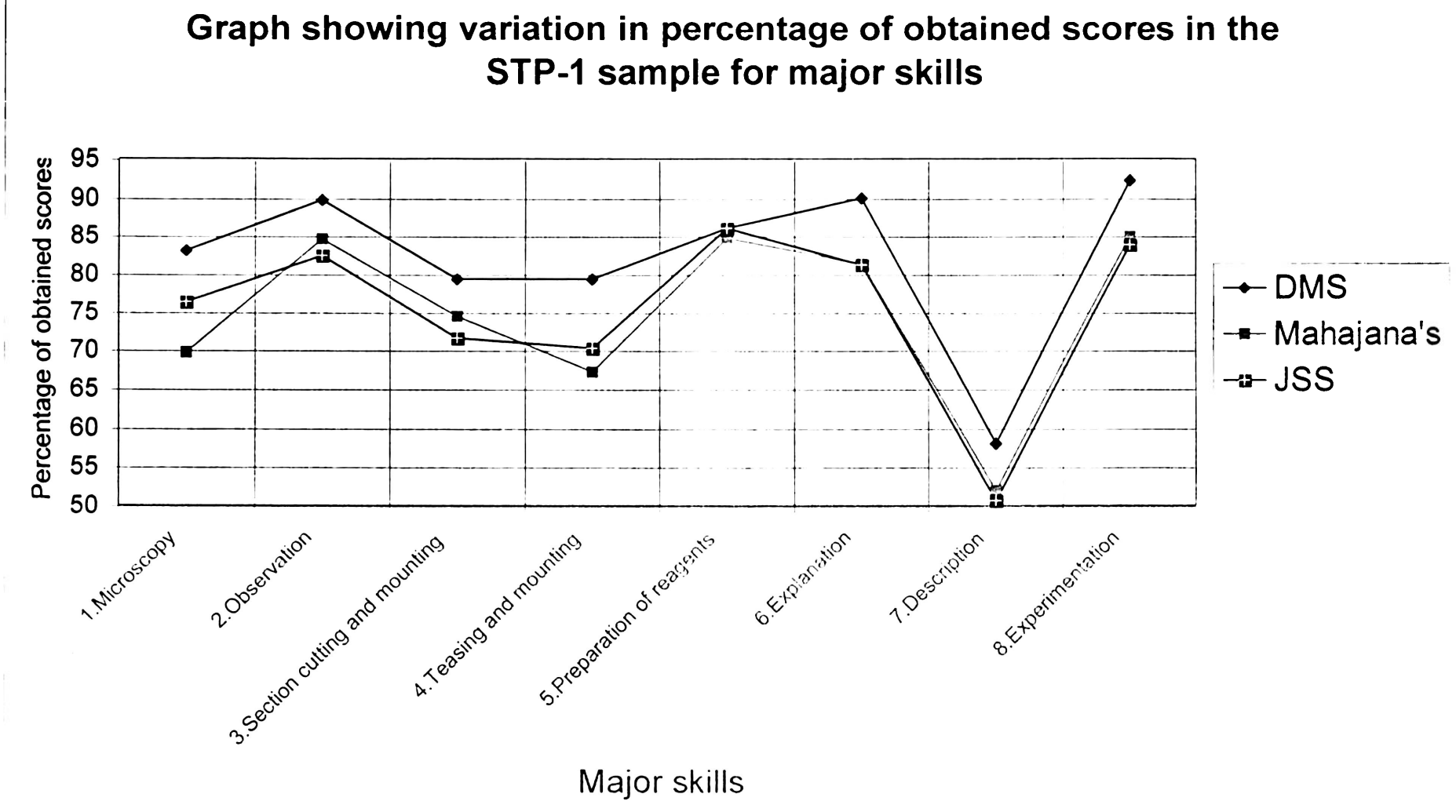
Table 3.1: Identification of difficult biology laboratory skills in higher secondary students of three schools.

Sl. No.	Major Skill	Obtained scores (%) in skill test			
		DMS	Mahajana's	JSS	Mean
1	Microscopy	83.08	69.72	76.30	76.37
2	Observation	89.71	84.62	82.41	85.58
3	Section cutting and Mounting	79.29	74.45	71.59	75.11
4	Teasing and Mounting	79.38	67.21	70.26	72.28
5	Preparation of Reagents	86.07	84.69	86.07	85.61
6	Explanation	89.96	81.34	81.22	84.17
7	Description	58.00	51.97	50.63	53.53
8	Experimentation	92.29	84.97	83.81	87.02

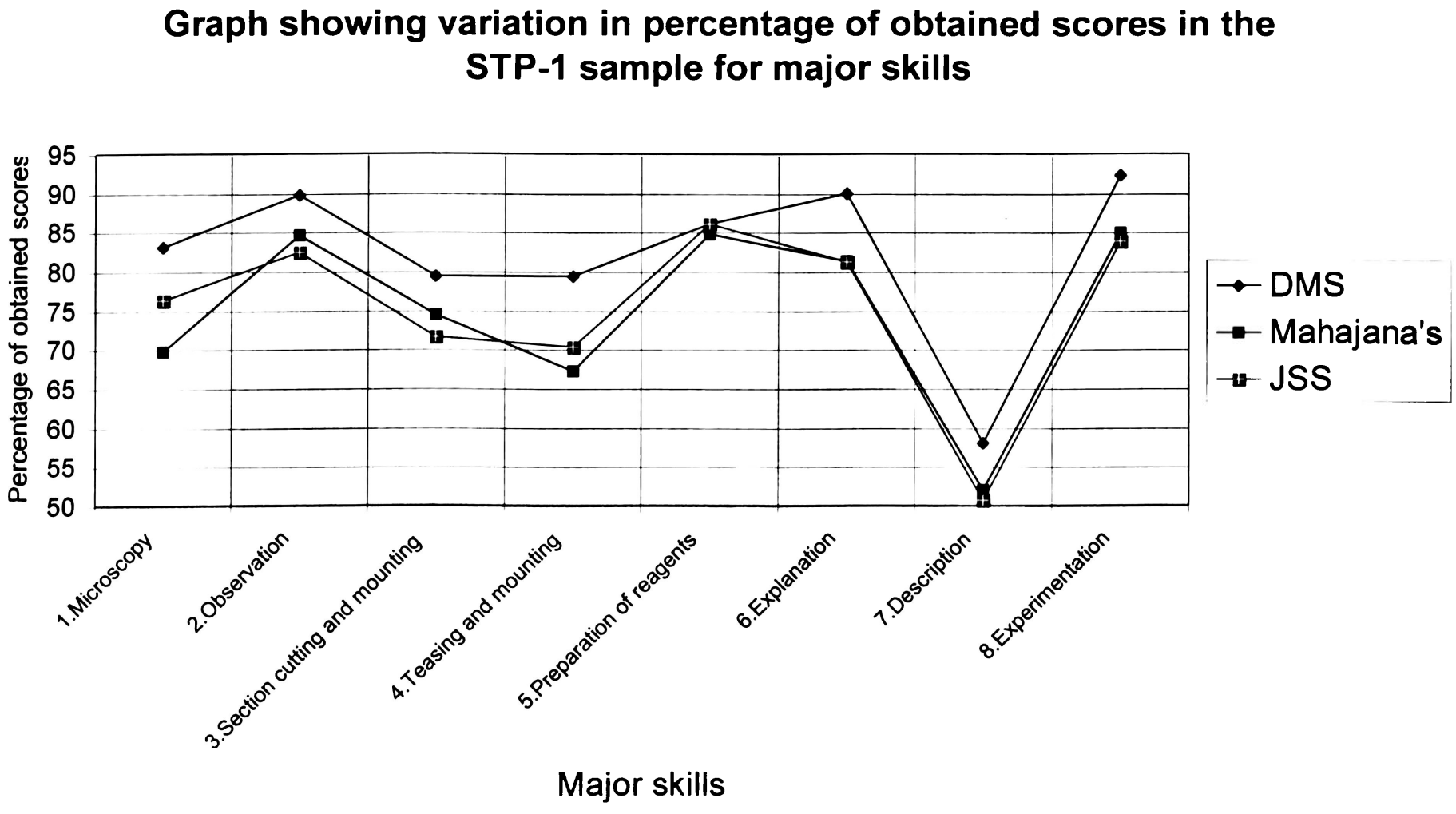
Table 3.2: Table showing difficulty level of students (%) in different biology practicals of three schools.

Sl. No.	Major skills	Difficulty level of students (%)		
		DMS	**Mahajana's**	**JSS**
1	Microscopy	16.92	30.28	23.63
2	Observation	10.29	15.38	14.42
3	Section cutting and Mounting	20.71	25.55	24.89
4	Teasing and Mounting	20.62	32.79	27.72
5	Preparation of Reagents	13.93	15.31	14.39
6	Explanation	10.04	18.66	15.83
7	Description	42.00	48.03	46.47
8	Experimentation	7.71	15.03	12.98

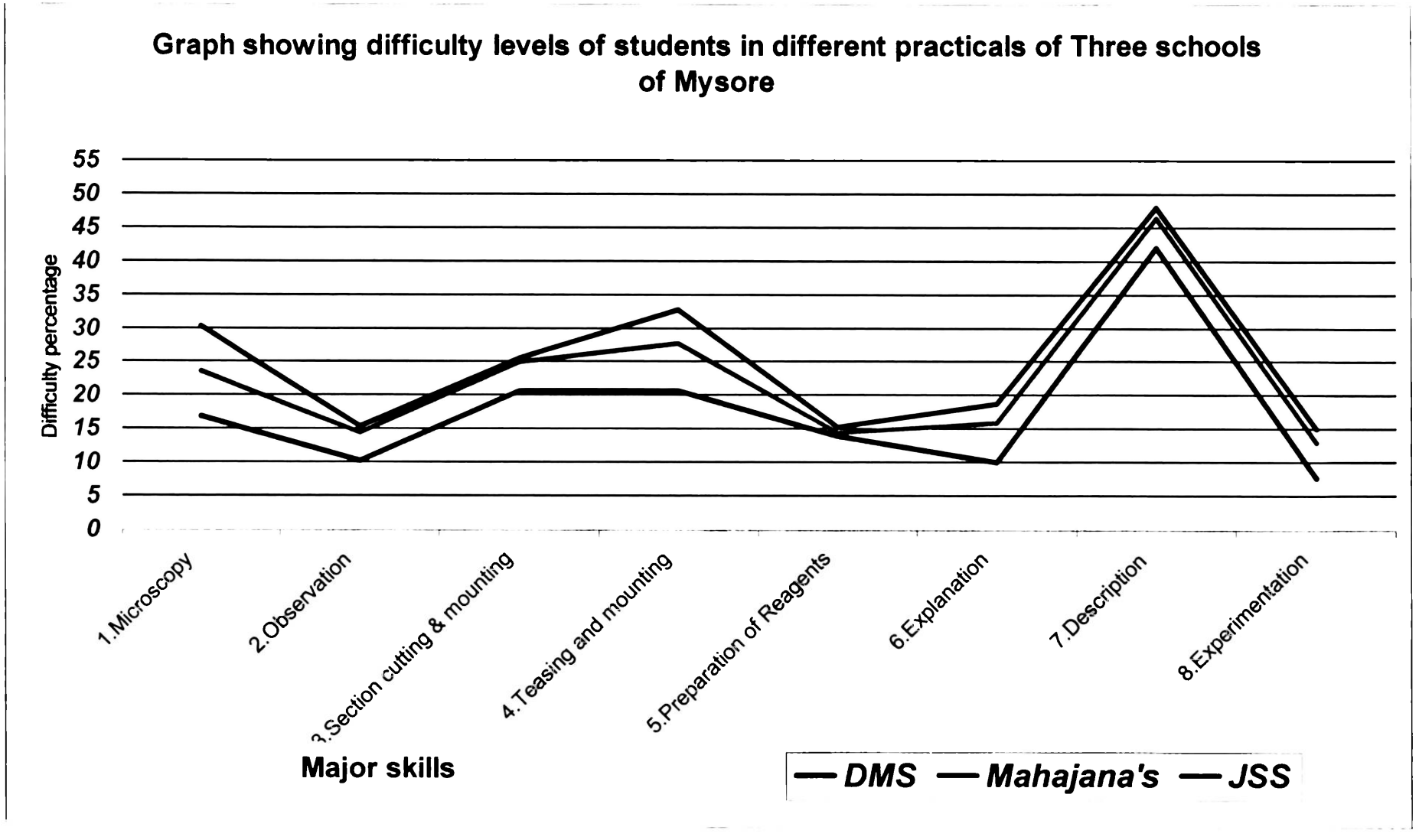
Graph 3.1: Graph showing variation in percentage of obtained scores in STP – 1 sample for eight major skills.



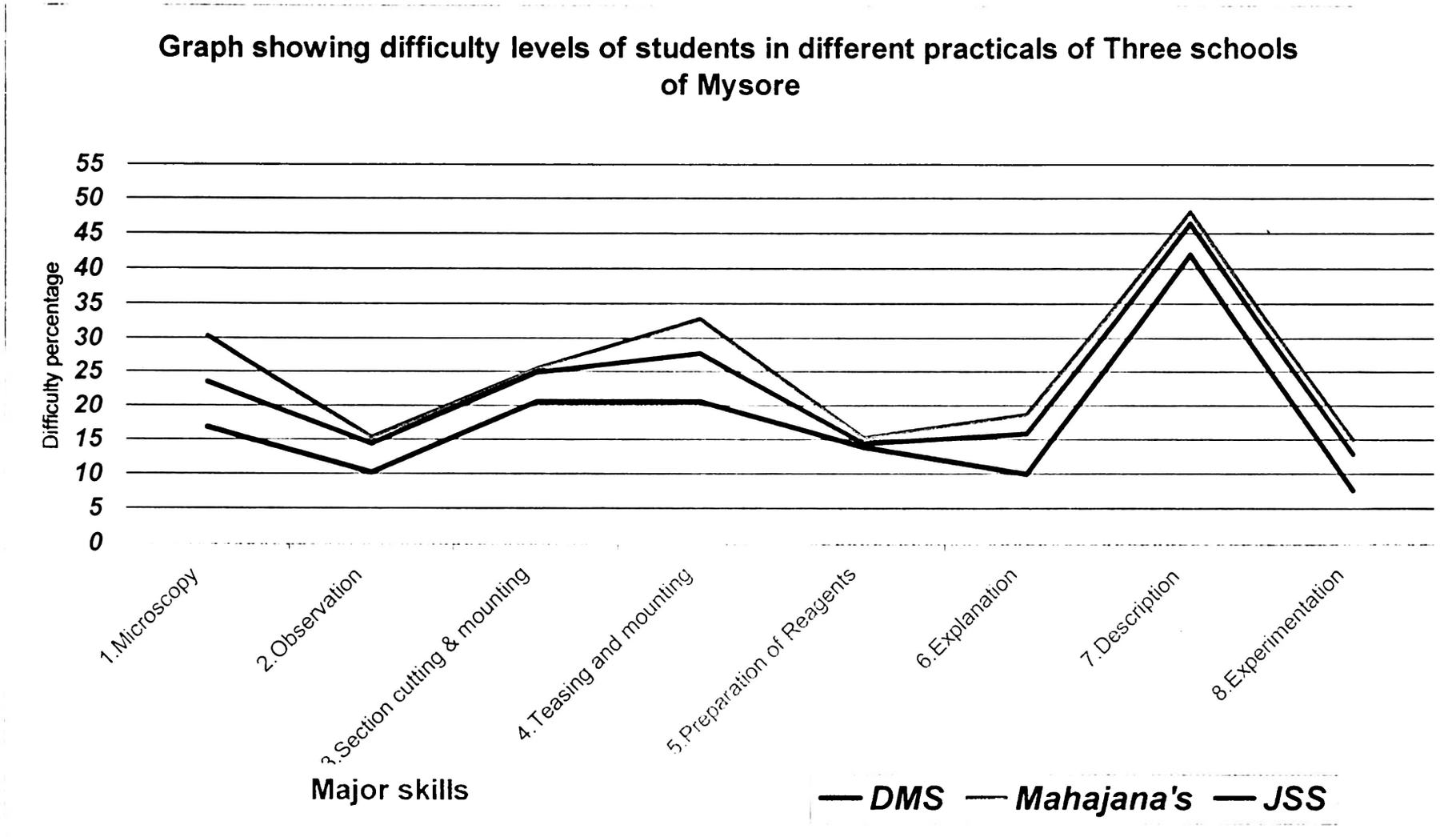
Graph 3.1: Graph showing variation in percentage of obtained scores in STP – 1 sample for eight major skills.



Graph 3.2: Graph showing difficulty levels of students (%) in STP – 1 sample for eight major skills.



Graph 3.2: Graph showing difficulty levels of students (%) in STP – 1 sample for eight major skills.



METHODOLOGY:

DMS school was selected for the comprehensive analysis of procedures involved in practicals in biology of 12^{th} standard (Earlier in STP – I three schools were taken for the study viz., DMS, JSS and Mahajana's school and on plotting a graph of the results obtained, a similarity in pattern of difficulties of three schools was observed). The DMS school was selected based on ready access, co-operation and feasibility of conduction of practicals.

DMS is a government owned school with CBSE syllabus. It has good lab facilities and admission is restricted and is based on merit. This time a sample of 16 students was taken which was different from the last year's working sample. There is a change in student sample number during the administration of content questionnaire and general questionnaire with the sample number changing from 16 to 19 students.

Eight practicals involving specific skills of microscopy, observation, section cutting and mounting, preparation of reagents, explanation, description and experimentation were identified and conducted (Table 3.3). After relocating difficult skills in the present sample of 16 students of DMS, a general questionnaire based on different aspects of student's background and their content knowledge respectively was prepared and administered. The data generated with the aid of study tools like check-lists, diagnostic tests and SPM tests along with their respective score sheets and answer keys were analysed with the help of standard statistical tools.

Construction of tools:

The experiments were selected carefully keeping major skills in mind. Several sub skills and the criterion measures were identified by critically going through the minute details of the instructional methodology for each experiment. Out of the tools used, 4 were constructed by us and the fifth was a standardized one (viz., Standard Progressive matrices test). All tools are given in the appendix.

Table 3.3: List of practicals and major skills.

Sl. No.	Practical	Major skill
1	Use and care of compound microscope	Microscopy
2	Observation of permanent slide of monocot stem	Observation
3	Making transverse sections of Dicot stem and study of different tissues under microscope	Section cutting and mounting
4	To prepare temporary mount of onion root tip to study various stages of Mitosis	Teasing and mounting
5	Preparation of reagents	Preparation of Reagents
6	Test for sugar and albumin	Explanation
7	Identification and description of China rose	Description
8	To study effect of temperature, pressure and solute concentration on osmotic movement of water	Experimentation

Based on the sub-skills identified along with their criterion measures, check lists were prepared for each experiment. Based on the checklists, scoring keys were prepared for each of the eight experiments. If a student is able to attain successfully a particular skill during the course of a practical it is ticked (✓). If not a cross (X) is put. Thus the cross is an indicator of levels of difficulties in skills.

Tool – 1: Check-lists for assessment of 8 major skills.

Check-lists for assessment of 8 practical skills were constructed, and scoring keys were used together by the investigators to generate the data. During the practical classes conducted for each experiment, the difficulties in acquiring biology lab skills were analyzed for each student with the help of criterion measures presented in the check lists and the scoring was done based on the scoring key. Based on the scores the skills were assessed and the data subjected to statistical analysis.

Tool – 2: Diagnostic test for eight practicals:

Diagnostic tests represent and cover the entire area of content pertaining to each practical. Care is taken to see that the items of the diagnostic tests are appropriate and up to the level of students of class 12^{th}. Due weightage was given to different types of questions like multiple choice questions, true or false, match the following etc., The test papers were evaluated with the help of answer keys and the

scores were assigned to each student based on his/her performance. Diagnostic Test and the answer keys for all the eight experiments are presented in Appendix.

Tool – 3: Standard Progressive Matrices Test:

To test the intelligence a 'standard progressive matrices test' was administered for each student. The test was designed by Raven (1996) of U. K. and has been consistently used by researchers throughout the world. The obtained scores were converted to percentage and final scoring is done based on the guidelines given in the manual depending on the exact age of the student.

All the three sets of data i.e., acquisition of practical skills (from scoring key based on practical skill), content knowledge (Diagnostic tests) of each experiments and intelligence test (SPMT) were analyzed and compared school wise. The difficulties exhibited by students in various skills and sub-skills were analyzed qualitatively.

Tool – 4: Content questionnaire:

A detailed content questionnaire for practicals with difficulties (Practicals 2, 3, 4, 5, 6 & 7) in skill attainment was prepared in order to identify/circumscribe loopholes in content knowledge. Care was taken to cover important concepts, keywords, terms, and processes of each of the practicals. The questions were mostly of the objective type (multiple choice). Content questionnaire was analyzed using an answer key (refer appendix) and the results were calculated. Half-an-hour time was given for attempting content questionnaire, which consisted of 84 multiple-choice questions. One mark was assigned per correct answer and total of obtained scores in each practical as well as obtained score by each student in all practicals was calculated. A broad scale of percentage of obtained marks in content questionnaire was prepared as follows in order to categorize the student's performance into very good to very poor .

Tool – 5: General questionnaire:

A list of questions were prepared with options (yes/no, sometimes-never-always) of this kind in order to assess what are the general reasons for the lack of attainment of skills. The questionnaire consisted of questions on 8 sections like loopholes/drawbacks of teacher competencies, instructional strategies, lack of instructional materials, student's socio-economic background, information processing skills, lack of ability to solve problems and lack of content back-up and problems in language components (refer Appendix).

In loopholes/drawbacks of teacher competencies, questions answered as 'rarely' reflected lack of teacher competency. In instructional strategies, questions answered as 'rarely' reflected lack of instructional strategies. In lack of instructional materials, lack of ability to solve problems, lack of content back-up and student background, total number of questions which reflected on the lack of instructional materials and student background were taken into consideration. In information processing, 'always' and 'never' has been taken into consideration. In problems in language components 'usually' and 'never' were taken into consideration.

RESULTS AND INTERPRETATIONS

Identification of difficult sub-skills in different major skills:

Table 4.1 shows percentage of students with difficulty in a particular skill (this was calculated as number of wrong attempts in each skill by 16 students X 100 / maximum marks in each skill)). The table also gives percentage of obtained scores in each skill (this was calculated as number of correct attempts in each skill X 100 / maximum marks in each skill). If up to 7% students showing difficulty is considered negligible, then a study of the former values brings to light five major skills viz., observation (10.63% students showing difficulty), section cutting (11.65% students showing difficulty), Explanation (17.62% students showing difficulty) and description (having a maximum of 33.16% students showing difficulty).

Table 4.1: Identification of difficult biology laboratory skills in higher secondary students of DMS school.

Sl. No.	Major Skill	Obtained scores (%) in skill test	Difficulty level in percentage
1	Microscopy	95.08	04.92
2	Observation	89.37	10.63
3	Section cutting	88.35	11.65
4	Teasing and mounting	80.46	19.54
5	Preparation of reagents	92.93	07.07
6	Explanation	82.38	17.62
7	Description	66.84	33.16
8	Experimentation	93.26	06.74

The table also points out that there is a reasonable amount of overall achievement in all the skills (86.08%) in the whole class.

Table 4.3 to 4.10 reveal a breakup of the major skills into various sub-skills, which were evaluated using checklists in the class for level of performance by the students.

All values of 10% and below (% of students showing difficulty) were ignored and an arbitrary scale of performance was tentatively prepared for analyzing this table as follows:

Table 4.2: Scale for marking performance of students.

Sl. no.	Level of difficulty	Grade/Remarks
1	0 – 20%	Excellent
2	20 – 40%	Very good
3	40 – 60%	Good
4	60 – 80%	Average
5	80 – 100%	Poor

The scale was applied to Tables 4.3 – 4.10 for further analysis (and for categorization of students based on difficulty level into excellent, very good, good, average and poor).

Table 4.3: Identification of difficult sub-skills under microscopy.

Sl. No.	Sub-Skills	% of Students showing difficulty in skill test
1	Eye piece adjustment	04.16
2	Objective adjustment	04.68
3	Use of diaphragm	00.00
4	Mirror/light Adjustment	18.75
5	Focusing the slide	00.00
6	Placement of the slide	00.00
7	Use of the adjustment	06.25
8	Sketching as seen under the microscopy	12.50

Table 4.3 reveals that in the major skill of microscopy the sub-skill of mirror or light adjustment was the most difficult (with 18.75% of students showing difficulty) followed by the sub-skill of sketching as seen under microscope (with 12.5% of students showing difficulty).

Table 4.4 reveals that under the major skill of observation, sub-skill of identifying diagnostic features (with 33.33% students showing difficulty) was the most

difficult followed by identification of section of monocot stem (15.62%), focusing (14.58%) and stage adjustment (14.06%) respectively.

Table 4.4: Identification of difficult sub-skills under Observation

Sl. No.	Sub-Skills	% of Students showing difficulty in skill test
1	Focusing	14.58
2	Stage adjustment	14.06
3	Scanning the slide	00.00
4	Selection of good slides	00.00
5	Use of pointer	00.00
6	Highlighting a section of T.S	08.33
7	Recognition	09.37
8	Identification of section of monocot stem	15.62
9	On diagnostic feature	33.33

Table 4.5: Identification of difficult sub-skills under Section cutting and Mounting.

Sl. No.	Sub-Skills	% of Students showing difficulty in skill test
1	Handling of razor and other materials and section cutting	04.16
2	Ability to keep section and to remove pith	12.50
3	Selection of good section and placement on slide	07.50
4	Staining the section	12.50
5	Ability to remove or wash excess stain	18.75
6	Use of cover slips and Glycerin	21.87
7	Focusing the slide	00.00
8	Ability to sketching as seen under the microscopy	21.87

Table 4.5 shows that under the major skill of section-cutting and mounting, the sub-skills of sketching as seen under microscope, use of cover slips and glycerine, ability to remove excess stain, ability to remove pith and ability to stain section were sub-skills in descending order of difficulty with 21.87%, 18.75% and 12.5% students showing difficulties respectively.

Table 4.6: Identification of difficult sub-skills under Teasing and mounting

Sl. No.	Sub-Skills	% of Students showing difficulty in skill test
1	Preparation of Fixative	37.50
2	Ability to use and handle Con.HCl	10.41
3	Ability to wash, root	15.62
4	Ability to use slide and stain	00.00
5	Heating and use of spirit lamp	20.83
6	Ability to squash	02.50
7	Observation and identification of stages	68.75
8	Sketching as seen under Microscope	15.62

Table 4.6 shows level of difficulties in sub-skills of Teasing and mounting (major skill). Observation and identification of stages was the most difficult sub-skill (an all-time maximum of 68.75% students showed difficulty here, this was the most difficult sub-skill in all the eight practicals), followed by the sub-skills of preparation of fixative (difficulty level of 37.5% students), heating and use of spirit lamp (20.83% difficulty level), sketching as seen under the microscope (15.62%), ability to wash root (15.62%) and ability to use and handle conc. HCl (10.41%).

Table 4.7: Identification of difficult sub-skills under Preparation of reagents

Sl. No.	Sub-Skills	% of Students showing difficulty in skill test
1	Use of Chemical Balance	12.50
2	Accurate weighing of chemicals	20.31
3	Use of measuring cylinder& pipette etc	03.12
4	Ability to mix &filter using filter paper	00.00
5	Ability to stir constantly	00.00
6	Knowledge of burner or hot plate use.	00.00

Table 4.7 revealed that in the major skill of preparation of reagents, the sub-skills of accurate weighing of chemicals (20.31% difficulty level in class) and use of chemical balance (12.5% difficulty level in class) were the most difficult ones in order.

Table 4.8: Identification of difficult sub-skills under Explanation

Sl. No.	Sub-Skills	% of Students showing difficulty in skill test
1	Use of pipette	00.00
2	Ability to use test tube holds	07.50
3	Use of burner(Bunsen)	00.00
4	Ability to distinguish colour changes	03.12
5	Ability to infer	46.87
6	Ability to mix with glass rods or by simple shaking	10.93

Table 4.8 shows sub-skills and percentage of students showing difficulty in skill of Explanation. It is observed from this table that subskill of ability to infer (46.87% difficulty level in class) was the most difficult followed by ability to mix (10.93% difficulty level in class).

Table 4.9: Identification of difficult sub-skills under Description

Sl. No.	Sub-Skills	% of Students showing difficulty in skill test
1	Classification Ability	25.00
2	Habit and Habitat	00.00
3	Finding root system	37.50
4	Ability to finding stem feature	12.50
5	Identifying the type of leaf	26.25
6	Identifying the type of inflorescence and flower	50.00
7	Ability to distinguish Calyx and Corolla	46.87
8	Ability to distinguish Androecium ,Gynoecium and Fruit	53.75
9	Knowledge of writing floral formula and diagram.	56.25

Table 4.9 highlights difficult skills under the major skill of description, knowledge of writing floral formula and diagram (56.25% difficulty level in class); ability to distinguish androecium, gynoecium and fruit (53.75% difficulty level in class); identifying type of inflorescence and flower (50%); ability to distinguish calyx and corolla (46.87%); finding root system (37.5%); identifying type of leaf (26.28%) and classification ability (25%) were in order.

Table 4.10: Identification of difficult sub-skills under Experimentation

Sl. No.	Sub-Skills	% of Students showing Difficulty in skill test
1	Knowledge of diffusion and osmosis	02.08
2	Knowledge of membrane type	18.75
3	Ability to handle the equipments	02.08
4	Ability to record turgidity time	07.29
5	Handling of thermometers	31.25
6	Ability to know the effect of pressure on osmosis (i.e., reasoning)	25.00
7	Ability to make observation	04.68
8	Ability to draw conclusion	08.33
9	Ability to draw experimental diagram	12.50

Table 4.10 depicts difficult sub-skills under experimentation. These were handling of thermometers (31.25% difficulty level); ability to reason (25% difficulty level); knowledge of membrane type (18.75% difficulty level) and ability to draw experimental diagram (12.5% difficulty level).

A cumulative table has been prepared showing all the sub-skills in descending order of difficulty (Table 4.11).

Since there is a mean of 80-81% students (refer Table 1) attaining the major 8 skills, we can conclude that minimum levels of skill attainment are achieved. However, the above difficulties (Table 4.11) are outstanding.

Table 4.11: Percentage of students showing difficulty in skills in descending order of difficulty.

Expt. No.	Sub skill No.	Sub skill	% of students showing difficulty in skill test	Remarks
E4	7	Observation and identification of stages	68.75	Poor.
E7	9	Knowledge of writing floral formula and diagram.	56.25	Average.
E7	8	Ability to distinguish Androecium, Gynoecium and Fruit	53.75	Average.
E7	6	Identifying the type of inflorescence and flower	50.00	Average.
E6	5	Ability to infer	46.87	Average.
E7	7	Ability to distinguish between Calyx and Corolla	46.87	Average.
E4	1	Preparation of Fixative	37.50	Good.
E7	3	Finding root system	37.50	Good.
E2	9	On diagnostic features	33.33	Good.
E7	5	Identifying the type of leaf	26.25	Good.
E7	1	Classification Ability	25.00	Good.
E3	6	Use of cover slips and Glycerin	21.87	Good.
E3	8	Ability to sketching as seen under the microscopy	21.87	Good.
E4	5	Heating and use of spirit lamp	20.83	Good.
E5	2	Accurate weighing of chemicals	20.31	Good.

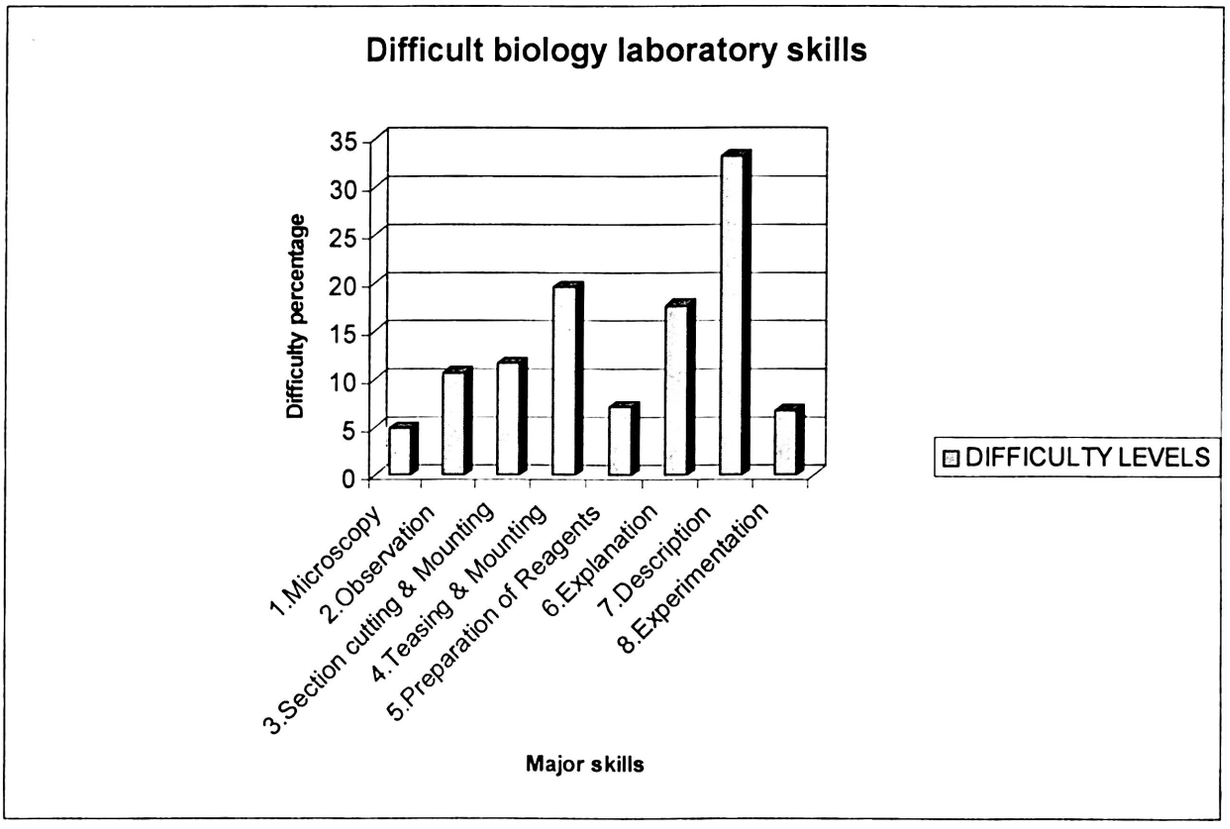
Performance scale.

% of students showing difficulty in skill test.	Performance remarks
0-20%	Very good.
20-40%	Good.
40-60%	Average.
60-80%	Poor.
80-100%	Very poor.

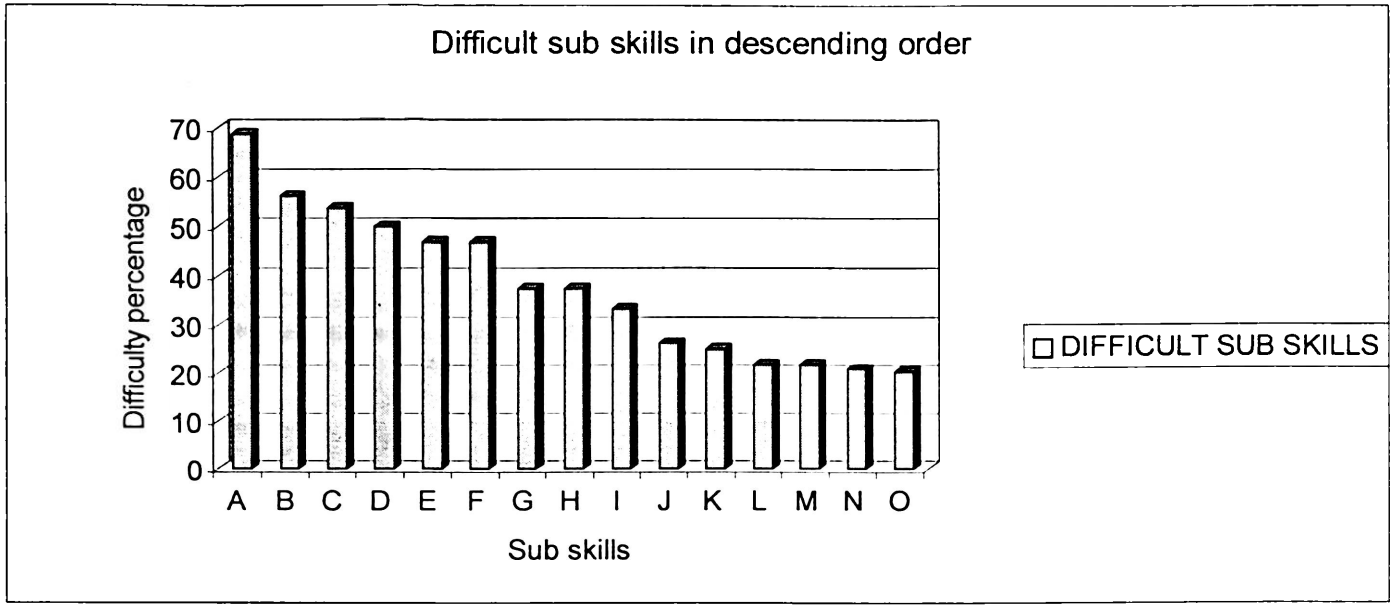
Preparation of a) a bar graph of major skills and percentage of students showing difficulty and b) a bar graph of sub skills and percentage of students showing difficulty are self-explanatory (refer bar graphs 4.1 & 4.2, from tables 4.1 and 4.11 respectively).

Table 4.11 depicts the percentage of obtained marks in the 8 major skills by 16 students of XII standard of DMS. Since the mean of obtained scores in all the practicals/skills is high i.e. 70±x, it shows that the level of skill attainment in all practicals is high though there may be drawbacks pertaining to individual sub-skills in each skill (Table 4.1 – 4.10) as described earlier. Skills with 10% and above difficulty level was prepared and the major difficult subskills outlined. Also, remarks on students performance has been given based on a performance scale (mentioned earlier) which is formulated based on the difficulty level in skill attainment in different sub-skills. Those with low difficulty level were the ones with high skill attainment. The more the difficulty level, the lower the skill attainment.

Bar graph 4.1 : Bar graph showing difficult biology laboratory skills in STP – II sample.



Bar graph 4.2: Percentage of students showing difficulty in sub skills in descending order in STP – II sample of 16 students.



Difficult sub-skills:

A = Observation and identification of stages.
B = Knowledge of writing floral formula and diagram.
C = Ability to distinguish Androecium, Gynoecium and Fruit.
D = Identifying the type of inflorescence and flower.
E = Ability to infer.
F = Ability to distinguish between calyx and corolla.
G = Preparation of Fixative.
H = Finding root system.
I = On diagnostic features.
J = Identifying the type of leaf.
K = Classification Ability.
L = Use of cover slips and glycerine.
M = Ability to sketch as seen under the microscope.
N = Heating and use of spirit lamp.
O = Accurate weighing of chemicals.

Table 4.12: Percentage of obtained marks in skill test in eight practicals.

Name of the student	Percentage of marks Experiments S1	S2	S3	S 4	S5	S6	S7	S 8	Mean
01.Akash.F.Patil	071.42	080.00	072.72	066.66	078.26	081.81	066.66	096.15	76.71
02.Arunkumar.S	100.00.	080.00	090.90	079.16	100.00	077.27	044.44	061.53	79.16
03.Deepika.G.prasad	100.00	093.33	086.36	079.16	100.00	086.36	077.77	100.00	88.29
04.Dhananjaya.KN	100.00	093.33	081.81	079.16	082.60	072.72	050.00	100.00	82.45
05.Dhaval.MK	092.85	083.33	095.45	087.50	100.00	077.27	052.77	100.00	86.14
06.Kezia.F	100.00	090.00	086.36	087.50	086.95	081.81	072.22	076.92	85.22
07.Milind	100.00	100.00	086.36	091.66	082.60	095.45	066.66	100.00	90.34
08.Nitin.N	100.00	90.00	077.27	079.16	100.00	077.72	072.22	100.00	87.04
09.Saumya.T	092.85	096.00	095.45	075.00	095.65	095.45	069.44	100.00	89.98
10.Shambhavi	092.85	086.66	090.90	083.33	082.60	081.81	069.44	100.00	85.94
11.Shivaramakrishnan.B	100.00	096.00	095.45	079.16	100.00	081.81	075.00	100.00	90.92
12.Shreesha.S	085.71	090.00	095.45	095.83	095.65	081.81	072.22	096.15	89.10
13.Sujina.V	092.85	093.33	095.90	087.50	095.65	086.36	077.77	088.46	89.10
14. Soujanya	100.00	086.66	095.45	079.16	086.95	072.72	058.33	084.61	87.12
15. Swamy	100.00	090.00	090.90	079.16	100.00	081.81	066.66	088.46	87.12
16. Yashas	092.85	080.00	081.81	075.00	100.00	086.36	077.77	100.00	86.72
Mean	92.85	89.24	88.65	70.31	92.93	82.40	62.32	93.26	

Table 4.12 shows the percentage of obtained marks in skill test in eight practicals. Also, mean value was calculated for marks obtained by 16 students in a single practical and for marks by each student in all the eight practicals. The former reveals that practical 7 involving description of China rose has minimum mean percentage of obtained marks showing that this was the most difficult practical of all 8. The other seven practicals show a mean of percentage of obtained marks ranging from 70% to 94%. Practical 4 (Teasing and mounting of onion root tips) shows mean of percentage of obtained marks as 70.31% and therefore this too perhaps leaves a lot to be desired in terms of attainment of skills when compared to the other with a mean of 82% and above.

A comparison of skill attainment by each student in all the eight practicals brings to light a range of values from 76% to 90%. If 80% is taken as the cut-off point for achievement of skills (comparison table 4.13, given below).

Table 4.13: Table showing scale for evaluation of skill achievement based on obtained scores.

Sl. no.	Percentage of Obtained marks	Remarks on skill achievement
1	0 – 20%	Very poor
2	20 – 40%	Poor
3	40 – 60%	Average
4	60 – 80%	Good
5	80 – 100%	Very good

Students 3 to 16 show very good achievement of skills whereas Akash and Arun kumar can do with a little bit of improvement to fall in line with the rest of the class. Application of remedial interventions in the difficult sub-skills to all the students (especially to Akash and Arun kumar) could lead to overall upgradation of the performance levels of the class.

Table 4.14: Percentage of obtained marks in diagnostic tests in eight practicals.

Name of the student	Percentage of marks Experiments								
	D1	D2	D3	D4	D5	D6	D7	D8	Mean
01.Akash. F. Patil	100.00	093.33	085.71	077.77	064.20	066.66	064.70	093.75	80.76
02.Arunkumar.S	094.44	060.00	092.85	061.11	071.42	075.0	070.00	093.75	77.32
03.Deepika.G.prasad	088.88	093.33	100.00	072.22	078.57	083.33	082.35	093.75	86.55
04.Dhananjaya.KN	094.44	080.00	092.85	088.88	078.57	083.33	072.94	075.00	80.75
05.Dhaval.MK	094.44	073.33	100.00	088.88	100.00	100.00	070.00	093.75	90.05
06.Kezia.F	094.44	040.00	092.85	077.77	085.71	083.33	070.00	087.5	78.95
07.Milind	083.33	086.66	071.42	066.66	078.57	075.00	070.00	075.00	75.83
08.Nitin.N	077.77	086.66	085.71	094.44	100.00	091.66	070.00	062.50	83.59
09.Saumya.T	094.44	060.00	100.00	072.22	085.71	075.00	070.00	093.75	81.39
10.Shambhavi	088.88	093.33	085.71	072.22	078.57	075.00	082.35	087.50	82.94
11.Shivaramakrishnan.B	088.88	066.66	078.57	072.22	092.85	100.00	070.00	093.75	82.86
12.Shreesha.S	077.77	026.66	078.57	055.55	092.85	083.33	064.70	081.25	70.08
13.Sujina.V	094.44	066.66	085.71	066.66	050.00	075.00	070.00	093.75	75.27
14. Soujanya	088.88	100.00	100.00	072.22	071.42	083.33	070.00	087.50	84.16
15. Swamy	100.00	073.33	100.00	083.33	078.57	066.66	058.82	100.00	82.58
16. Yashas	100.00	080.00	085.71	083.33	085.71	091.66	070.00	100.00	87.05
Mean	91.31	68.12	94.63	85.06	80.78	81.76	70.36	88.28	

Table 4.14 depicts values of percentage obtained marks in content (diagnostic) tests of all the eight practicals. This was done primarily to test whether content has any bearing on skill

attainment. Mean of percentage of obtained marks by each student for all practicals and percentage of obtained scores by 16 students in each of the 8 practicals were calculated separately and are depicted in last vertical and last horizontal rows respectively. When one considers the mean score of each student in all the 8 diagnostic tests, Arunkumar, Kezia, Milind, Shreesha and Sujina fall slightly short of the grade of 80% required for very good content knowledge attainment. For the rest of the class, the values range from 80 to 90%.

An analysis of the mean of percentage of obtained scores of the class in each of the diagnostic tests shows that content knowledge ranges from good to very good. However, content level in practical 2 on Observation of T. S. of monocot stem (68.12%) and practical 7 on Description of china rose (70.36%) can be improved for the whole class using remedial measures.

In Tables 4.15 and 4.16, the percentage of obtained score values obtained from theory (diagnostic) and skill attainment tests have been correlated with values obtained from standard progressive matrices scores (obtained by SPM tests as given in Raven's manual).

Table 4.15 gives diagnostic test and skill test values as percentage of obtained scores. t – value was calculated using the formula {t = (r / square root of $1 - r^2$) X square root of n – 2} where, r = correlation coefficient and n = sample size and this value has been interpreted by Garret where $t_{tab} = 2.15$ at 5% level of significance. In practicals 1,2, 4, 6 and 8 the correlation is negative and not significant. In practicals 3, 5 and 7 t – value is not significant but correlation is positive. Therefore, in practicals 1, 2, 4, 6 and 8 the correlation though not significant is negative, i.e. the change here is in opposite direction. When one increases, the other decreases. In practicals 3, 5 and 7 though the t – value is not significant there is positive correlation between diagnostic test and skill test values meaning there-by that to a certain extent content knowledge does influence skill attainment.

Table 4.16 shows the correlation between MDT, MST and SPMT values. Here it is seen that the correlation between content and skill attainment is negative and between skill attainment and IQ test is negative. t – value is not significant in both the cases meaning that content and IQ have no bearing on skill attainment. However, correlation between diagnostic test and IQ test

Table 4.15: Correlation between Content knowledge (Diagnostic test) and acquisition of skills (Skill test) of DMS students.

Student no.	Obtained score (%)															
	D1	S1	D2	S2	D3	S3	D4	S4	D5	S5	D6	S6	D7	S7	D8	S8
1	100.00	071.42	093.33	080.00	085.71	072.72	077.77	066.66	064.20	078.26	066.66	081.81	064.70	066.66	093.75	096.15
2	094.44	100.00.	060.00	080.00	092.85	090.90	061.11	079.16	071.42	100.00	075.0	077.27	070.00	044.44	093.75	061.53
3	088.88	100.00	093.33	093.33	100.00	086.36	072.22	079.16	078.57	100.00	083.33	086.36	082.35	077.77	093.75	100.00
4	094.44	100.00	080.00	093.33	092.85	081.81	088.88	079.16	078.57	082.60	083.33	072.72	072.94	050.00	075.00	100.00
5	094.44	092.85	073.33	083.33	100.00	095.45	088.88	087.50	100.00	100.00	100.00	077.27	070.00	052.77	093.75	100.00
6	094.44	100.00	040.00	090.00	092.85	086.36	077.77	087.50	085.71	086.95	083.33	081.81	070.00	072.22	087.5	076.92
7	083.33	100.00	086.66	100.00	071.42	086.36	066.66	091.66	078.57	082.60	075.00	095.45	070.00	066.66	075.00	100.00
8	077.77	100.00	086.66	90.00	085.71	077.27	094.44	079.16	100.00	100.00	091.66	077.72	070.00	072.22	062.50	100.00
9	094.44	092.85	060.00	096.00	100.00	095.45	072.22	075.00	085.71	095.65	075.00	095.45	070.00	069.44	093.75	100.00
10	088.88	092.85	093.33	086.66	085.71	090.90	072.22	083.33	078.57	082.60	075.00	081.81	082.35	069.44	087.50	100.00
11	088.88	100.00	066.66	096.00	078.57	095.45	072.22	079.16	092.85	100.00	100.00	081.81	070.00	075.00	093.75	100.00
12	077.77	085.71	026.66	090.00	078.57	095.45	055.55	095.83	092.85	095.65	083.33	081.81	064.70	072.22	081.25	096.15
13	094.44	092.85	066.66	093.33	085.71	095.90	066.66	087.50	050.00	095.65	075.00	086.36	070.00	077.77	093.75	088.46
14	088.88	100.00	100.00	086.66	100.00	095.45	072.22	079.16	071.42	086.95	083.33	072.72	070.00	058.33	087.50	084.61
15	100.00	100.00	073.33	090.00	100.00	090.90	083.33	079.16	078.57	100.00	066.66	081.81	058.82	066.66	100.00	088.46
16	100.00	092.85	080.00	080.00	085.71	081.81	083.33	075.00	085.71	100.00	091.66	086.36	070.00	077.77	100.00	100.00
Correlation	- 0.20514		- 0.11045		0.17987		- 0.39163		0.378612		- 0.28204		0.104305		- 0.22166	
t - value	- 0.7838		- 0.4155		0.6838		- 1.5917		1.5299		- 1.0994		0.8922		- 0.8505	

Table 4.16: Correlation of Skill tests (acquisition of skills) with Diagnostic tests (content knowledge) and SPMT (mental aptitude) of students.

Student. No.	DMS School students		
	MDT	**MST**	**SPMT**
01	80.76	76.71	58
02	77.32	79.16	54
03	86.55	88.29	46
04	80.75	82.45	45
05	90.05	86.14	59
06	78.95	85.22	50
07	75.83	90.34	46
08	83.59	87.04	55
09	81.39	89.98	56
10	82.94	85.94	59
11	82.86	90.92	54
12	70.08	89.10	54
13	75.27	89.10	53
14	84.16	87.12	57
15	82.58	87.12	56
16	87.05	86.72	57

Correlation value between MDT and MST = - 0.02938, t – value = - 0.1099.
Correlation value between MST and SPMT = - 0.14518, t – value = - 0.5487.
Correlation value between MDT and SPMT = 0.298723, t – value = 1.1707.

MDT-Mean diagnostic test, MST- Mean skill test, SPMT- Standard Progressive Matrices Test, Corre- Correlation co-efficient, *Significant value.

Table 4.17: Table showing approximate IQ values of the 12th std. students of DMS, Mysore – 06.

Sl. No.	Name of the student	Raw SPMT score	Chronological age	Mental age (approx.)	IQ value (approx.)	Remarks
01	Akash F. Patil	58	17.6	18.56	105	Average
02	Arun kumar S.	54	17	17.9	105	Average
03	Deepika G. Prasad	46	16.11	16.8	104	Average
04	Dhananjaya K. N.	45	16.11	16.86	104	Average
05	Dhaval M.K.	59	17.8	18.78	105.5	Average
06	Kezia F.	50	16	16.83	105	Average
07	Milind	46	16.10	16.86	104	Average
08	Nitin N.	55	17.6	18.51	105	Average
09	Sowmya T.	56	16.2	17.13	105	Average
10	Shambhavi	59	16.1	17.08	106	Average
11	Shivaramakrishnan B.	54	16.7	17.6	105	Average
12	Shreesha S.	54	17.10	18	105	Average
13	Sujina V.	53	17.7	18.58	104	Average
14	Sowjanya	57	16.1	17.05	105	Average
15	Swamy	56	17.1	18.03	105	Average
16	Yashas	57	17.1	18.05	105	Average
17	Jaimeer kaur	55	17	17.91	105	Average

value seems to be positive. The t – value is not significant but the positive correlation pointed to the fact that IQ has bearing on content attainment. Therefore, it can be said as a natural corollary that IQ influences content attainment and content in turn influences skill to a certain extent. Hence, it has been attempted to bring in remedial interventions in content through activities such as Word search, Crossword, Quiz, Flashcards, Concept maps and Glossary on the difficult practicals and remedial interventions in skill attainment through power point presentations and graphical instructions of the experimental procedures.

Table 4.17 gives a comparison of SPMT score with chronological and mental age of the 16 students along with approximate IQ values. IQ of the students according to these calculations seems to be average.

Table 4.18 shows scores of students in figures in comparatively difficult practicals. These were identified earlier (see Tables 4.1 and 4.12) as practicals with maximum difficulty levels in skill attainment. The last row shows practical wise percentage of obtained scores and it can be concluded that practicals 2 (43.13), 3 (53.78), 4 (63.66) and 7 (41.98) show less than 70% scores and are therefore more difficult for the class as a whole than practical 5 and practical 6 where more than 70% scores are obtained. Content improvement remedial measures are therefore developed in practical 2, 3, 4 and 7. High difficulty levels in skill attainment are observed in practicals 2 and 7. Therefore, this could be due to lack of content comprehension.

A detailed analysis of content questionnaire was carried out. For this, key words of each practical were selected and total number of wrong attempts pertaining to these keywords in each practical determined for the whole class.

Table 4.18: Content questionnaire showing scores of students in difficult practicals.

Sl. no.	Name of the student	Number of correct answers in each practical						Student' total score
		Pr – 2 1 sub skill	Pr – 3 2 sub skills	Pr – 4 4 sub skills	Pr – 5 1 sub skill	Pr – 6 1 sub skill	Pr – 7 7 sub skills	
01	Akash. F. Patil	2 (6)	1 (7)	4 (17)	3 (4)	3 (5)	15(51)	28 (84)
02	Deepika. G. Prasad	5 (6)	6 (7)	11(17)	4 (4)	5 (5)	29(51)	60 (84)
03	Dhananjaya. K. N.	3 (6)	3 (7)	9 (17)	4 (4)	4 (5)	21(51)	44 (84)
04	Dhaval. M. K.	-	4 (7)	9 (17)	4 (4)	3 (5)	10(51)	31 (84)
05	Kezia. F	1 (6)	2 (7)	11(17)	2 (4)	4 (5)	22(51)	42 (84)
06	Milind	4 (6)	2 (7)	9 (17)	3 (4)	2 (5)	16(51)	35 (84)
07	Nitin. N	3 (6)	2 (7)	6 (17)	3 (4)	3 (5)	21(51)	38 (84)
08	Pratiksha	2 (6)	4 (7)	15(17)	4 (4)	5 (5)	29(51)	59 (84)
09	Saumya. T	4 (6)	3 (7)	11(17)	3 (4)	5 (5)	27(51)	53 (84)
10	Shambhavi	2 (6)	4 (7)	15(17)	4 (4)	5 (5)	30(51)	60 (84)
11	Shivaramakrishnan. B	3 (6)	6 (7)	16(17)	2 (4)	5 (5)	25(51)	57 (84)
12	Shreesha. S	-	3 (7)	10(17)	2 (4)	2 (5)	16(51)	33 (84)
13	Sowjanya. R. K.	4 (6)	4 (7)	16(17)	2 (4)	4 (5)	18(51)	48 (84)
14	Sujina. V	3 (6)	2 (7)	11(17)	3 (4)	5 (5)	35(51)	60 (84)
15	Swamy. S.	4 (6)	2 (7)	12(17)	4 (4)	5 (5)	18(51)	45 (84)
16	Yashas Rai. K.	2 (6)	5 (7)	14(17)	4 (4)	4 (5)	20(51)	49 (84)
17	Jaimeer kaur	2 (6)	1 (7)	5 (17)	2 (4)	2 (5)	12(51)	24 (84)
Practical wise score		44	64	184	53	66	364	766
Percentage		43.13	53.78	63.66	77.94	77.64	41.98	53.64

***Content questionnaire:** Number of correct answers.
Numbers in parentheses indicate the total number of questions given.

In Table 4.18A, one can observe that content related diagnostic features of monocot stem seem to be difficult. Maximum numbers of students (14) have committed mistakes in content questions related to pith followed by cell type, vascular bundle type and arrangement (the latter 8 students each).

Table 4.18B shows content mistakes pertaining to the sub-skill of use of cover slips and glycerine. Maximum mistakes (by 14 and 15 students) were made with respect to the key words mounting medium and glycerine in this sub-skill.

Practical 2: Observation of permanent slide of monocot stem.
TABLE 4.18A: Sub skill - Diagnostic features of monocot stem.

Major content area (key word of each question)	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	Number of students who have made wrong attempts
Cells	√	√	√	-	√	X	√	X	X	√	X	X	X	X	X	√	-	08
VB type	X	√	√	-	X	X	√	-	√	X	√	X	X	√	X	√	X	08
Pith	X	X	X	-	X	X	X	X	X	√	X	X	X	X	√	X	X	14
VB arrangement	√	√	-	-	X	X	X	√	X	X	X	√	X	√	X	√	-	08
Major tissues	X	√	√	-	√	√	√	√	X	√	X	√	X	√	√	X	√	05
Cambium	X	√	X	-	-	X	√	√	√	√	√	√	X	√	√	√	√	04

Practical 3: Making transverse sections of Dicot stem and study of different tissues under microscope.
TABLE 4.18B: Sub skill - Use of cover slips and glycerin.

Major content area (key word of each question)	Students of Class XII.																	Number of students who have made wrong attempts
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	
Mounting medium	X	√	X	X	X	X	X	X	X	X	X	√	√	X	X	X	X	14
Glycerin	X	X	X	X	X	X	X	X	X	X	X	√	X	X	X	-	X	15
Cover slip	√	√	√	√	√	X	√	√	√	√	√	√	√	√	√	√	√	1

Footnote:
Students of Class XII: **1.** Akash F. Patil. **2.** Deepika G. Prasad. **3.** Dhananjaya K. N. **4.** Dhaval M.K. **5.** Kezia. F. **6.** Milind, **7.** Nitin, N. **8.** Saumya T. **9.** Shambhavi. **10.** Shivaramakrishnan, B. **11.** Shreesha S. **12.** Sowjanya, R. K. **13.** Sujina V. **14.** Swamy S. **15.** Yashas Rai K. **16.** Pratiksha. **17.** Jaimeer kaur.

TABLE 4.18C: Sub skill - Ability to sketch as seen under the microscopy.

Major content area (key word of each question)	Students of Class XII.																	Number of students who have made wrong attempts
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	
Condenser	X	√	√	X	-	√	X	√	√	X	√	√	X	√	X	X	√	07
Light control	X	√	X	√	X	X	X	X	√	√	√	√	X	√	X	X	√	09
Oil immersion lens	X	√	X	√	X	X	X	-	X	√	X	X	X	X	X	X	√	12
Micro preparation	X	√	√	√	X	√	√	-	√	X	√	√	√	√	√	√	√	03

Practical 4: To prepare temporary mount of onion root tip to study various stages of mitosis.
TABLE 4.18D: Sub skill - Observation and Identification of stages.

Major content area (key word of each question)	Students of Class XII.																	Number of students who have made wrong attempts
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	
Interphase	-	√	√	X	X	√	√	X	√	√	√	√	X	√	X	X	X	07
Prophase	-	X	√	√	√	√	√	√	√	√	√	√	√	√	X	√	√	02
Metaphase	-	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	00
Anaphase	-	√	X	X	X	√	X	√	√	√	√	√	√	√	√	X	√	05
Telophase	-	X	√	√	√	X	√	X	√	√	√	√	X	√	X	√	√	05

TABLE 4.18E: Sub skill - Preparation of fixatives.

Major content area (key word of each question)	Students of Class XII.																	Number of students who have made wrong attempts
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	
Fixative composition	-	X	X	-	-	X	X	-	√	X	√	√	√	√	√	√	√	05
Fixative preparation	-	√	X	-	-	√	X	-	√	√	√	√	√	√	√	-	√	02

TABLE 4.18F: Sub skill - Heating and use of spirit lamp.

Major content area (key word of each question)	Students of Class XII.																	Number of students who have made wrong attempts
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	
Using spirit lamp	√	√	√	√	X	X	X	X	X	X	X	√	√	X	X	X	X	14
Solvent	X	√	√	√	X	X	X	X	X	X	X	√	X	X	X	-	X	15
Heating a test tube	X	√	√	X	√	X	√	√	√	√	√	√	√	√	√	√	√	1

TABLE 4.18G: Sub skill - Ability to wash, root.

Major content area (key word of each question)	Students of Class XII.																	Number of students who have made wrong attempts
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	
Tip of the roots	X	√	X	X	X	√	√	-	√	X	√	√	X	√	√	√	√	06
Dipping of roots	√	√	X	√	-	X	X	-	√	√	√	√	√	√	√	√	√	03
Further washing	√	√	X	√	-	√	X	-	√	√	√	√	√	√	√	√	√	02
Washing of roots	X	√	X	√	-	√	X	-	√	X	√	√	X	√	X	√	√	06
Washing with water	X	X	√	√	-	X	X	-	√	√	√	√	√	√	√	√	√	04
Used water	√	X	√	X	-	√	X	-	X	X	X	√	X	√	√	X	√	08

Practical 5: Preparation of Reagents.

TABLE 4.18H: Sub skill - Accurate weighing of chemicals.

Major content area (key word of each question)	Students of Class XII.																	Number of students who have made wrong attempts
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	
Molar solution	X	√	√	√	√	√	√	√	√	X	√	√	√	X	√	√	√	03
Molal solution	√	√	√	√	-	X	√	√	√	√	√	√	X	√	X	√	√	03
1 M NaCl solution	√	√	√	√	√	√	X	√	√	√	√	X	√	X	√	√	√	03
One gram	√	√	√	√	X	X	√	X	√	√	√	X	X	√	√	√	√	05

Practical 6: Test for Sugar and Albumin.
TABLE 4.18I: Sub skill - Ability to infer.

Major content area (key word of each question)	Students of Class XII.																	Number of students who have made wrong attempts
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	
Turbidity	√	√	√	√	√	√	√	X	√	√	√	√	√	√	√	√	√	01
Benedict's reagent	√	√	X	X	X	√	X	√	√	√	√	√	√	√	√	√	√	04
Albumin precipitation	√	√	√	-	-	√	X	-	√	√	√	√	-	X	√	√	-	02
Clear solution	-	√	√	√	X	X	√	√	√	√	√	√	**X**	√	√	√	√	03
Deeper precipitate colour	-	√	√	√	√	√	**X**	√	√	√	√	√	X	√	√	√	√	02

Practical 7: Identification and description of China rose.
TABLE 4.18J: Sub skill - Knowledge of writing floral formula and diagram.

Major content area (key word of each question)	Students of Class XII.																	Number of students who have made wrong attempts
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	
Circle	√	√	√	-	-	√	X	-	X	X	X	X	X	X	√	X	X	09
Bracketed structure	X	√	X	-	-	X	X	-	√	X	√	√	√	√	√	X	X	07
Sickle shaped structure	X	√	X	-	-	X	X	-	√	X	√	√	X	X	√	√	X	08
Epipetalous stamens	X	**X**	X	-	-	√	X	-	√	√	√	√	√	√	√	X	**X**	05
T.S. of ovary	√	X	-	-	-	√	√	-	-	X	-	-	X	-	√	-	**X**	04

TABLE 4.18K: Sub skill - Ability to distinguish between Androecium, Gynoecium and Fruit.

Major content area (key word of each question)	Students of Class XII.																	Number of students who have made wrong attempts
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	
Stamen	√	X	√	X	-	X	X	-	√	√	√	X	X	√	√	-	√	06
Pistil	√	X	√	X	-	√	√	-	√	X	√	√	X	-	X	X	X	07
Carpel	X	√	√	X	-	√	√	-	-	√	-	√	X	√	√	X	√	04
Fruit	X	√	X	√	-	√	X	√	X	X	X	√	X	X	√	X	√	09
Fruit content	X	√	√	-	-	√	√	X	X	√	√	√	X	√	√	√	X	05
L.S. of flower	X	√	X	-	-	X	X	-	√	√	√	√	√	X	√	√	X	06

TABLE 4.18L: Sub skill - Identifying the type of inflorescence and flower.

Major content area (key word of each question)	Students of Class XII.																	Number of students who have made wrong attempts
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	
Types of inflorescence	X	X	√	√	-	X	X	-	X	√	X	√	X	√	X	√	X	09
Essential parts	√	X	√	√	X	X	√	√	√	X	√	X	√	√	√	X	-	06
Stalk of flower	X	√	√	-	√	√	√	√	√	√	√	X	√	X	√	√	√	03
Stalk of inflorescence	X	X	√	-	√	√	X	X	√	√	√	X	√	√	√	X	√	06
Complete flower	X	√	√	√	X	√	√	√	√	√	√	√	X	-	√	√	√	03
Epicalyx	X	√	X	X	-	√	√	-	X	√	X	√	X	√	√	-	√	06
Cymose inflorescence	√	X	X	-	-	X	X	√	X	X	X	X	X	-	X	-	X	11
Hibiscus	√	X	X	-	-	√	X	-	√	X	√	√	X	X	√	X	√	07
Bract	√	√	X	X	X	√	X	√	X	√	X	X	√	X	√	X	X	10
Bisexual flower	X	X	X	√	X	X	X	X	X	√	X	X	√	X	X	X	√	13
Racemose inflorescence	X	√	√	X	√	X	X	-	√	X	√	X	X	X	X	√	X	10

TABLE 4.18M: Sub skill - Ability to distinguish between calyx and corolla.

Major content area (key word of each question)	Students of Class XII.																	Number of students who have made wrong attempts
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	
Lowermost whorl	X	X	X	√	X	√	X	√	√	√	√	X	X	X	√	X	√	09
Calyx composition	X	√	√	-	√	X	X	√	√	X	√	X	X	X	√	X	X	09
Second whorl	X	√	X	-	√	X	X	√	√	√	√	X	X	√	√	-	X	07
Corolla composition	√	√	-	-	√	X	√	√	√	√	√	√	√	√	√	-	√	01
Perianth	X	√	√	-	√	√	√	√	√	√	√	√	X	√	√	√	√	02
Free petals	√	√	X	-	-	X	√	√	√	√	√	√	-	X	√	X	X	05
Fused petals with stamen	-	X	X	-	-	X	X	X	X	√	X	X	X	X	X	X	X	13
Unit of perianth	X	√	X	-	-	X	X	√	√	√	√	X	X	-	√	X	-	07
Actinomorphic corolla	X	X	√	-	-	X	X	√	X	√	X	X	X	√	√	√	-	08
Pentamerous condition	-	√	√	√	-	X	X	√	√	√	√	√	√	√	√	√	√	02
Aestivation	-	√	X	-	-	X	-	√	X	X	X	√	X	X	X	√	√	08

TABLE 4.18N: Sub skill - Finding root system.

Major content area (key word of each question)	Students of Class XII.																	Number of students who have made wrong attempts
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	
Root	√	√	√	√	√	X	√	√	√	√	√	√	√	-	√	X	√	02
Tap root system	√	√	√	X	√	√	√	√	√	√	√	√	√	√	√	√	√	01
Monocot	√	√	√	X	√	√	√	-	√	√	√	√	√	√	√	√	√	01
Tap root growth	-	√	X	X	X	√	X	√	X	X	X	X	X	X	√	√	√	10
Adventitious roots	-	X	√	X	X	√	X	-	X	X	X	X	X	X	X	√	X	12

TABLE 4.18O: Sub skill - Identifying the type of leaf.

Major content area (key word of each question)	Students of Class XII.																	Number of students who have made wrong attempts
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	
Simple leaf	√	√	X	X	√	X	X	X	X	X	X	X	√	X	X	X	X	13
Venation	X	√	X	X	X	X	X	√	X	X	X	√	X	X	√	X	X	13
Stalk of leaf	X	X	√	√	√	√	X	√	√	X	√	√	X	X	√	√	X	07

TABLE 4.18P: Sub skill - Classification ability.

Major content area (key word of each question)	Students of Class XII.																	Number of students who have made wrong attempts
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	
Family	**X**	√	√	√	-	√	X	-	√	√	√	√	X	√	√	√	√	03
Botanical name	**X**	√	X	-	-	√	√	-	√	X	√	√	√	√	√	√	√	03
Polypetalae	√	√	X	-	-	X	X	X	√	√	√	√	X	X	√	-	X	07
Thalamiflorae	X	**X**	X	-	-	X	√	-	√	√	√	**X**	√	**X**	**X**	-	**X**	08
Gamopetalae	X	X	**X**	-	-	X	**X**	X	√	X	√	√	X	**X**	√	**X**	**X**	13

Table 4.18C highlights difficult keywords pertaining to the sub-skill of ability to sketch as seen under the microscope (12 students showed lack of knowledge pertaining to oil immersion lens and some in light control of the microscope).

Table 4.18D reveals difficult content areas pertaining to the sub-skill of observation and identification of stages of mitosis. More difficulty was observed in identification of the stages of interphase, anaphase and telophase.

Analysis of content knowledge in the sub-skill on preparation of fixatives reveals that 5 out of the class (16 students) have difficulties pertaining to fixative composition.

Table 4.18E shows the analysis of content questionnaire of practical 4 showing difficulties related to the sub-skill of preparation of fixatives. 5 students lack content knowledge in fixative composition. In the same practical, under the sub-skill of heating and use of spirit lamp, the students (14/15) lack knowledge in the use of spirit lamp and solvent. Within the sub-skill of ability to wash root there is lack of content knowledge regarding the structure of tip of the roots, washing of root tips and what to do with the used water.

In the practical 5 on the preparation of reagents, 3 to 5 students lack knowledge about molar and molal solutions and in practical 6 (Test for sugar and albumin) in the sub-skill, ability to infer, students lack knowledge about Benedict's reagent.

Table 4.18J shows that there are difficult content areas pertaining to floral formula and floral diagram of China rose. Sufficient knowledge is lacking regarding representation of stem axis (O), calyx, corolla, epipetalous stamens and T.S. of ovary.

Under the sub-skill of distinguishing between androecium, gynoecium and fruit difficult content areas are that of fruit, pistil, L.S. of flower, stamen, etc. (6 – 13 students reported to be lacking in these areas), cymose inflorescence, types of inflorescence, essential parts, stalk of inflorescence, bract, bisexual flower and racemose inflorescence.

Under the sub-skill of ability to distinguish between calyx and corolla, 7 – 13 students lack content on fused petals with stamens, 9 regarding lowermost whorl and

calyx composition, 8 regarding actinomorphic corolla and aestivation and 7 regarding unit of perianth. Content loopholes pertaining to tap root growth and adventitious roots also exist (10 – 12 students).

In the sub-skill of identifying type of leaf in practical 7, simple leaf and venation are not understood properly (13 students).

In Table 4.18P, students show lack of information or content back-up regarding taxonomic rankings and their meanings (about 7 – 13 students make content mistakes regarding Polypetalae, Thalamiflorae and Gamopetalae).

Table 4.19 shows results of general questionnaire administered based on 8 reasons commonly encountered for difficulty in skill attainment viz., that of lack of teacher competencies, lack of instructional strategies, lack of instruction materials; student background, information processing, lack of ability to solve problems, lack of content back-up and problems in language components. It is evident that the prime reasons for lack of skill attainment are that of lack of instruction materials (with this reason being cited in 34% cases) followed by lack of information processing (with this reason occurring in 33% cases), lack of content backup (with this reason being encountered in 25% cases) and student background (this reason occurring in 20% cases). An effort has been made hence to bring out a power point presentation on instructional strategies in the CD for the 1st reason encountered. For lack of content back up the CD has been updated with content feedback in the form of glossaries and flash cards and content related exercises such as crosswords and wordsearches. Crosswords and wordsearches in combination with visuals, concept maps and graphical representations of instructions are strategies to enhance information processing skills in the brain involving co-ordination of different functions of the brain. It is suggested that remedial interventions suggested should be made available to all irrespective of school/student background to bring about an overall improvement in student skill attainment.

Table 4.19: General questionnaire showing reasons (1-8) for difficulty in attainment.

Sl. No.	Student name	Reasons							
		1st sec (9)	2nd sec (12)	3rd sec (9)	4th sec (9)	5th sec (12)	6th sec (14)	7th sec (11)	8th se- (6)
01	Akash.F.Patil	01	00	06	00	01	04	04	00
02	Deepika. G. Prasad	02	03	03	05	05	03	03	00
03	Dhananjaya. K. N.	00	01	03	00	09	01	00	00
04	Dhaval. M. K.	03	01	05	04	06	07	03	01
05	Kezia. F	00	00	02	01	00	00	01	01
06	Milind	00	01	03	02	06	03	01	01
07	Nitin. N	01	02	03	01	02	05	05	00
08	Pratiksha	00	00	04	03	04	04	02	00
09	Saumya. T	00	01	04	02	06	03	02	01
10	Shambhavi	00	00	04	02	04	03	02	00
11	Shivaramakrishnan. B	00	00	02	03	06	00	02	00
12	Shreesha. S	00	00	02	01	00	00	04	01
13	Sujina. V	03	05	03	02	02	00	03	01
14	Soujanya	04	06	05	02	06	03	02	03
15	Swamy	01	01	00	01	02	02	01	00
16	Yashas	04	05	02	00	06	02	05	00
17	Jaimeer kaur	03	02	01	01	03	00	05	00
% Occurrence of each reason		14.37	13.72	33.98	19.60	33.33	16.8	24.06	8.82

* GENERAL QUESTIONNAIRE – Number of positive answers in each section. Number in the parentheses indicates the total number of questions given in each section.

***Foot note:**

1st sec – Teacher competencies.
2nd sec – Instructional strategies.
3rd sec – Lack of Instruction materials.
4th sec – Student background.
5th sec – Information processing.
6th sec – Lack of ability to solve problems.
7th sec – Lack of content back up.
8th sec – Problems in language components.

DISCUSSION

The major intention of the present project was to reidentify the difficulties for XII std. students in science practicals especially to identify the difficult skills and sub-skills and develop remedial interventions for each of these. We can sum up that practicals 2, 3, 4, 5 and 7 were found to be difficult with one, two, three, one and six difficult sub-skills respectively (refer Table 4.11). Practical 6 shows one difficult sub-skill and practical 3 shows 2 difficult sub-skills. For practical reasons, only 2, 3, 4 and 7 experiments were picked up for the development of Remedial Interventions and the content of the remaining two (viz., Practicals 5 and 6) were covered in a general way.

Difficult content areas and keywords for each of the difficult practicals and their sub-skills were identified by administering a content questionnaire. Analysis of content difficulties was carried out using check-lists (Tables 4.18A to 4.18P). These difficult content areas and keywords have been taken care of for remediation through quizzes, glossary, cross-words, word-searches and flash cards.

To circumscribe what kind of specific difficulty is faced in practical classes, a list of 8 general reasons generally encountered in labs were identified from literature surveys. A general questionnaire was prepared and administered to the students, which showed that lack of instruction materials, lack of information processing and lack of content back-up were the major culprits. Since content has been taken for upgradation through quizzes, glossary, cross-words, word-search items and preparation of flash cards; lack of instruction materials, auditory, visual processing and other comprehensive problems were tackled through the preparation of power-point presentation of instructions, graphical instructions and concept-maps and visuals for each of the difficult practicals mentioned above.

Preparation and Administration of the Remedial Intervention Programmes:

1) Literature has revealed that, generally science is not child centered – it has been our prime aim to make the teaching of lab skills student-centered and child-centered

through the employment of word-searches and cross- word activities thereby simplifying the task of content attainment and making it more interesting to the student. Key words are learnt here in a play-way method;

2) That science methods and processes do not provide motivation to the natural curiosity of children and this has been attended to by providing more visuals and graphics on the difficult practicals. This also makes information processing easier;

3) That there is lack of depth in curricular content – this is being attended to by providing an exhaustive glossary of key-words and instruction materials, the glossary is a kind of dictionary of terms within reach;

4) And that there is lack of experimentation, investigation and analysis. This is attended to by listing out project works pertaining to the different practicals, which in turn will also help in information processing and other psychomotor functions.

All the remedial interventions prepared have been brought out in the form of a package CD and also in the form of a brochure enclosed in this report. The package was applied on a sample of 5 (of 16) students taken up for re-identification of difficulties in XII standard students in science practicals. Remedial interventions of this kind could be used as an overall strategy of school science educational development. The projects, quizzes etc., give a thrust to science in daily life. We have already seen under literature review that it is difficult to answer the question as to which one of the strategies / methods of teaching are the most effective? That Shishta (1990) found blending strategies of different modes of teaching more useful has already been stated. A combination of all methods was used here as remedial interventions. Totally 10 remedial interventions were prepared viz.,

1) Concept maps.
2) Cross-word.
3) Flash cards.
4) Glossary.
5) Instructional graphics.
6) Power point presentations.
7) Quizzes.
8) Suggested project works.
9) Visuals.
10) Word search.

Results of the administered remedial intervention programme are given in the above tables 5.1 and 5.2.

For cross-word and word search activities, difficult terms and keywords of each practical were selected and built into these items.

All terms and keywords associated with each of the four difficult practicals were compiled into a glossary which has been arranged alphabetically.

Difficult concepts and terms were put in the form of questions (objective and short answer type) for the preparation of quizzes.

Some of the terms with definitions have been done up in the form of cards called flash cards that can be used for remedial teaching.

Select photographs pertaining to each of the practicals have been presented as visuals. Concepts involved in each of the 4 difficult practicals have been explained diagrammatically and termed concept maps.

The instructional methodology for the practicals have been improved using graphics – these are live diagrams with labels explaining the entire experimental procedure in a step wise fashion. Also, photographs of each step of experimental procedure were taken and developed using a computer into a power point presentation that can be readily comprehended by the students.

A CD containing the above remedial interventions viz., crosswords, wordsearches, glossary, quiz, power-point presentation of instructions, concept maps, visuals, project works suggested have been prepared and tagged at the end of this report. A copy of the remedial intervention programme in the form of a pamphlet including an additional item of flash cards for remedial teaching is appended herewith.

Validation of Remedial intervention programme:

Table 5.1: A Cumulative table showing percentage of obtained scores after the application of remedial interventions.

Sl. No.	Remedial Interventions / Name of the students	Cross word (Pr-2 & 3)	Word search (Pr-2 & 3)	Quiz (Pr-2 & 3)	Cross word (Pr-4)	Word search (Pr-4)	Quiz (Pr-4)	Cross word (Pr-7)	Word search (Pr-7)	Quiz (Pr-7)	Mean
1	Dhaval M. K.	0	23.07	21.87	77.7	33.33	64.70	8.3	25	12.5	29
2	Jaimeer kaur	41.6	69.23	56.25	100	0	64.70	33.33	18.75	45	47.65
3	Nitin N.	50	61.53	37.5	100	44.44	58.82	66.6	31.25	57.5	56.40
4	Shivaramakrishnan B.	25	46.15	31.25	100	66.66	35.29	33.3	25	32.5	43.90
5	Swamy S.	58.3	53.84	75	77.7	33.33	29.41	8.3	43.75	20	44.4
	Mean	34.98	50.76	44.37	91.08	35.55	50.58	29.96	28.75	33.5	

Table 5.2: A Cumulative table showing percentage of obtained scores after the application of remedial interventions.

Sl No.	Remedial Interventions	Diagnostic test values					Skill test values					Diagnostic test values (previous)					Skill test values (previous)				
	Name of the students	D2	D3	D4	D7	Mean	S2	S3	S4	S7	Mean	D2	D3	D4	D7	Mean	S2	S3	S4	S7	Mean
1	Dhaval M. K.	73.3	85.7	77.7	35.2	67.9	96.6	95.4	95.83	83.3	92.7	73.3	100	88.8	70.0	83.0	83.3	95.4	87.5	52.7	
2	Jaimeer kaur	40	85.7	72.2	11.7	52.4	100	95.4	79.1	80.5	88.7	-	-	-	-	-	-	-	-	-	
3	Nitin N.	46.6	71.4	61.1	41.1	55.0	86.6	100	70.8	69.4	81.7	86.6	85.7	94.4	70.0	84.1	90.0	77.2	79.1	72.2	
4	Shivaramakrishnan	66.6	57.1	72.2			93.3	95.4	100	83.3	93	66.6	78.5	72.2	70.0	71.8	96.0		75.0	69.4	
5	Swamy S.	33.3	0	0	0	8.3	93.3	95.4	95.8	86.1	92.6	73.3	100	83.3	58.8	78.8	90.0		79.1	66.6	
	Mean	51.9	59.9	56.5	27.0		93.9	96..	8	80.5		59.9	72.8	67.7	53.7	-	71.8	71.	64.1	52.1	

REMEDIAL INTERVENTION PROGRAMME FOR SELECT DMS STANDARD XII BOTANY PRACTICALS.

By

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And

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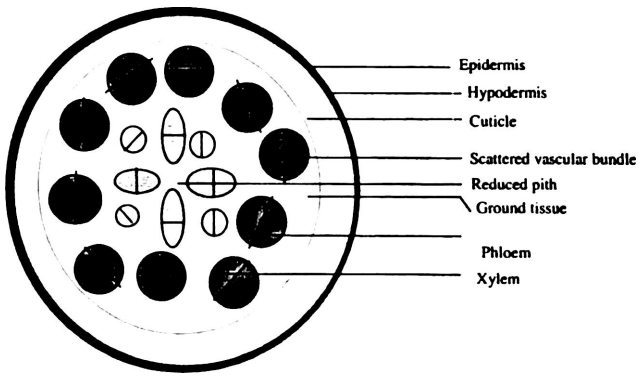
RIE, MYSORE – 06.

April 2005.

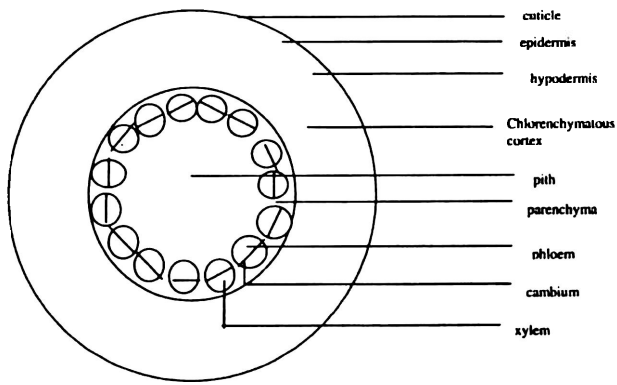
INTERVENTION 1: CONCEPT MAPS

CONCEPT MAP OF T.S. OF MONOCOT STEM

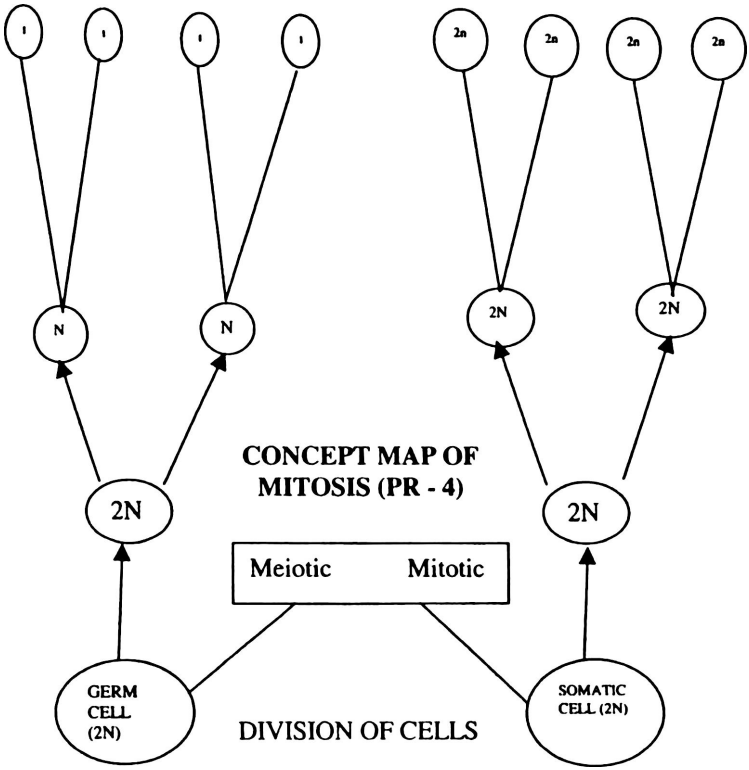


PR.2. OBSERVATION OF A TEMPORARY MICROPREPARATION OF MONOCOT STEM

CONCEPT MAP OF T.S. OF DICOT STEM



PR. 3. MAKING A TEMPORARY MICROPREPARATION OF DICOT STEM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CONCEPT MAP OF
MITOSIS (PR - 4)
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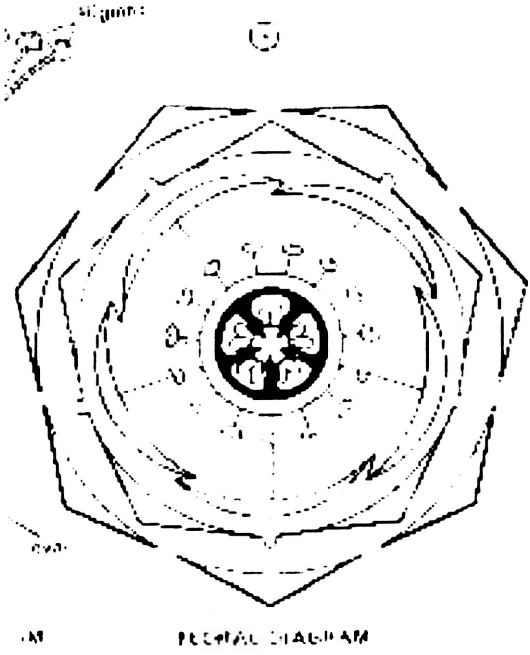
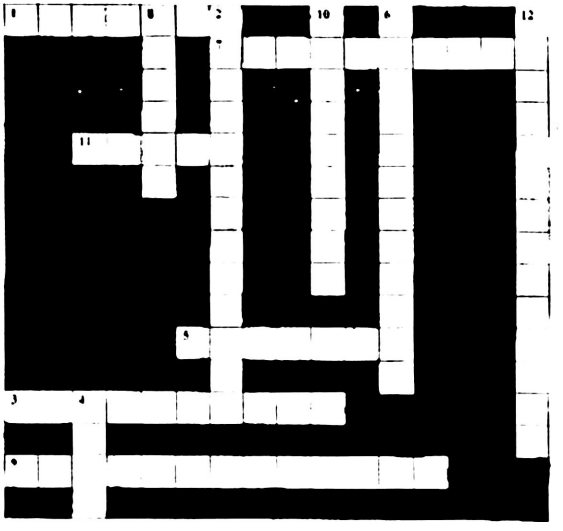
2N
Meiotic
Mitotic
GERM
CELL
(2N)
SOMATIC
CELL (2N)
DIVISION OF CELLS



⊕ ♀, Epi $_{(10)}$, K $_{(5)}$, $\overline{\text{C}_{(5)}, \text{A}_{\infty}}$, G $_{(5)}$

INTERVENTION 2: CROSS-WORD

CROSS WORD FOR PRACTICALS 2 & 3.



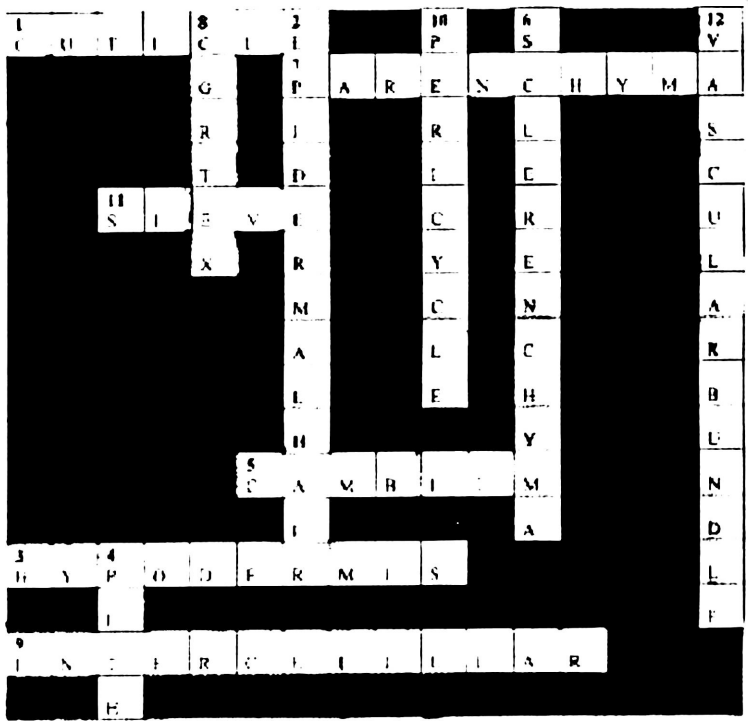
Across:

1. Outer most layer of single row of cells (7).
3. Layer of cells below the outermost layer in all cross-sections (10).
5. Meristematic tissue in vascular bundle responsible for secondary growth (7).
7. Thin walled cells of the cortex with chloroplast or starch (10).
9. Between cells (13).
11. Cells found in phloem (5).

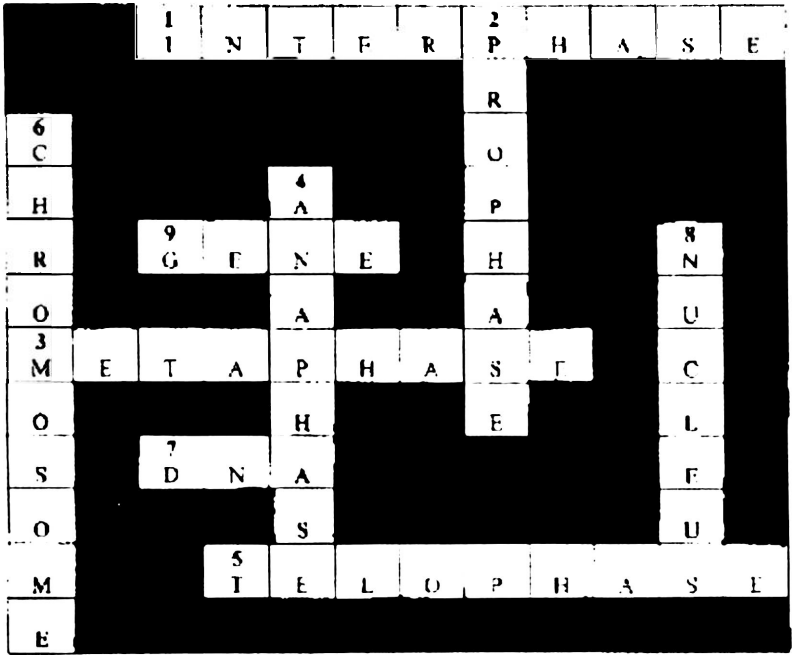
Down:

2. Appendages on the outermost layer (13).
4. Central tissue in cross section of stem (4).
6. Lignified tissue made up of dead cells responsible for giving mechanical support (12).
8. Several layers of cells between epidermis and endodermis (6).
10. Single layer of thin walled cells forming outermost layer of stele (9).
12. Tissue made up of xylem and phloem responsible for conduction(14).

ANSWERS OF CROSSWORD FOR PRACTICALS 2 & 3.



ANSWERS OF CROSS WORD FOR PRACTICAL 4.



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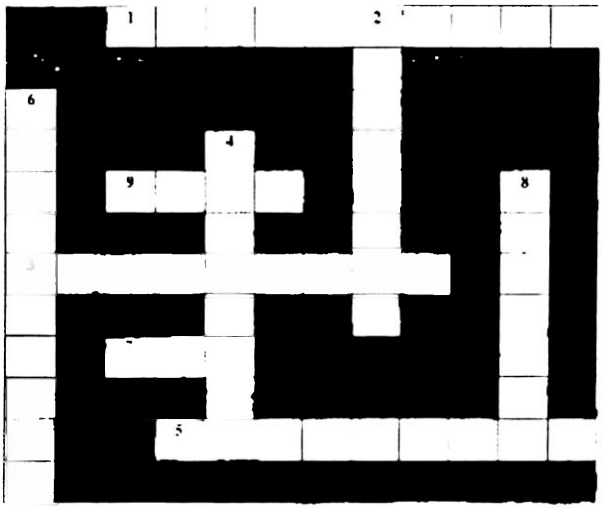


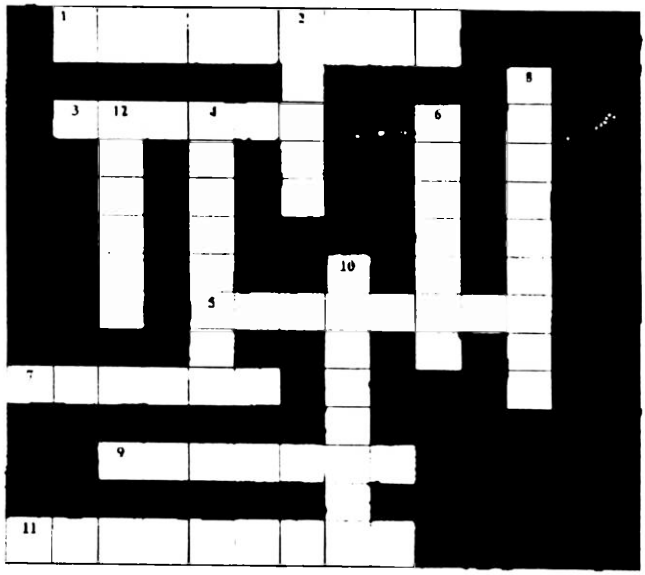
Across:

1. Stage prior to actual mitotic cycle (10).
3. Stage in which centromeres of the chromosomes are arranged on the equatorial plate (9)
5. Stage in which chromosomes increase in length and become thread like (9).
7. Bearer of hereditary information (3)
9. Segment of DNA double helix (4).

Down:

2. Stage in which chromosomes become coiled and shortened (8).
4. Stage in which centromere of each chromosome gets split into two (8).
6. Group of nuclear body made up of DNA and histone proteins (10).
8. Membrane bound organelle containing DNA of eukaryotic cells (7).

CROSS WORD FOR PRACTICAL – 7.



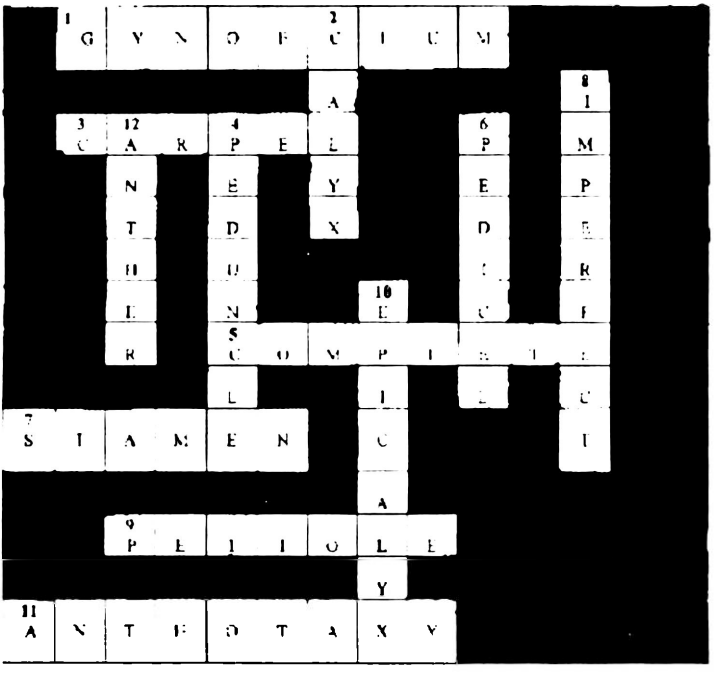
Across:

1. Female reproductive whorl of a flower (9).
3. Component of the Gynoecium (6)
5. A flower with all four whorls (8).
7. Unit of Androecium (6).
9. Stalk of a leaf (7).
11. Type of arrangement in an inflorescence (9).

Down:

2. Outermost whorl of a flower (5).
4. Stalk of the inflorescence (8).
6. Stalk of a flower (7).
8. Unisexual flower (9).
10. Sepaloid green bracteoles just below the calyx (8).
12. Swollen terminus of a stamen (6).

ANSWERS FOR CROSS WORD OF PRACTICAL – 7



INTERVENTION 3:
FLASH CARDS

COLLENCHYMA

A simple permanent tissue with physiological and mechanical functions.

CLOSED VASCULAR BUNDLE

A vascular bundle without cambium as seen in monocot stems.

ANAPHASE

The stage in mitosis in which the two chromatids of each chromosome are separated and move towards the respective poles of the spindle.

CHROMOSOME

Thread like entities found in nucleus of all eukaryotes. They are made up of DNA and proteins.

CALYX

The outermost whorl of a flower made up of units called sepals.

ASYMMETRICAL

Refers to the symmetry of a flower. Such flowers cannot be cut into two equal halves in any plane.

INTERVENTION 4: GLOSSARY

GLOSSARY

A

Å: Abbreviation for an Angstrom, 0.0001 of a micron.
Acentric: Chromosomes, which lack centromere.
Acrocentric: A type of chromosome where the centromere is almost at one end of the chromosome.
Actinomorphy: Regular floral symmetry where a flower can be cut into two equal halves in more than one plane.
Adventitious root system: Roots, which develop from stems or leaves.
Aerenchyma: Modified parenchyma where there are large intercellular spaces to store air which function in gas exchange.
Aggregate fruits: Fruits developing from the apocarpous gynoecium of a flower.
Albuminous cells: A cell in the phloem that is connected to a sieve cell by numerous plasmodesmata.
Aleurone: A layer of tissue between seed coat and endosperm in the monocotyledonous seeds. It contains aleurone protein crystals in its cells.
Allosomes: Also called sex chromosomes. These chromosomes have a direct role to play in determining an organisms sex.
Amitosis: Nuclear division or cell division (as in prokaryotes) that does not follow the pattern of mitosis.
Anaphase: The stage in mitosis in which the two chromatids of each chromosome are separated and move toward the respective poles of the spindle.
Anatomy: The science of study of internal structure of organs, also called internal morphology.
Androecium: The male reproductive whorl of a flower consisting of units called stamens.
Androphore: The second internode between corolla and androecium in the thalamus of a flower.
Angiosperm: A fruit bearing plant. The fruit develops from the ovary of the flower.
Annuals: Herbaceous plants that live for a year or less than a year.
Annulus: A row of uniquely thick walled cells of the sporangial wall in ferns, that helps in the dehiscence of the sporangium.
Anther: The swollen terminus of a stamen which produces pollen grains.
Anthotaxy: The types of flower arrangement in an inflorescence.
Asexual reproduction: A type of reproduction which does not involve gametes.
Asymmetrical: refers to the symmetry of a flower. Such flowers cannot be cut into two equal halves in any plane.
Atactostele: The condition seen in monocot stems where the vascular bundles are scattered.
Autogamy: Also called self pollination, it is the transfer of pollen from anther to the stigma of the same flower.
Autopolyploid: Polyploids with chromosomal sets of single species.

Autosome: Chromosomes not directly involved in sex determination. A human cell has 44 autosomes.
Autumn wood: Secondary xylem or wood with small sized vessels produced during autumn season.
Axial bundle: a major vascular bundle in the shoot or root.
Axillary bud: A bud present in the axil of leaf. It can produce stem, flower or an inflorescence.
Axillary bud primordium: arises in the axil of a leaf primordium.

B

Bark: The external group of tissues, from the cambium outwards, of a woody stem or root.
Bast: A term used as a synonym for the phloem tissue.
Bicollateral bundle: contains one mass of xylem and two masses of phloem, one toward the interior and one toward the exterior.
Blade: Refers to leaf lamina which is effective in capturing sunlight for photosynthesis.
Botany: A branch of biology dealing with structure, growth, reproduction and life cycle of plants.
Bract: A modified leaf from the axil of which arises a flower or an inflorescence.
Bud: An underdeveloped shoot, largely meristematic tissue, generally protected by modified scale-leaves.
Budding: An asexual process of reproduction where an offspring is produced as an outgrowth of the parent.
Bulb: Short, flattened or disc shaped underground stem, with many fleshy scale-leaves filled with stored food.
Bulbil: A multicellular structure that assists in vegetative reproduction.
Bundle sheath: the layer of tightly packed cells that surround the vascular tissue in leaves.
Bundle sheath extension: a group of cells that connect a vein to the epidermis in a leaf.

C

Callus: an irregular proliferation of cells.
Calyx: The outermost whorl of a flower made up of units called sepals.
Cambium: A type of lateral meristem that causes secondary growth.
Carpels: Components of the gynoecium of a flower (referred to also the pistil or female part of a flower). The carpel produces ovary, style and stigma. a simple pistil consists of one carpel and a compound pistil consists of fused carpels.
Casparian strip: A waxy band encircling an endodermal cell along its radial walls.
Cell: An organized unit of protoplasm, bounded by a membrane or wall, and usually divisible into a nucleus and cytoplasm.
Cell wall: a rigid layer of cellulose and other polysaccharides, proteins and sometime lignin on the outside of the plasma membrane of a plant cell.

Cellulose: the structural (microfibrillar) portion of the plant cell wall. Cellulose is a polymer of glucose.
Centriole: A cytoplasmic organelle from which microtubules of the mitotic spindle appear to originate.
Centromere: A zone (centromeric zone) present at the primary constrictions of chromosomes, which are necessary for the anaphasic movement of the chromosomes.
Chlorenchyma: Modified parenchyma tissue for photosynthesis.
Chloroplast: contains chlorophyll, internal membranes organized as grana, specialized for photosynthesis.
Chromatid: One of the two longitudinal halves that make up a chromosome during prophase and metaphase.
Chromonema: One of the thread like, DNA-bearing structures within the nucleus, which give rise to the chromosomes during mitosis; an interphase chromosome.
Chromonemata: Thread like structural units of the chromosomes made up of DNA and proteins.
Chromoplast: contains red, orange, or yellow carotenoid pigments impart color to fruits, etc.
Chromosomes: Thread like entities found in nucleus of all eukaryotes. They are made up of DNA and proteins.
Cladode: a stem that is leaf-like in appearance.
Class: In taxonomy a hierarchy of related orders.
Closed Vascular bundle: A vascular bundle without cambium as seen in monocot stems.
Collateral Vasculature: A type of conjoint vascular bundle where phloem is external in location with reference to the xylem.
Collenchyma: A simple permanent tissue with physiological and mechanical functions.
Companion cells: a cell in the phloem that is connected to a sieve-tube member by numerous plasmodesmata.
Complete flower: A flower with all four whorls – sepals, petals, stamen and carpels.
Concentric bundle: A type of vascular bundle where xylem fully encloses phloem or vice versa.
Conjoint: A term referring to vascular bundles where in a vascular bundle xylem or phloem are the same radius.
Cork: Also called phellem it is a dead tissue of suberized cells produced as a result of extra stelar secondary growth.
Cork cambium: A secondary meristem also called phellogen which is the cause for extra stelar secondary growth.
Cortex: A peripheral zone of all roots and dicot stems. The epidermis/epiblema is the outermost part and endodermis is the inner most part.
Costa: The prominent vein or mid rib found in the leaf blade of lamina.
Cotyledon: The embryonic leaf or a pair of embryonic leaves found in seeds.
Cuticle: A waxy layer surrounding the outer wall of the epidermis.
Cytoplasm: The non-nuclear part of protoplasm.

D

Dermal tissue system: Tissues derived from the protoderm or cork cambium that cover the surface of the plant body. The dermal tissues are complex (composed of several cell types).

Dichogamy: A condition in a bisexual flower where the androecium and gynoecium matures at different times.

Dicotyledonae: A class of flowering plants (Angiosperm) having seeds with two cotyledons, flower parts in fives or multiple of fives and reticulate venation in leaves.

Dictyostele: a siphonostele with numerous leaf gaps; superficially appears to be composed of vascular bundles.

Dioecious: A situation where plants are either male flower bearing or female flower bearing.

Diploid: A condition where the nucleus has two sets of chromosomes. Often written as 2n.

DNA: Deoxyribonucleic acid, the bearer of hereditary information.

E

Embryo: An early stage in the development of an organism which begins with the first division of the zygote.

Endarch: A term associated with arrangement of protoxylem (towards center of stem). The condition is a result of the centrifugal development of primary xylem.

Endodermis: A layer of specialized cells in many roots and some stems, delimiting the inner margin of the cortex.

Endosperm: a triploid nutritive tissue that develops in the ovule, may be absorbed by the before the seed matures.

Epiblema: The outermost layer of parenchyma cells in root which becomes the functional outer layer when the piliferous layer is sloughed off as the roots increase in age.

Epicalyx: A whorl of bracteoles developing on the calyx.

Epidermis: The characteristic outermost tissue of leaves and of young roots and stems.

Epigynous: Having the perianth and stamens attached at or near the top of the ovary, rather than beneath it.

Epipetaly: The condition where stamens develop from a gamopetalous corolla.

Etaerio: A type of fruit that develops from the apocarpous gynoecium of a flower.

Euchromatin: It is the genetically active regions of the chromonemata (chromosomes) that is uncoiled at prophase and highly coiled at metaphase stage of cell division.

Eustele: The arrangement of vascular bundles in one ring surrounding the pith as seen in dicot stems.

Exarch: A condition of primary xylem found in roots. The protoxylem is away from the center and metaxylem is towards the center of the root. It is a result of the centripetal direction of development of primary xylem.

F

Family: An assemblage of related genera in a taxonomical hierarchy.
Fascicular cambium: Arises within vascular bundles.
Fertilization: The process of gametic fusion to produce a diploid cell, the zygote.
Fibre: An elongated sclerenchyma cell with thick lignified that provides mechanical strength and many fibres are of commercial value like ramie and cotton fibres.
Fiber tracheid: A cell in the xylem that is intermediate between a tracheid and a libriform fiber.
Filament: stalk-like portion of the stamen.
Flora: Plants of a particular geographical region.
Floral organs: modified leaves specialized for reproduction.
Fruit: A ripened ovary very often produced by fertilization containing seeds. Fruits protect seeds and aids seed dispersal.
Funiculus: The stalk that attaches a seed to the inside of a fruit.

G

Gene: A segment of a DNA double helix that governs the hereditary characteristics of an organism.
Genetics: The branch of science dealing with the study of gene structure, function and patterns of gene transmission.
Genome: One complete set of chromosomes, i.e., a chromosome complement.
Genotype: Refers to the genetic constitution or genetic makeup of an organism.
Ground tissue system: Tissues derived from the ground meristem. All are simple tissues composed of a single type of cell, which is named after the tissue.
Growth: A complex sequence of event like cell division, cell elongation and tissue differentiation often accompanied by build up of protoplasmic mass.
Guard cells: cells that surround and control the size of stomatal pores.
Gymnosperms: A group of primitive seed plants where seeds are not enclosed in a fruit.
Gynoecium: It is the female reproductive whorl of a flower. It is also called a pistil and has units called carpels.
Gynophore: The third internode between androecium and gynoecium in the thalamus of a flower.

H

Haploid: A nucleus with one set of chromosomes often written as n.
Hemicellulose: the alkali-soluble portion of the cell wall matrix.
Hydathode: a structure in the margins of leaves that secretes water.
Hypocotyl: The part of the embryo below the cotyledons. The hypocotyl produces the root.
Hypodermis: A layer or layers of cells beneath the epidermis that is derived from the ground meristem, but distinct in appearance from adjacent ground tissue. May be called an *endodermis* if it has a Casparian strip.
Hypogeal: A pattern of seed germination where the cotyledons remain in the soil.

I

Imperfect flower: Flower that is unisexual. Such flowers have either androecium or gynoecium.
Incomplete flower: A flower where one of the whorl is missing.
Integuments: Protective covering of the ovules.
Intercalary meristem: Meristems found at the base of internode or leaf bases mainly responsible for vertical growth.
Interfascicular cambium: arises between vascular bundles.
Internode: The region between two nodes along a stem.
Intrafascicular cambium: It is the primary cambium found in the vascular bundle.
Irregular: A term applied to flowers that cannot be cut into two equal halves in any plane.

K

Karyokinesis: The first stage in eukaryotic cell division in which the nucleus divides into two nuclei.
Kingdom: A level of taxonomic hierarchy that groups together members of related divisions or phyla.

L

Lateral meristem: Meristems responsible for lateral growth like the cambium and cork cambium.
Lateral root primordium: Arises in the pericycle.
Leaf: A lateral appendage of the stem produced by the shoot apical meristem.
Leaf dimorphism: Leaves of two distinct types produced by the same plant
Leaf gap: In a siphonostele, a break in the vascular cylinder above the point where a leaf trace arises.
Leaf primordium: Arises at the shoot apical meristem.
Leaf trace: A vascular bundle that connects a leaf to the axial vascular system.
Lenticel: A region of the periderm where cells are loosely packed, allows gas exchange.
Libriform fiber: A cell in the xylem that is very long and thin and has simple pits, sometimes called "**xylary fibers**" to distinguish them from extraxylary fibers, which look similar, but have a different evolutionary origin.
Lignin: An aromatic polymer that rigidifies many secondary cell walls. Lignin is stained red by phloroglucinol solutions.
Lithocysts: Literally translated "rock cells", cells containing a granule of calcium carbonate called a **cystolith**.
Locule: A cavity containing ovules, in a compound ovary there is one locule per carpel.

M

Medulla: Also called pith. It is the core or central zone seen commonly in monocot roots and dicot stems.
Meristem: A type of tissue where the cells have retained their ability to divide.

Meristematic region: A general zone in which cell division is frequent.
Mesophyll: A type of chlorenchyma tissue found in the leaf lamina for the function of photosynthesis.
Metacentric: A type of monocentric chromosomes where the centromere is located at the center of the chromosome.
Monera: The taxonomic kingdom comprising prokaryotes like bacteria, cyanobacteria and mycoplasma.
Monocotyledonae: A class of flowering plants characterized by seeds with a single cotyledon floral parts in 3's, parallel veins in leaves.
Monoecious: Having both male and female parts on the same plant.
Morphology: The branch of biology that studies form and structure of organisms.

N

Nodes: The regions of the stem from where leaves develop.
Nucleus: The large membrane bound organelle containing DNA of eukaryotic cells.

O

Oil cavities: A cavity lined with cells that secrete oils.
Open Vascular bundle: A vascular bundle with cambium between the xylem and phloem.
Order: A level of taxonomic hierarchy of related families.
Organelle: A specialized part of a cell having some particular function.
Organism: A living entity able to maintain its organization obtain and use energy, reproduce, grow and respond to stimuli.
Ovary: The portion of the pistil that bears the ovules.
Ovule: An embryo sac with egg surrounded by nucellus and two integuments.
***Embryo sac*:** The eight-celled megagametophyte of flowering plants.
***Integuments*:** The outer protective layer of the ovule.
***Micropyle*:** An opening in the integuments through which a pollen tube enters.
***Nucellus*:** The inner nutritive layer of the ovule.

P

p-protein: A stringy protein within sieve elements that blocks sieve plate pores when the sieve tube is damaged.
Palisade mesophyll: The region of ground tissue in a leaf where the chlorenchyma cells are elongated and arranged perpendicular to the epidermis, usually in the upper half of the leaf.
Parenchyma: A simple, permanent tissue with physiological function. The main function is food storage.
Pedicel: A stalk of the flower.
Perfect flower: Flowers which have both androecium and gynoecium.
Perforation plate: The end wall of a vessel element where the secondary cell wall was not deposited and the primary cell wall has been digested.

Pericycle: A tissue that constitutes the outermost part of the stele from which lateral roots and vascular cambium develop.
Periderm: The cork cambium and the tissues it produces, outer bark.
Petal: Interior to sepals, usually conspicuous to attract pollinators.
Phloem: The photosynthate-conducting tissue of plants.
Phyllode: A leaf that consists of an enlarged midrib and lacks blades.
Phyllotaxy: The pattern of leaf initiation at the apical meristem.
Pistillode: A sterile or nonfunctional gynoecium or pistil.
Pistil: Innermost, bears the ovules, may occur singly or in clusters.
Pit: A region where the secondary cell wall is absent, but the primary cell wall is present.
Pith: Ground tissue in the center of a stem.
Plasmodesma(ta): Cytoplasmic channels lined with plasma membrane that connect the protoplasts of adjacent cells across the cell wall.
Plastids: A group of organelles characterized by a double membrane envelope and a complex of internal membranes. Plastids contain DNA and replicate autonomously.
Pollen: The male gametophyte, includes two cells:
***Tube nucleus*:** Located within the tube cell.
***Generative cell*:** Divides to form two sperm.
Pollen sac: One of four cavities in an anther that contain pollen.
Polyarch: A protostele with many arms of xylem, most common in monocots.
Polysaccharide: A polymer composed of sugars.
Primary cell wall: A cell wall layer deposited while a cell is growing; typically extensible.
Primary meristem: A meristem that is present in the embryo of a plant; generally responsible for increase in the length of plants
Primary meristematic tissue: A group of cells beneath the apical meristem that has become distinct in appearance from neighboring groups of cells, a precursor to one of the tissue systems:
procambium: develops into the vascular tissue system.
protoderm: develops into the dermal tissue system.
ground meristem: develops into the ground tissue system.
Primordium: A cell or organ in its initial stage of development.
Proplastids: Specialized for dividing to form new plastid, usually found in meristematic cells.
Protostele: A single central vascular bundle.

R

Radial vasculature: The arrangement of xylem and phloem in different radii. A feature seen in the roots.
Receptacle: The tip of a floral stem supports the floral organs.
Regular: A term applied to flowers that can be cut into two equal halves in one plane or
more than one plane.
Residual procambium: Procambium located between mature xylem and phloem.

Resin duct: A tube lined with cells that secrete resin.
Rhizome: An underground stem.
Root: The portion of a plant axis produced by the root apical meristem.
Root apical meristem: A meristem located at the apex of a root.
Root hairs: Elongated unicellular extensions from outer surface of roots which help in water absorption.
Root nodules: Structures that develop on the roots of plants that form symbiotic associations with nitrogen-fixing bacteria.

S

Sclerenchyma: A simple tissue made up of dead cells with lignified secondary walls. Sclerenchyma is represented by fibres and sclereids, which provide mechanical strength.
Secondary cell wall: Innermost layer of a cell wall deposited after cell enlargement has ceased, often lignified.
Secondary meristem: A meristem that arises from tissues produced by a primary meristem; generally responsible for increase in thickness of plants
Secondary phloem: Photosynthate-conducting tissue produced by the vascular cambium
Secondary vascular bundles: Vascular bundles that do not develop from procambium.
Secondary xylem: Water-conducting tissue produced by the vascular cambium
Seed: A mature ovule, includes:

- ***embryo:*** a young plant present in the seed before germination.
- ***radicle*:** the root portion of the embryo.
- ***plumule*:** the shoot portion of the embryo.
- ***cotyledon*:** the first leaves of an embryo, may or may not resemble true leaves.
- ***coleorhiza*:** in monocots, a sheath that covers the radicle.
- ***coleoptile*:** in monocots, a sheath the covers the plumule.

Seed coat: The outermost layer of a seed, develops from the integuments.
Sepal: Outermost and most leaf-like, usually encloses the rest of the flower in the bud.
Shoot apical meristem: A meristem located at the apex of a shoot.
Sieve cell: A sieve element that lacks perforation plates, characteristic of gymnosperms.
Sieve element: A conducting cell in the phloem.
Sieve plate: The end wall of a sieve-tube element that is perforated by sieve plate pores.
Sieve plate pore: Enlarged plasmodesmata that perforates a sieve plate.
Sieve tube: A long tube of sieve elements (also called sieve tube members) connected by sieve plates.
Sieve-tube member: A sieve element with perforation plates, characteristic of angiosperms.
Silica cells: Cells in the epidermis of grasses that contain silica deposits.

Siphonostele: A cylinder of vascular tissue with a central parenchymatous pith.
Spine: A stem or leaf modified for protection.
Spongy mesophyll: The region of ground tissue in a leaf where parenchyma cells are branched and intercellular air spaces are extensive, usually in the lower half of the leaf.
Stamen: It is the unit of androecium; typically, a stamen has filament, anther lobes and connective.
Staminode: A sterile and non-functional stamen.
Stele: The arrangement of vascular bundles in roots and stems.
Stem: The portion of a plant axis produced by the shoot apical meristem.
Stigma: The portion of the pistil that receives the pollen.
Stomate (plural: stomata): An opening defined by pairs of guard cells that controls gas exchange and water loss.
Style: It is the part of the pistil that joins the ovary and the style.
Subsidiary cells: Cells adjacent to guard cells that are distinct in appearance from ordinary epidermal cells.

T

Tannins: Phenolic compounds than complex with protein; function in plant defense.
Tap root system: An anchoring system produced from the radicle of the embryo. It has a main root and many lateral roots.
Tapetum: A layer of nutritive cells that lines the pollen sac.
Taxonomy: The science of classifying and grouping organisms on the basis of their morphology and evolution.
Tendril: A stem of leaf modified to coil around other plants or objects.
Thalamus: A condensed stem from the nodes of which different parts of a flower develop.
Tissues/tissue systems: Groups of cells that share a similar function, such as transport (vascular tissue) or protection (dermal tissue).
Tracheary element: A conducting cell of the xylem characterized by an elongated shape and lignified secondary cell wall.
Tracheid: A tracheary element that lacks perforations plates, water flows from between tracheids through pits.
Trichomes: Cells that project from the surface of the epidermis.
Tuber: A swollen underground stem, such as a potato.

U

Unicellular: The description of an organism, where the cell is the organism.

V

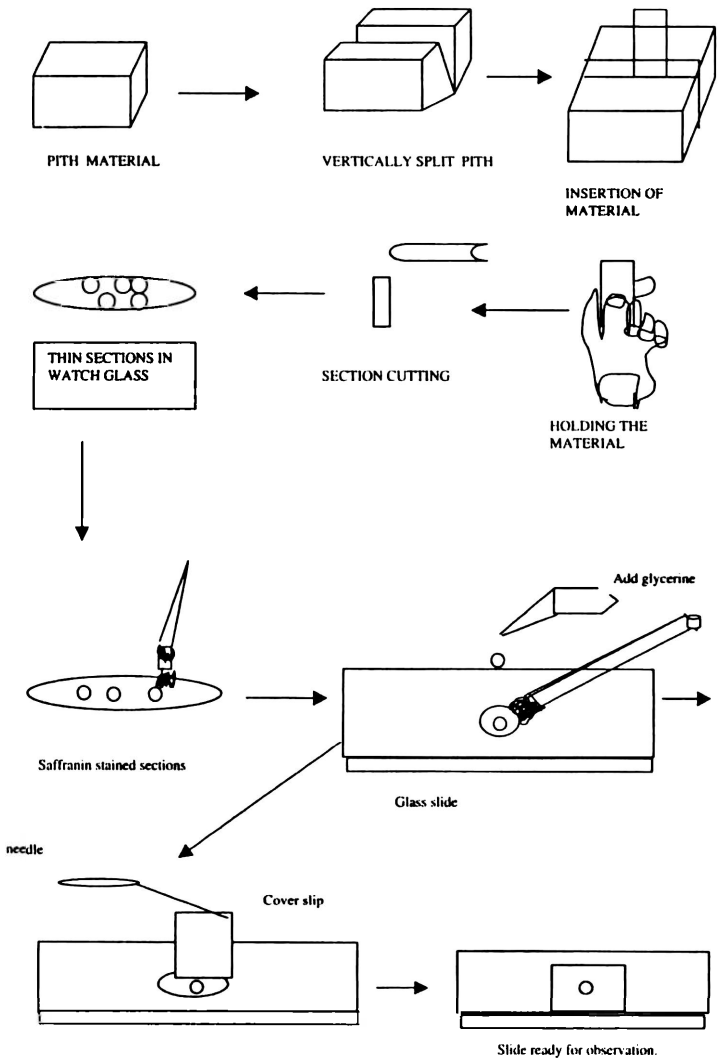
Vacuole: A large organelle found in the center of a plant cell.
Vascular bundle: The structural association of xylem and phloem.
Vascular cambium: Also called stelar cambium that causes stelar secondary growth.

Vascular tissue system: Tissues derived from the procambium or vascular cambium that transport water and photosynthate. The vascular tissues are complex (composed of several cell types).
Vein: A vascular bundle in a leaf.
Velamen: A multistratose epidermis found in aerial roots.
Vessel: A long tube of vessel elements connected by perforation plates
Vessel element: A tracheary element with perforation plates.

X

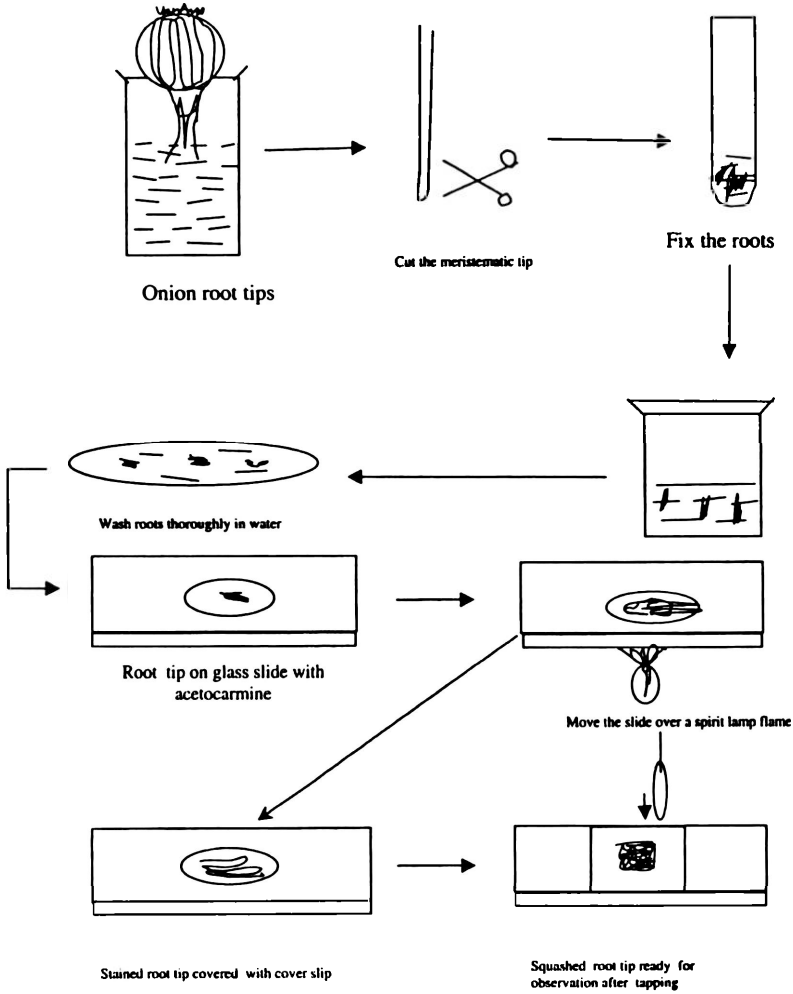
Xylem: The water-conducting tissue of plants.

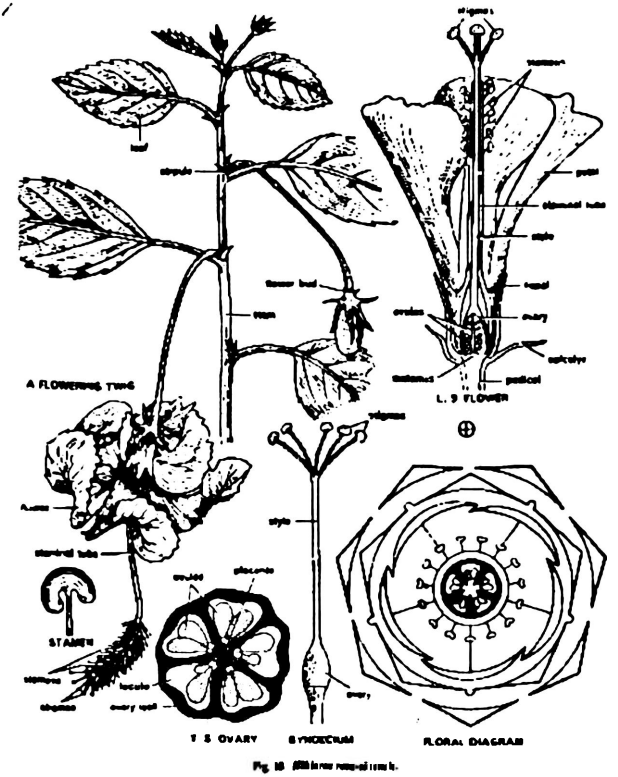
INTERVENTION 5: INSTRUCTIONAL GRAPHICS



INSTRUCTIONAL GRAPHICS FOR THE TEMPORARY PREPARATION OF TRANSVERSE SECTION OF DICOT STEM MATERIAL.

INSTRUCTIONAL GRAPHICS FOR THE STUDY OF MITOSIS EXPT.





INSTRUCTIONAL GRAPHICS FOR THE STUDY OF TAXONOMIC DESCRIPTION OF CHINA ROSE PLANT.

INTERVENTION 6: POWER POINT PRESENTATIONS

Practical 1.

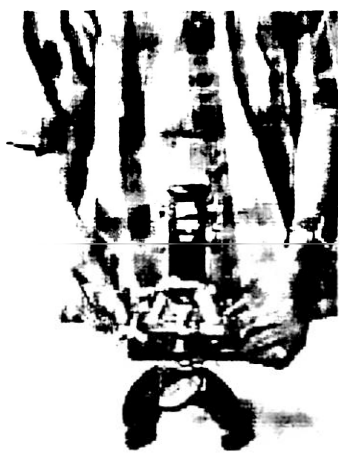
Observation of permanent slide of monocot stem.
Photography: Johnsheen. A., RIEM.

Step 1.

- Select a good permanent slide of transverse section of monocot stem. Clean it with a cloth to free it from finger prints and dust

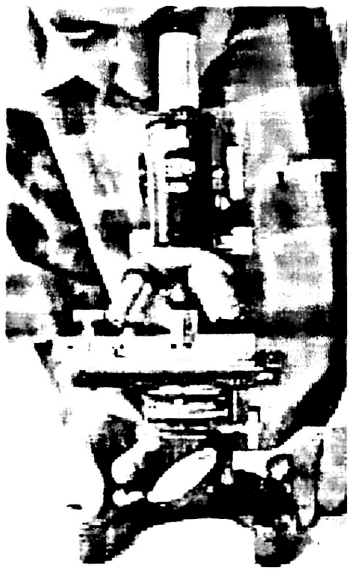
Step 2.

- Fix the permanent slide on the stage with the help of clips.



Step 3.

- View through the eye-piece, using the low power objective first.

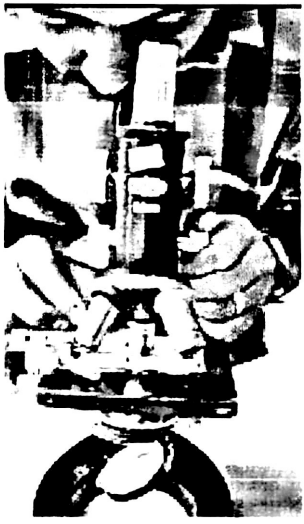


Step 4.

- Using coarse adjustment, first focus the slide.

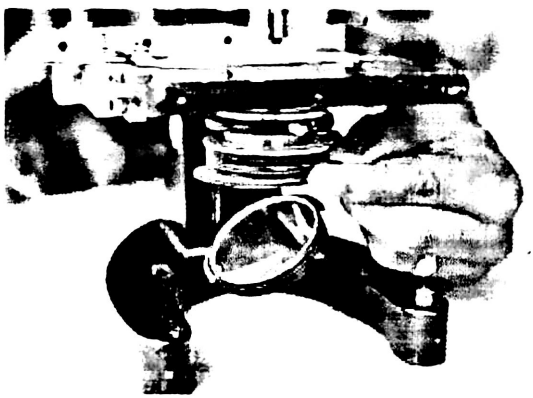
Step 5.

- For finer details, adjust the focus with fine adjustment.



Step 6.

- Control the light with the help of diaphragm.



Step 7.

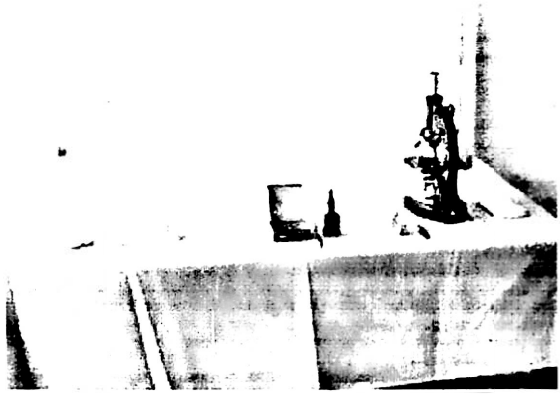
- Change the objective to high power objective lens (40x) for finer details.
- Take care that the objective should not touch the slide.

Practical 2.

- Making Transverse section of dicot stem and study of different tissues under microscope.
- Photography: Johnsheen. A., RIEM.

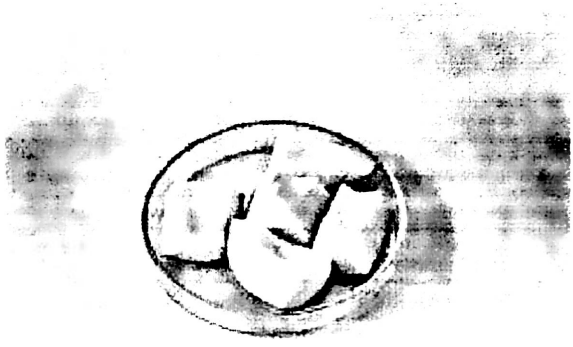
Step 1.

- The experimental set-up.



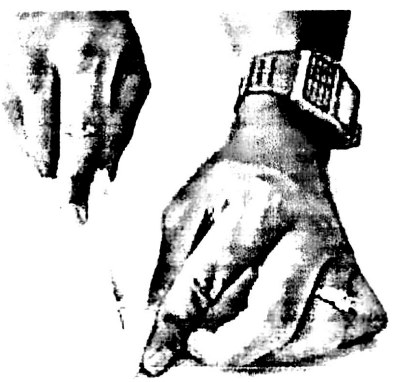
Step 2.

- Papaya as pith material.
- Also Carrot, Radish, Potato etc. can be used as pith material.



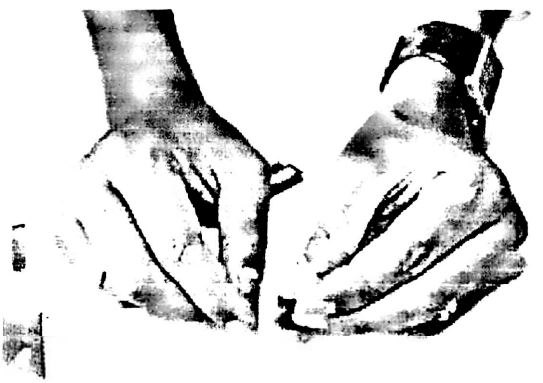
Step 3.

- Make a slit at the center of the pith material with the help of a knife or scalpel.



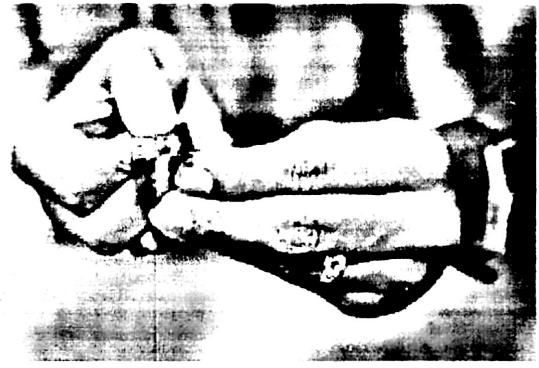
Step 4.

- Insert the stem material to be sectioned in the slit made in the pith material.
- Hold the pith material with both thumb and fore finger.



Step 5.

- Hold the blade in the right hand horizontal to the pith material.



Step 6.

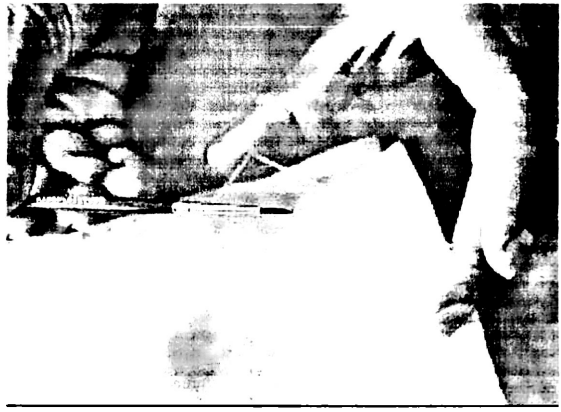
- Take transverse sections of the stem material.

Step 7.

- Collect sections in a watch glass filled with water.

Step 8.

- Stain the sections using few drops of Saffranin stain.



Step 9.

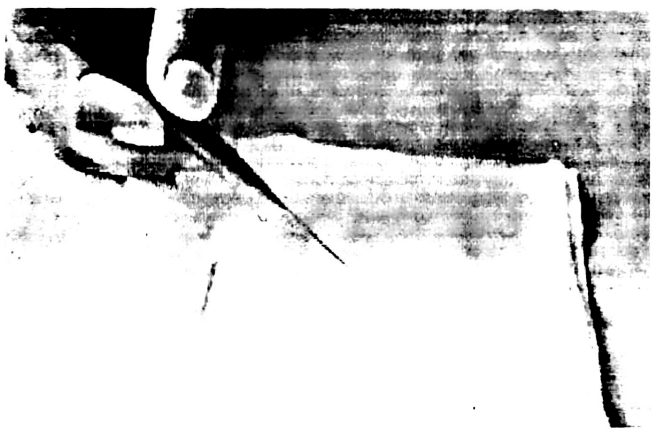
- Select a good section on a clean glass slide with the help of a brush.

Step 10.

- Put two drops of glycerine over the section.

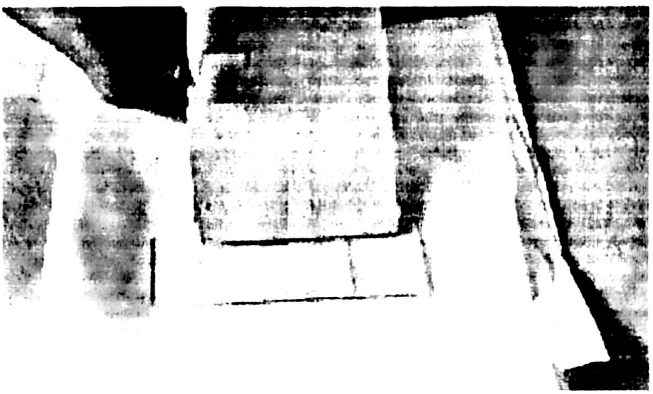
Step 11.

- Hold the cover slip with the help of a needle in a slanting position, in order to avoid air bubbles and cover the preparation with cover slip.



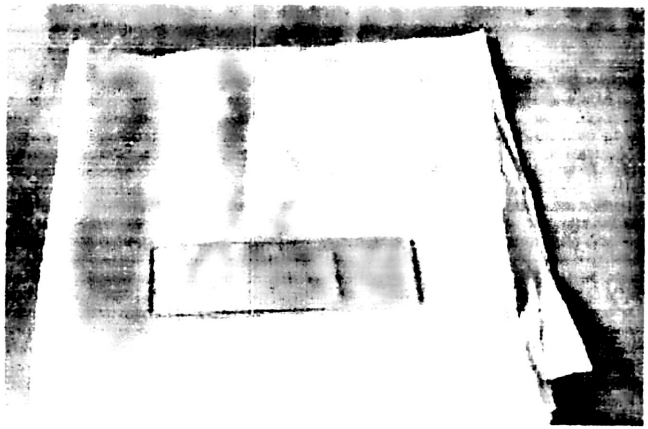
Step 12.

- Blot the excess glycerine on the slide with the help of a blotting paper.



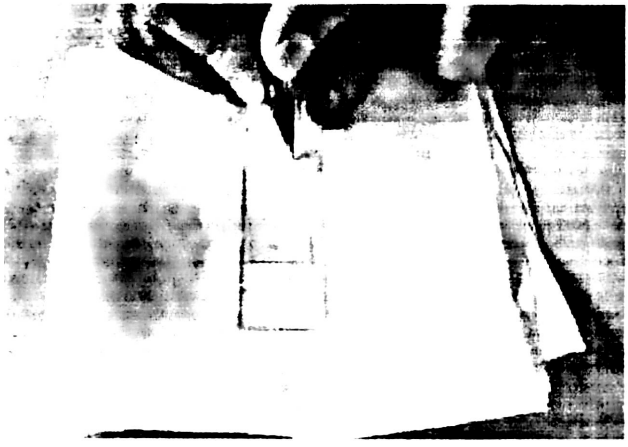
Step 13.

- The slide is ready for observation.



Step 14.

- Label the temporary micro preparation.



Step 15.

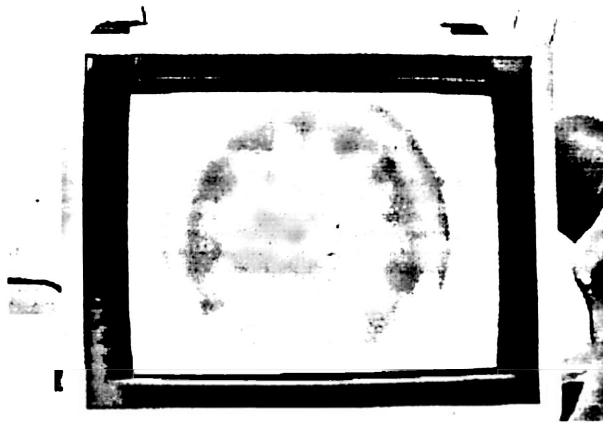
- Observe the slide under microscope.

Step 16.

- Microscope fitted with camera and computer set-up for capturing the image.

Step 17.

- Transverse section of a dicot stem as seen in computer generated image captured by a microscope fitted with camera.



Practical 4.

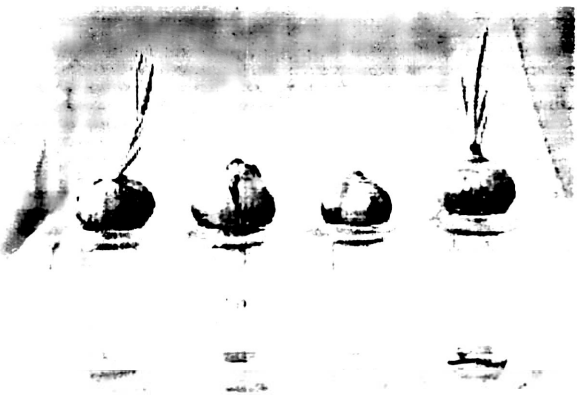
- To prepare temporary mount of Onion root tip for the study of various stages of Mitosis.
- Photography: Johnsheen. A., RIEM.

Step 1.

- An onion in a flask filled with water.

Step 2.

- After one week, the onion roots grow in water.



Step 3.

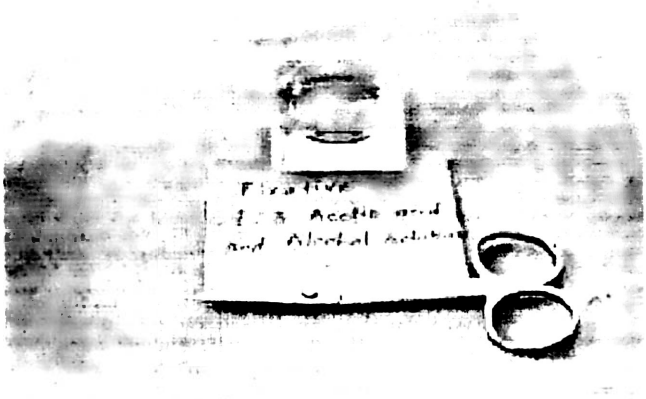
- Cut the root tips between 8-10 a.m. when they show active mitosis.

Step 4.

- Preparation of fixative (Acetic acid and alcohol solution in the ratio of 1:3).

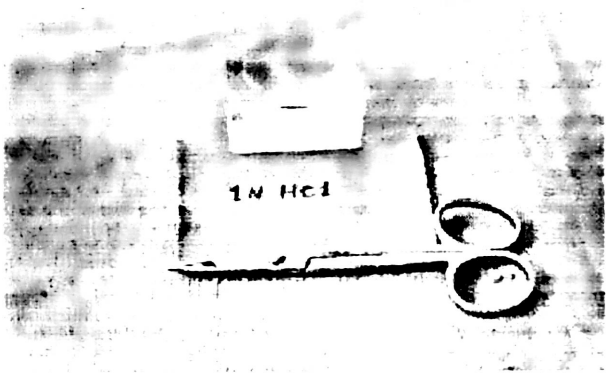
Step 5.

- The cut root tips are dipped in the fixative.



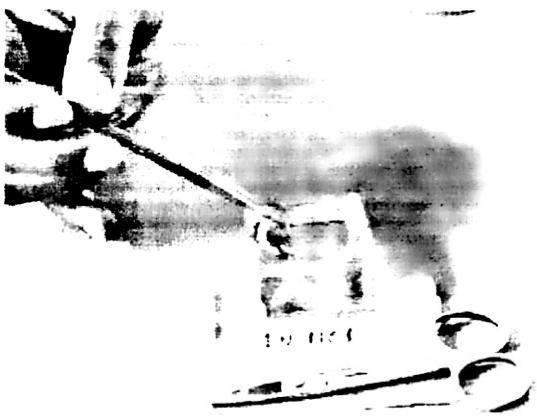
Step 6.

- The root tips are then dipped in 1N HCl.



Step 7.

- The root tips are washed in 1 N HCl and removed immediately with the help of a brush.



Step 8.

- The root tips are washed in water.

Step 9.

- Take a root tip on a clean glass slide, put a drop of acetocarmine stain and allow it to stand for 8-10 minutes.

Step 10.

- Move the slide gently over the flame of the spirit lamp and cool it.

Step 11.

- Check the heat by gently touching the slide to the back of the palm.

Step 12.

- Put fresh stain on the slide and cover it with the help of cover slip.

Step 13.

- Blot the excess stain on the slide with the help of a blotting paper.

Step 14.

- Tap gently on the cover slip with the help of plastic end of the needle until the preparation gives a cloudy appearance. The root tip squash is ready for observation.

Step 1.

- Habit of the China rose plant (Hibiscus rosa sinensis).

Practical 7.

- Identification and description of China rose (Hibiscus rosa sinensis).
- Photography: Johnsheen. A., RIEM.

Step 2.

- Stem portion of China rose plant.

Step 3.

- Simple leaf of China rose plant.

Step 4.

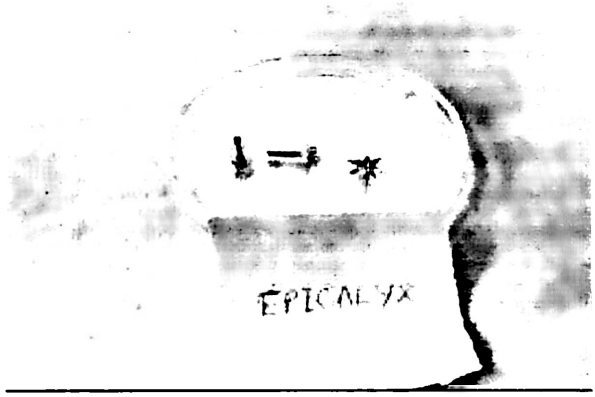
- Axillary inflorescence of China rose plant (Cymose inflorescence).

Step 5.

- Dissection of epicalyx.

Step 6.

- Dissected epicalyx portion.



Step 7.

- Dissection of calyx.

Step 8.

- Dissected calyx portion.

Step 9.

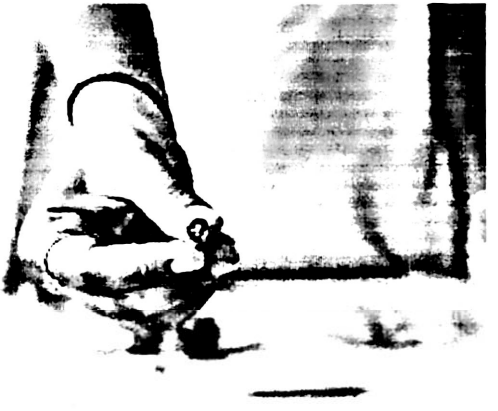
- Dissection of corolla.

Step 10.

- Dissected corolla portion showing gamopetalous condition.

Step 11.

- Twisted aestivation in transverse section of bud.



Step 12.

- Dissection of androecium i.e., splitting of staminal tube.

Step 13.

- Dissected androecium portion showing L. S. of staminal tube.

Step 14.

- Dissected gynoecium portion showing pistil, ovary, style and stigma.

Step 15.

- Observation of floral components under stereo microscope.

INTERVENTION 7: PROJECT WORKS

Suggested project works:

- Listing out the dicot plants/trees of RIE campus.
- Listing out the monocot plants and grasses of RIE campus.
- Preparation of a photo album on flora of RIE campus.
- Study of transverse sections of stem of different dicot plants on the campus.
- Study of monocot and dicot stem with a neatly labeled diagram.
- Listing the Internet resources on the taxonomical data of plant species.
- Preparation of a working model for showing different stages of mitosis.
- Preparation of flow chart showing different stages of mitosis with a neatly labeled diagram.
- Growing different plants in green house for the study of mitosis.
- Explanation of different types of microscopes and their working principles with a neatly labeled diagram.
- Preparation of a working model of different types of microscopes.
- Study of fixatives and their uses.
- Listing out different types of fixatives with their composition.
- Listing out different types of stains used in laboratory.
- Preparation of collages of common flowers.
- Study of flowering cycle of onion.
- Preparation of collages of dicot spp. on campus.
- Preparation of collages of monocot spp. on campus.
- Study of culture of onion roots and comparison of stages fixed at different times of the day.
- Preparation of herbarium of different plant spp. of RIE campus.
- Preservation of dicot and monocot spp. in the laboratory.

INTERVENTION 8:
QUIZ

Plant tissues (Practicals 2 & 3):

1. Primary tissues of a plant
   (a) add to the length of roots and shoots (b) add to the diameter of existing roots and shoots (c) are only in the embryo (d) are only in the seedling.
2. Secondary tissues of a plant
   (a) add to the length of roots and shoots (b) add to the diameter of existing roots and shoots (c) are only in the embryo (d) are only in the seedling.
3. The most common type of ground tissue is
   (a) epidermis (b) collenchyma (c) sclerenchyma (d) parenchyma.
4. Mature parenchyma cells take part in regeneration of other plant parts, because they
   (a) are centrally located in the heartwood (b) are the only mature cells with nuclei (c) retain their ability to divide and differentiate (d) have no cell walls.
5. Most metabolism of a plant is carried out by the
   (a) epidermis (b) collenchyma tissues (c) sclerenchyma tissues (d) parenchyma tissues.
6. Tissues that form long, tough strands, as in the leaf stalks of celery, are
   (a) epidermis (b) collenchyma (c) sclerenchyma (d) parenchyma.
7. Lignin is a component of the secondary cell walls of
   (a) epidermis (b) collenchyma (c) sclerenchyma (d) parenchyma.
8. Which of the following cell types has the thinnest walls?
   (a) epidermis (b) collenchyma (c) sclerenchyma (d) parenchyma.
9. Which of the following cells is often dead when functioning?
   (a) epidermis (b) collenchyma (c) sclerenchyma (d) parenchyma.
10. Which of the following tissues is composed of dead cells?
    (a) Ground (b) Xylem (c) Phloem (d) Epidermis.
11. Which of the following tissues is composed of dead cells?
    (a) Periderm (b) Collenchyma (c) Parenchyma (d) Lateral meristem.
12. The primary plant body is covered with a layer of cells, the
    (a) epidermis (b) periderm (c) ground tissue (d) cuticle.
13. Root hairs are formed from extensions of the
    (a) ground tissue (b) periderm (c) cuticle (d) epidermis.
14. The function of a root hair is to
    (a) hold ions by attractions of opposite charges. (b) produce air pockets for gas exchange. (c) attract symbiotic microorganisms. (d) increase the surface area for absorption.
15. Dead outer cells of a stem are called
    (a) epidermis (b) lateral collenchyma (c) cork cells (d) sclerenchyma.
16. Dividing cells not yet committed to becoming a particular cell type are
    (a) ground cells (b) epidermal cells (c) periderm cells (d) meristem cells.
17. Primary growth involves the activity of the

(a) vascular cambium (b) apical meristem (c) cork cambium (d) lateral meristem.

18. Secondary growth involves activity of the
    (a) root tips (b) shoot tips (c) apical meristem (d) lateral meristem.
19. Transportation of fluids is carried out by
    (a) ground tissue (b) vascular tissue (c) dermal tissue (d) none of these.
20. The cytoplasms of adjacent cells are connected by
    (a) stomata (b) pith (c) plasmodesmata (d) xylem.
21. A type of ground cell having thin primary wall is
    (a) collenchyma (b) parenchyma (c) sclerenchyma (d) none of these.
22. A type of ground cell having unevenly thickened primary wall and usually lacking secondary walls is
    (a) collenchyma (b) parenchyma (c) sclerenchyma (d) none of these.
23. A type of ground cell having thick secondary walls strengthened with lignin is
    (a) collenchyma (b) parenchyma (c) sclerenchyma (d) none of these.
24. The flesh of most fruit is composed of
    (a) collenchyma (b) parenchyma (c) sclerenchyma (d) none of these.
25. A noncellular layer covering the surface of a plant body is called
    (a) epidermis (b) stomata (c) guard cells (d) cuticle.
26. Cuticular layer which protects against water loss and invasion by microorganisms is composed of
    (a) lignin (b) pectin (c) amylopectin (d) cutin.
27. Dome shaped regions at the tips of shoots and roots are
    (a) lateral meristems (b) apical meristems (c) phloem (d) xylem.
28. Leaves are attached to the stem at
    (a) nodes (b) internodes (c) auxiliary meristems (d) apical meristems.
29. The pith and cortex of a stem are formed of
    (a) ground tissue (b) dermal tissue (c) vascular tissue (d) meristematic tissue.
30. Plants with little or no secondary growth are
    (a) dicots (b) herbaceous (c) deciduous (d) evergreen.
31. The narrow band of the meristematic tissue between the xylem and phloem is the
    (a) pith meristem (b) cortex meristem (c) cork cambium (d) vascular cambium.
32. Meristematic tissue that arises within the cortex is the
    (a) pith meristem (b) cortex cambium (c) cork cambium (d) none of these.

Cell division and the cell cycle (Practical 4):

1. In mitosis, the number of chromosomes sets in daughter cells will be
   (a) half the number in the parent cell (b) twice the number in the parent cell (c) the same as in the parent cell (d) one fourth the number in the parent cell.
2. The process in prokaryotic cell division where the DNA and its copy are divided through attachment and then growth of the plasma membrane is called
   (a) cytokinesis (b) fusion (c) fission (d) meiosis.
3. Mitosis is the process by which eukaryotic cells
   (a) grow (b) multiply (c) become specialized in structure and function (d) expose the genes for protein synthesis.
4. In eukaryotic cell division, the process of cytoplasmic division is called
   (a) cytokinesis (b) cytomeiosis (c) cytoplasmosis (d) cytomitosis.
5. As mitosis begins, a condensed chromosome consists of two
   (a) centromeres (b) centrioles (c) kinetochores (d) chromatids.
6. DNA replication occurs in which phase of the cell cycle?
   (a) Prophase (b) Interphase (c) Anaphase (d) Telophase.
7. During which phase of the cell cycle does the cell grow?
   (a) Interphase (b) Metaphase (c) Anaphase (d) Prophase.
8. The cell doubles in size during which phase of the cell cycle?
   (a) G_1 (b) S (c) G_2 (d) M
9. When a cell stops growing, say due to shortage of nutrients, this will occur in which phase of the cell cycle?
   (a) G_1 (b) S (c) G_2 (d) M
10. Normal cellular activities, such as protein synthesis, occur primarily during
    (a) prophase (b) metaphase (c) anaphase (d) interphase.
11. The division of a prokaryotic cell into two parts is called
    (a) binary fission (b) cytokinesis (c) karyokinesis (d) none of these.
12. In eukaryotic cells, the process by which the cytoplasm is divided is called
    (a) karyokinesis (b) amitosis (c) Interphase (d) cytokinesis.
13. Human body cells have
    (a) 23 chromosomes (b) 30 chromosomes (c) 46 chromosomes (d) none of these.
14. Which one of the following is the correct sequence of phases in mitosis?
    (a) Telophase-metaphase-anaphase-prophase
    (b) Metaphase-telophase-prophase-anaphase
    (c) Prophase-metaphase-anaphase-telophase
    (d) Anaphase-metaphase-prophase-telophase.
15. The thread like structure that begin to radiate from each centromere by the end of prophase are
    (a) kinetochore microtubules (b) polar microtubules (c) aster microtubules (d) spindle microtubules.
16. The spindle fibers formed during mitosis connect to the

(a) nucleoli (b) sugar-phosphate strands (c) kinetochores (d) nuclear membrane.

17. At what stage does cytokinesis typically begin?
(a) Anaphase (b) Prophase (c) Metaphase (d) Interphase.

Taxonomy (Practical 7):

1. The stalk of the flower is called
   a) Pedicel b) Petiole c) Peduncle d) None of these.
2. The stalk of the inflorescence is called
   a) Petiole b) Peduncle c) Pedicel d) None of these.
3. When all the four sets of members are present in a flower it is called
   a) Complete flower b) incomplete flower c) both d) none of these.
4. A whorl of sepaloid green bracteoles just below the calyx is
   a) Calyx b) Corolla c) Epicalyx d) Androecium
5. Cymose inflorescence has flowers in
   a) Basipetalous succession b) acropetalous succession c) whorled arrangement d) none of these.
6. *Hibiscus* shows
   a) Cymose inflorescence b) racemose inflorescence c) capitulum d) none of these.
7. Bract is found at
   a) The base of leaf b) the base of inflorescence c) near the sepal d) none of these.
8. Bisexual flower has
   a) No sexual whorls b) both male and female whorls fused c) male and female whorls separate d) none of the above.
9. Racemose inflorescence has an axis of
   a) Limited growth b) unlimited growth c) condensed axis d) none of these.
10. The lowermost whorl of a flower is
    a) Calyx b) Corolla c) Pedicel d) None of these.
11. Calyx is composed of
    a) Carpels b) Stamens c) Petals d) Sepals.
12. The second axillary whorl of flower is called
    a) Androecium b) Gynoecium c) Corolla d) Calyx.
13. Corolla is composed of
    a) Calyx b) Pedicel c) Petals d) Carpels.
14. If calyx and corolla cannot be distinguished, then it is known as
    a) Pedicel b) Perianth c) Petiole d) Petal.
15. If the petals are free, it is
    a) Gamopetalous b) polypetalous c) gamosepalous d) polysepalous.

16. If the edges of petals are fused with stamen then it is called
    a) Gamopetalous b) polypetalous c) epipetalous d) gamosepalous.
17. An appendage on both the sides of basal part of a leaf is called
    a) Young leaf b) petiole c) stipule d) vein.
18. A leaf with out stalk is known as
    a) Petiolate b) sessile c) simple d) compound.
19. an inflorescence refers to
    a) Arrangement of leaf on leaf axis b) arrangement of fruits c) arrangement of flowers on floral axis d) none of these.
20. Unit of perianth is
    a) Petal b) tepal c) sepal d) carpel.
21. Actinomorphic corolla is
    a) Regular b) irregular c) whorled d) none of these.
22. If sepals are in the condition of one in and one out then the aestivation is
    a) Valvate b) twisted c) imbricate d) quinquincial.
23. A root is
    a) positively geotropic c) negatively geotropic
    b) positively phototropic d) none of these.
24. Tap root system is in
    a) Dicots b) monocots c) both d) none of these.
25. Monocots possess
    a) Taproot system b) Fibrous root system c) both d) none of these.
26. Tap root has
    a) Limited growth b) unlimited growth c) is stunted d) none of these.
27. Adventitious root system
    a) is external b) is deep c) from any part of the plant d) none of these.
28. A simple leaf has
    a) No leaflets b) leaflets c) a single leaflet d) none of the above.
29. Venation represents
    a) Vasculature b) lines c) design on leaf d) none of these.
30. Stalk of leaf is called
    a) Pedicel b) Perianth c) Petiole d) Petal.
31. In a floral diagram, circle denotes
    a) Stalk b) stem c) thalamus d) none of these.
32. In a floral diagram, bracketed structure denotes
    a) Calyx b) corolla c) Androecium d) Gynoecium.
33. In a floral diagram, sickle shaped structure denotes
    a) Calyx b) corolla c) Androecium d) Gynoecium.
34. In a floral diagram, epipetalous stamens are drawn attached to
    a) Calyx b) corolla c) Androecium d) Gynoecium.
35. Fruit is a
    a) Mature flower b) mature carpel c) mature ovary d) none of these.

36. China rose belongs to family
    a) Rutaceae b) Annonaceae c) Malvaceae d) Myrtaceae
37. Botanical name of China rose is
    a) *Lathyrus odoratus* b) *Mimosa pudica* c) *Hibiscus rosa sinensis* d) *Michelia champaca*
38. Thalamiflorae is
    a) Series b) order c) division d) none of these.
39. Gamopetalae is characterized by
    a) no petals b) fused petals c) free petals d) fused petals and epipetalous stamens.
40. Fruit contains
    a) Fruit wall b) fruit wall and seeds c) only seeds d) none of these.

Answers to Objective questions of Plant tissues (Practicals 2 & 3):

1. a
2. b
3. d
4. c
5. d
6. b
7. c
8. d
9. c
10. b
11. a
12. a
13. d
14. d
15. c
16. d
17. b
18. d
19. b
20. c
21. b
22. a
23. c
24. b
25. d
26. d
27. b
28. a
29. a
30. b
31. d
32. c

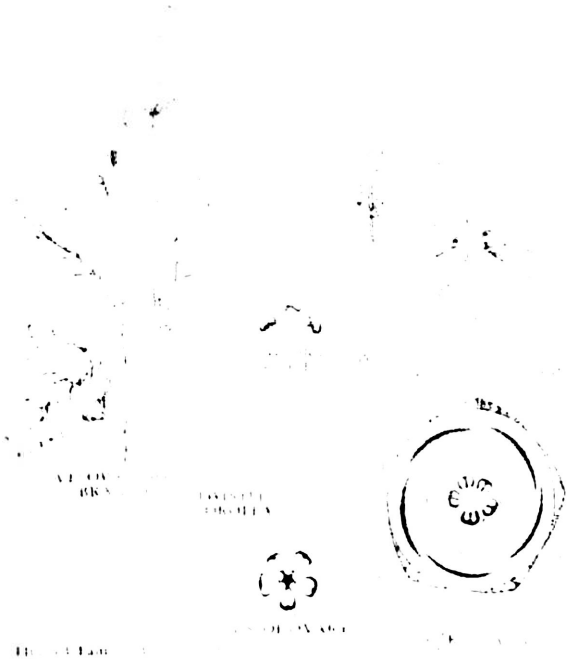
Answers to Objective questions of Cell division and the Cell cycle (Practicals 4):

1. c
2. c
3. b
4. a
5. d
6. b
7. a
8. a
9. a
10. d
11. a
12. d
13. c
14. c
15. a
16. c
17. a

Answers to Objective questions of Taxonomy (Practicals 7):

1. a
2. b
3. a
4. c
5. a
6. a
7. a
8. c
9. b
10. a
11. d
12. c
13. c
14. b
15. b
16. c
17. c
18. b
19. c
20. b
21. a
22. b
23. a
24. a
25. b
26. b
27. c
28. a
29. a
30. c
31. a
32. a
33. b
34. b
35. c
36. c
37. c
38. a
39. d
40. b

INTERVENTION 9: VISUALS



TAXONOMIC DESCRIPTION OF CHINA ROSE PLANT.

Hibiscus rosa-sinensis

ROOT AND TWIG WITH FLOWER OF A CHINA ROSE PLANT.

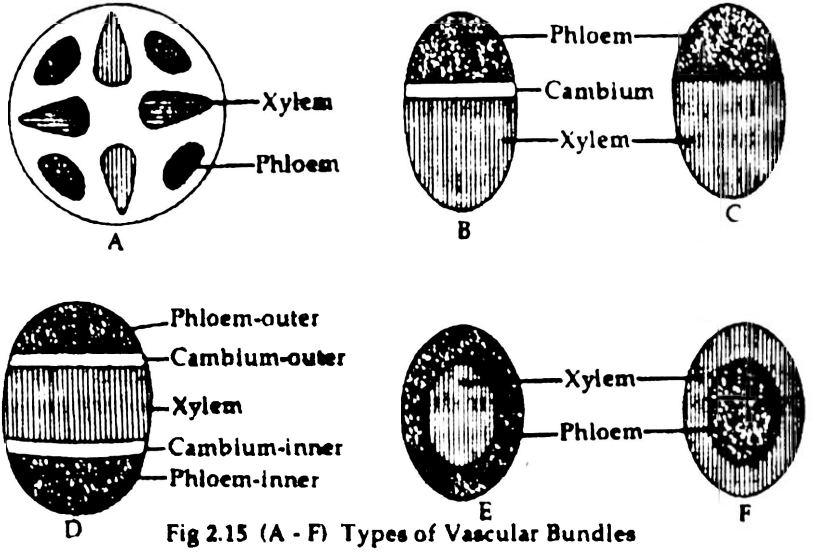


Fig 2.15 (A - F) Types of Vascular Bundles

(A) Radial ; (B) Collateral - open ; (C) Collateral - closed ;
(D) Bicollateral ; (E) Amphicribral ; (F) Amphivasal.

TYPES OF VASCULAR BUNDLES.

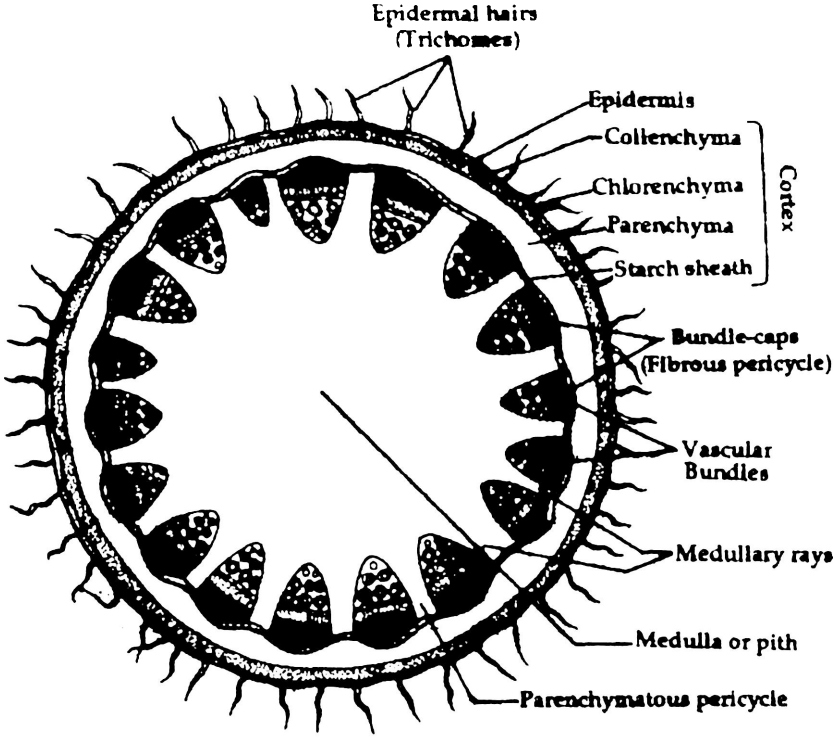
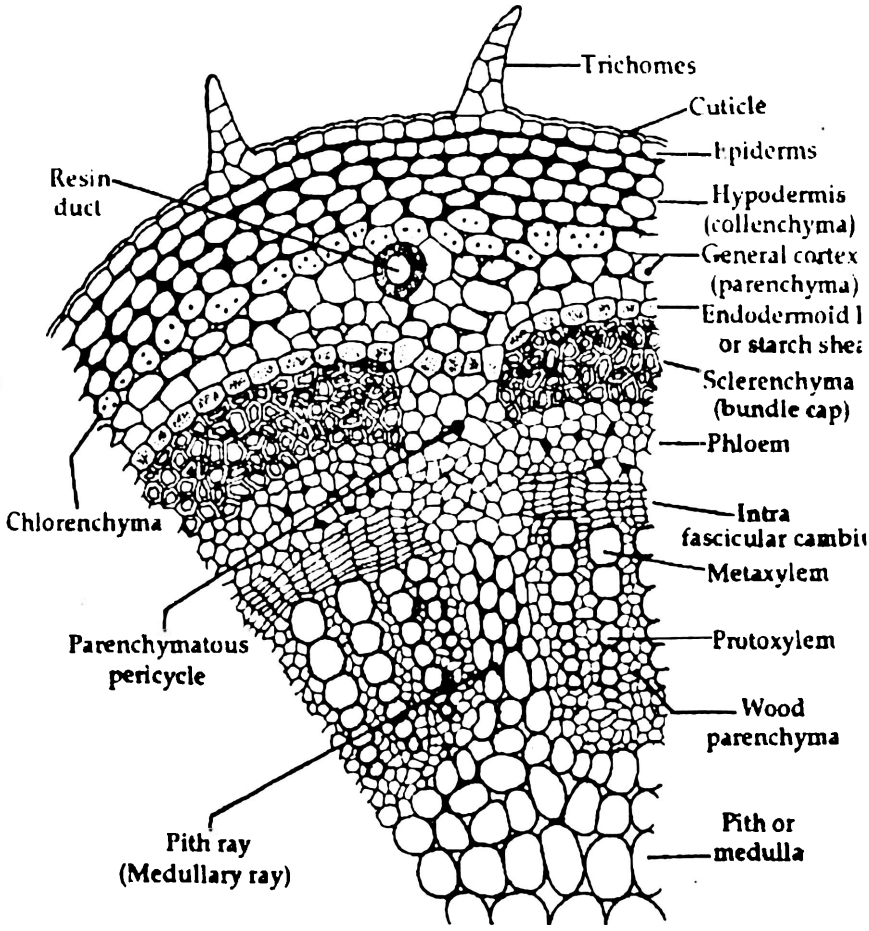


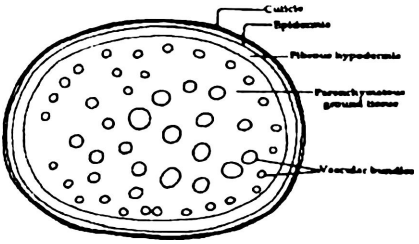
Fig 2.18 (A)

Ground plan of a transverse section of young stem of *Helianthus annus* (sunflower-diagrammatic).

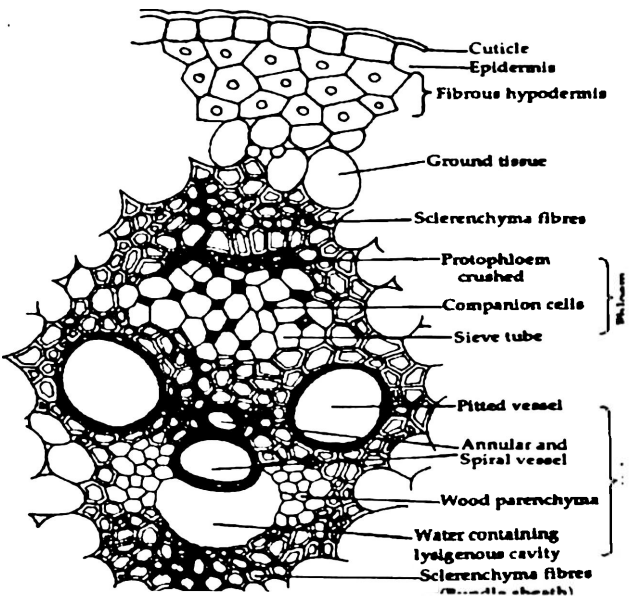
GROUNDS PLAN OF T.S. OF YOUNG STEM OF SUNFLOWER.



YOUNG SUNFLOWER STEM (A SECTOR) IN TRANSECTION.



Ground plan of maize (*Zea mays*) stem as seen in a transverse section



T. S. OF MONOCOT STEM (GROUND PLAN AND A SECTOR ENLARGED).

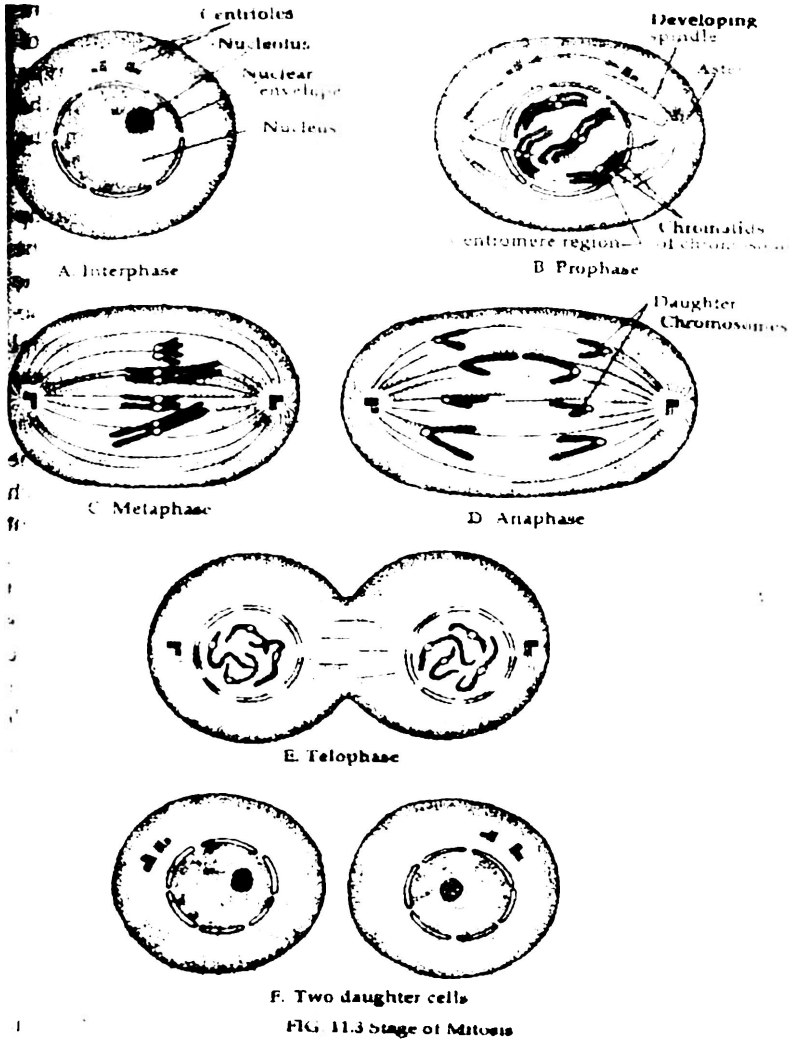


FIG 11.3 Stage of Mitosis

STAGES OF MITOSIS.

INTERVENTION 10: WORD SEARCH

WORD SEARCH FOR PRACTICAL – 2 & 3.

E	N	D	O	D	E	R	M	I	S	X	C
C	O	M	P	A	N	I	O	N	C	Q	O
R	G	V	C	B	D	R	Y	W	A	H	L
M	Y	R	V	L	A	G	L	R	T	Q	L
E	P	I	D	E	R	M	I	S	T	X	A
H	H	J	F	T	C	L	O	S	E	D	T
W	L	N	R	Z	H	T	X	I	R	G	E
C	O	N	J	O	I	N	T	E	E	D	R
U	E	S	Z	T	C	J	K	V	D	S	A
V	M	E	T	A	X	Y	L	E	M	G	L
B	U	N	D	L	E	S	H	E	A	T	H
R	E	P	R	O	T	O	X	Y	L	E	M

WORD SEARCH FOR PRACTICAL – 4.

M	P	C	E	N	T	R	I	O	L	E	U
X	O	C	H	U	D	X	Q	K	M	U	L
J	S	V	L	C	G	Z	C	W	H	C	U
N	C	T	N	L	S	B	E	N	K	H	S
S	T	Z	C	E	P	B	N	G	B	R	R
C	C	H	R	O	M	A	T	I	D	O	F
I	U	D	P	L	R	S	R	Q	I	M	N
T	N	F	R	U	D	I	O	L	P	A	H
E	Q	C	N	S	W	Q	M	P	L	T	P
N	G	G	E	N	O	M	E	L	O	I	Y
E	B	D	T	F	Z	B	R	H	I	N	X
G	E	N	O	T	Y	P	E	C	D	B	W

WORD SEARCH FOR PRACTICAL – 7.

C	X	P	R	T	X	B	U	Z	J	Z	E	S	P
O	J	I	T	G	H	C	H	Y	K	U	M	T	K
R	K	S	T	Y	L	E	J	G	L	T	B	U	L
O	L	T	T	F	J	U	Q	O	V	A	R	Y	R
L	H	I	H	I	R	G	Y	M	S	N	Y	S	T
L	T	L	N	G	G	K	V	O	E	J	O	T	G
A	C	T	I	N	O	M	O	R	P	H	Y	A	X
G	N	E	P	R	S	Y	A	P	A	O	H	M	F
J	Z	P	E	T	A	L	D	H	L	F	D	I	J
O	S	A	Q	K	J	H	F	Y	R	H	S	N	Q
V	K	L	R	M	N	V	T	U	Q	J	E	O	B
U	D	D	E	X	T	Z	I	C	P	K	E	D	N
L	P	G	P	I	S	T	I	L	L	O	D	E	Y
E	Y	J	K	P	E	R	I	A	N	T	H	G	J

ANSWERS FOR WORD SEARCH OF PRACTICALS - 2 & 3.

E	N	D	O	D	E	R	M	I	S	X	C
C	O	M	P	A	N	I	O	N	C	Q	O
R	G	V	C	B	D	R	Y	W	A	H	L
M	Y	R	V	L	A	G	L	R	T	Q	L
E	P	I	D	E	R	M	I	S	T	X	A
H	H	J	F	T	C	L	O	S	E	D	T
W	L	N	R	Z	H	T	X	I	R	G	E
C	O	N	J	O	I	N	T	E	E	D	R
U	E	S	Z	T	C	J	K	V	D	S	A
V	M	E	T	A	X	Y	L	E	M	G	L
B	U	N	D	L	E	S	H	E	A	T	H
R	E	P	R	O	T	O	X	Y	L	E	M

ANSWERS FOR WORD SEARCH OF PRACTICAL – 4.

M	P	C	E	N	T	R	I	O	L	E	U
X	O	C	H	U	D	X	Q	K	M	U	L
J	S	V	L	C	G	Z	C	W	H	C	U
N	C	T	N	L	S	B	E	N	K	H	S
S	T	Z	C	E	P	B	N	G	B	R	R
C	C	H	R	O	M	A	T	I	D	O	F
I	U	D	P	L	R	S	R	Q	I	M	N
T	N	F	R	U	D	I	O	L	P	A	H
E	Q	C	N	S	W	Q	M	P	L	T	P
N	G	G	E	N	O	M	E	L	O	I	Y
E	B	D	T	F	Z	B	R	H	I	N	X
G	E	N	O	T	Y	P	E	C	D	B	W

ANSWERS FOR WORD SEARCH OF PRACTICAL – 7.

C	X	P	R	T	X	B	U	Z	J	Z	E	S	P
O	J	I	T	G	H	C	H	Y	K	U	M	T	K
R	K	S	T	Y	L	E	J	G	L	T	B	U	L
O	L	T	T	F	J	U	Q	O	V	A	R	Y	R
L	H	I	H	I	R	G	Y	M	S	N	Y	S	T
L	T	L	N	G	G	K	V	O	E	J	O	T	G
A	C	T	I	N	O	M	O	R	P	H	Y	A	X
G	N	E	P	R	S	Y	A	P	A	O	H	M	F
J	Z	P	E	T	A	L	D	H	L	F	D	I	J
O	S	A	Q	K	J	H	F	Y	R	H	S	N	Q
V	K	L	R	M	N	V	T	U	Q	J	E	O	B
U	D	D	E	X	T	Z	I	C	P	K	E	D	N
L	P	G	P	I	S	T	I	L	L	O	D	E	Y
E	Y	J	K	P	E	R	I	A	N	T	H	G	J

Crossword:

A comparison of percentage of obtained scores in cross-word with diagnostic (content) test results in tables 5.1 and 5.2 reveals that out of the 5 students, one student did not attempt cross-word for practicals 2 and 3. The other four got marks ranging from 25 to 58% in practicals 2 and 3. This is lesser in comparison to what they got in earlier test before the application of remedial interventions.

In practical 4 all have scored 78-100%. Both Nitin and Shivaramakrishnan have improved with 100% scores. In practical 7, crossword scores range from 8-66%. This leaves much to be desired as the scores are less compared to earlier scores (Ref. Table 4.14).

Word search:

In word search, scores range from 23-70% in practicals 2 and 3. In practical 4 it ranges from 33-67% with one person having not attempted the exercise at all. In practical 7, the percentage of obtained score ranges from 19-44%. All these scores are much below what they obtained in earlier tests (Refer Tables 4.14, 5.1 and 5.2).

Quiz:

In the quizzes for practicals 2 and 3, percentage of obtained scores range from 23-75%: In practical 4, it ranges from 29-65%. In practical 7, it ranges from 13-58%. All these scores are much below the diagnostic test scores obtained earlier (Refer Tables 4.14, 5.1 and 5.2).

Diagnostic test:

The diagnostic tests given earlier were repeated on this sample of students after application of remedial measures. In practical 2, Dhaval and Shivaramakrishnan maintained status quo and retained the same percentage whereas the other two Nitin and Swamy have deteriorated in performance In practical 3, Dhaval, Nitin and Shivaramakrishnan have all improved their performance whereas

Swamy has not attempted the test. In practical 4, Dhaval has deteriorated, Nitin has improved, Shivaramakrishnan has maintained status quo and Swamy has not attempted the test. In practical 7, Dhaval, Nitin and Shivaramakrishnan have deteriorated in their performance while Swamy has not attempted the test.

From the above it is clear that there are stray and individual cases of improvement on application of remedial measures. Nitin and Shivaramakrishnan are two of the five students who showed improvement in performance with remedial measures (both with respect to crosswords and diagnostic tests). Drastic conclusions cannot be drawn for the time-being since the sample size was less (only 5) of those who underwent the remedial intervention programme. The intervention programme needs to be applied to a larger sample in order to get concrete results.

Table 5.1 (a, b, c & d) and 18 (a & b) give us an idea about the performance of student sample of 5 (out of the former 16/19 students) after the administration of remedial interventions. It is observed that though content wise they show no improvement (compare diagnostic test means of students with mean of Crosswords, word searches and quizzes in Table 5.2). Skill attainment has definitely improved. If we compare means of the earlier and recent skill tests for each of the 5 students in the difficult practicals we can see that

1) Dhaval has scored 92.7% in skill test in contrast to 79.7% earlier; also, the variation in percentage of obtained scores has reduced from 53 to 96% earlier to 83 to 97% now. He has secured only 68% in content in contrast to 83% earlier, he has not improved in content;
2) Jaimeer kaur has not given the previous tests. However, her present scores (52.4% in diagnostic tests and 88.7% in skill tests) are comparable to the rest of the group.
3) Nitin has obtained a mean of 55% only in content in comparison to the earlier value of 84% earlier showing that content wise he has not bettered himself. He has secured 88% in skill test now improving thereby on his earlier record of 80%.
4) Shivaramakrishnan obtains mean of 61% in content as against 72% earlier. Therefore no improvement content wise. Skill attainment however has improved from 84% earlier to 93% now.

5) Swamy has tumbled down drastically content wise from 79% to 8% now. Skill attainment has improved from 82% earlier to 93% now. Therefore 4 out of 5 students who attempted the remedial intervention programme show improvement in skill attainment.

No improvement in mean of content scores per practical is seen and this could perhaps be attributed to the hurried manner in which the remedial intervention programme had to be administered because of lack of time. Also, the deterioration in content attainment as against the upgradation in skill acquisition recalls to the mind that during the administration of check-lists, diagnostic tools and SPMT tools to the earlier sample of 16 students (taken for reidentification of difficult skills) show that the correlation between content and skill attainment was negative (Table 4.15). Therefore, these contradict each other in the remedial intervention programme as well. Probably skill acquisition is not necessarily related to content knowledge. It could also mean that what sub-skill one performs with the hands is not related to factual information A comparison of earlier and present mean of skill test performance values for all students per practical (mean of S2, S3, S4 and S7 at present and the earlier values) shows that there is overall improvement in skill attainment. The improvement can be recorded as follows:

Table 5.3: Table showing Skill test values before and after administering Remedial Interventions.

Skill test	Present values	Previous values
S2	93.9	59.9
S3	96.3	72.8
S4	88.3	67.7
S7	80.5	53.7

The use of these remedial interventions is therefore mandatory and validated hereby and justified.

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Chapter 6: References

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Appendix 7.1: Check-list for practical 'Use and care of compound microscope' with major skill 'Microscopy'.

Sl. No.	Sub-Skills	Criterial Measures	Max. Marks	Obtained scores
	A. Use of Microscopy			
1	Eye piece adjustment	a. Inline b. Sufficient light c. Magnification	3	
2	Objective Adjustment	a. Inline b. Sufficient light c. Distance from slide d. Magnification	4	
3	Use of diaphragm	a. Ability to open and close	1	
4	Mirror/ light adjustment	a. Ability to adjust mirror to ensure sufficient light	1	
5	Focusing the slide	Ability to focus a. tissue types b. section profile	2	
6	Placement of slide	a. Ability to place the slide properly on the stage	1	
7	Use of fine adjustment	a. Ability to focus using fine adjustment	1	
8	Sketching as seen under the Microscopy	a. Ability to sketch diagrams as observed in microscope	1	
		Total	14	

Appendix 7.2: Check-list for practical 'Observation of Permanent Slide of Monocot Stem' with major skill 'Observation'.

Sl. No.	Sub-Skills	Criterial Measures	Max. Score	Obtained Score
1.	Focusing	a) Clear slides b) Appropriate light adjustment c) Clarity of profile section	3	
2.	Stage adjustment	a) Proper use of Clips on stage b) Adjustment of stage at proper angle c) Proper light adjustment d) Alignment of eye piece and objective	4	
3.	Scanning the slide	a) Working slide with stage adjustment screws b) Keeping the slide within focus c) Selection of stage to be observed	3	
4.	Selection of good slides	a) Thin sectioning/mounting b) Complete/whole section c) Uniformity of the section	3	
5.	Use of pointer	a) Knowledge of use b) Ability to point/ focus c) Ability to fit pointer in eye piece	3	
6.	Highlighting a Section of T.S.	a) Knowledge of section b) Ability to recognize the contents c) Ability to focus	3	
7.	Recognition	a) Knowledge of content b) Ability to differentiate c) Ability to recognize d) Ability to identify	4	
8.	Identification of section of monocot stem	a) Knowledge of content b) Ability to differentiate c) Ability to recognize d) Ability to identify	4	
9.	On diagnostic feature	a) Ability to list b) Ability to identify c) Ability to describe	3	
		Total	30	

Appendix 7.3: Check-list for practical 'Making transverse sections of Dicot stem and study of different tissues under microscope' with major skill 'Section cutting and mounting'.

Sl. No.	Sub-Skills	Criterial Measures	Max. Marks	Obtained scores
1	Handling of razor and other materials and section cutting	a. Ability to handle sectioning material b. Ability to handle razor c. Ability to take section	3	
2	Ability to keep section and to remove pith	a. Ability to keep sections in H_2o in a watch glass	1	
3	Selection of good section and placement on slide.	a. Ability to select thin section b. Ability to Select uniform section c. Ability to select complete section d. Ability to pick the right section with brush e. Ability to place the section at the center of the slide	5	
4	Staining the Section	a. Ability to use stain of proper dilution. b. Ability to stain sections in watch glass c. Ability to allow the section for appropriate period in watch glass	3	
5	Ability to remove or wash excess stain	a. Ability to use acid water to wash b. Ability to remove excess stain c. Knowledge of avoiding improperly stained section. d. Ability to handle section while washing.	4	
6	Use of cover slips & Glycerine	a. Ability to place cover slip properly. b. Ability to use Glycerine properly.	2	
7	Focusing the slide	a. Ability to focus properly. b. Ability to adjust light properly.	2	
8	Ability to sketching as seen under the Microscopy	a. Ability to sketch b. Ability to label properly	2	
			22	

Appendix 7.4: Check-list for practical 'To prepare temporary mount of onion root tip to study various stages of Mitosis' with major skill 'Teasing and Mounting'.

Sl. No.	Sub-Skills	Criterial Measures	Max. Score	Obtained Score
1.	Preparation of Fixative	a) Knowledge of preparation of fixative b) Knowledge of using rusted needles c) Ability to squash and tease material with rusted needles d) Knowledge of using 1N HCL and Iron compounds.	4	
2.	Ability to use and handle Con. HCL	a) Ability to dip root in HCL b) Proper handling of HCL c) Ability to remove roots immediately	3	
3.	Ability to wash, root	a) Ability to wash properly b) Knows the reason necessary for thorough washing (otherwise it will not stain)	2	
4.	Ability to use slide and stain.	a) Ability to use slide properly b) Able to add stain on slide drop wise c) Ability to allow stain to soak material.	3	
5.	Heating and use of spirit lamp	a) Ability to heat gently b) Ability to heat and cool alternately c) Knowledge of the importance of repeating crit. (b)	3	
6.	Ability to squash	a) Ability to put fresh stain b) Knowledge of using cover slips to cover stained root tip c) Knowledge of using folded filter paper over cover slip before tapping d) Ability to hold filter paper along the sides of the slide e) Ability to tap material gently till it gives a cloudy appearance	5	
7.	Observation and identification of stages	a) Ability to focus all 4 stages clearly b) Ability to identify all 4 stages viz., prophase, metaphase anaphase and telophase	2	
8.	Sketching as seen under Microscope	a) Ability to sketch b) Ability to label	2	
Total			24	

Appendix 7.5: Check-list for practical 'Preparation of Reagents' with major skill 'Preparation of reagents'.

Sl. No.	Sub-Skills	Criterial Measures	Max. Score	Obtained Score
1.	Use of Chemical Balance	a) Ability to handle properly b) Ability to adjust the balance c) Ability to set balance at zero	3	
2.	Accurate weighing of chemicals	a) Ability to use weights b) Ability to use rider c) Ability to ensure the accurate swinging of needle d) Ability to take correct reading	4	
3.	Use of measuring cylinder & pipette etc.,	a) Ability to take accurate amount in cylinder b) Ability to ensure lower meniscus of solution accordingly c) Ability to pour out d) Ability to draw solution in to pipette e) Ability to adjust the amount of liquid in pipette f) Ability to pour out the liquid from the pipette	6	
4.	Ability to mix & filter using filter paper	a) Ability to use glass rod b) Ability to fold filter paper c) Ability to set filter paper in funnel d) Ability to use funnel stand	4	
5.	Ability to stir constantly	a) Ability to move the wrist constantly b) Ability to ensure non-breakage of glassware c) Ability to dissolve completely	3	
6.	Knowledge of burner or hot plate use.	a) Ability to ensure glassware surface free from moisture b) Knowledge of putting on & off of burner/hotplate c) Ability to light the burner with match sticks	3	
			23	

Appendix 7.6: Check-list for practical 'Test for Sugar and Albumin' with major skill 'Explanation'.

Sl. No.	Sub-Skills	Criterial Measures	Max. Score	Obtained Score
1.	Use of Pipette	a) Ability to select appropriate pipette b) Ability to suck solution in a proper way by holding the pipette with index and thumb c) Ability to draw exact amount of solution to marked level d) Ability to pour out the exact amount	4	
2.	Ability to use test tube holds.	a) Ability to select appropriate holder b) Proper tightening of test tube holder c) Ability to keep test tube in slant d) Ability to keep away test tube from the body while heating e) Ability to loosen (test tube) it after the test.	5	
3.	Use of burner (Bunsen)	a) Ability to turn off to left and right to put on and off. b) Ensure constant blue flame c) Ability to hold test tube bottom at the tip of the flame	3	
4.	Ability to distinguish colour changes	a) Ability to distinguish green from orange and violet colours. b) Ability to identify precipitation by holding test tube against white background	2	
5.	Ability to infer	a) Knowledge of chemical reactions involved b) Ability to spell out the reaction and chemical equations c) Knowledge of relationship between precipitation and chemical reaction d) Ability to differentiate green (with less precipitation) and orange (with more precipitation)	4	
6.	Ability to mix with glass rods or by simple shaking	a) Ensure uniformity of the solution b) Ability to distinguish settled and unsettled solution c) Ability to smell the test tube in a proper way d) Proper handling of test tube	4	
		Total	22	

Appendix 7.7: Check-list for practical 'Identification and description of China Rose' with major skill 'Description'.

Sl. No.	Sub-Skills	Criterial Measures	Max. Score	Obtained Score
1.	Classification Ability	Ability to identify a) Systematic group b) Order c) Family d) Genus e) Species	5	
2.	Habit and Habitat	Ability to classify habit/habitat into a) Herb b) Shrub c) Tree d) Cultivated e) Ornamental f) Wild	6	
3.	Finding root system	a) Ability to distinguish between tap root and fibrous root system.	1	
4.	Ability to finding stem feature	Ability to know the a) Posture (erect) b) Texture (soft or woody)	2	
5.	Identifying the type of leaf	Ability to identify a) Type of leaf (simple or compound) b) Type of leaf margin c) Presence or absence of petiole d) Venation of leaf e) Shape of apex	5	
6.	Identifying the type of inflorescence and flower	Ability to identify the a) Type of inflorescence b) Type of the flower c) Sexuality of the flower d) Position of the flower	4	
7.	Ability to distinguish Calyx and corolla	Ability to a) No. of sepals and colour b) Type of sepals and position c) Type of Aestivation d) No. of petals and colour e) Type of petals and position f) Type of Aestivation	6	
8.	Ability to distinguish Androecium, Gynoecium and Fruit	Ability to know the a) Number of stamens/ anthers b) Position of the Androecium c) Different parts of the Gymoecium d) Position of Gynoecium. e) Type of fruit	5	
9.	Knowledge of writing floral formula and diagram.	Ability to a) Write floral formula b) Floral diagram.	2	
		Total	36	

Appendix 7.8: Check-list for practical 'To study effect of temperature, pressure and solute concentration on osmotic movement of water' with major skill 'Experimentation'.

Sl. No.	Sub-Skills	Criterial Measures	Max. Marks	Obtained scores
1	Knowledge of diffusion and osmosis	Ability to understand process of a. Osmosis b. Diffusion c. Kind of Osmosis (Endosomosis & Exosmosis)	3	
2	Knowledge of membrane type	a. Ability to differentiate permeable, semi permeable and non permeable membrane	1	
3	Ability to handle the equipments	a. Ability to handle beakers b. Ability to pour water and glucose to beaker c. Ability to put raisin to water	3	
4	Ability to record turgidity time	Ability to record the time of a. Ice cold water with raisin b. Hot water with raisin c. 20% Glucose solution with raisin d. 5% Glucose solution with raisin e. 20 ml of water with raisin f. 20 ml of water with raisin pressured by piston	6	
5	Handling of thermometers	a. Ability to handle thermometers properly b. Ability to read the temperature using thermometers	2	
6	Ability to know the effect of pressure on osmosis	a. Ability to use piston b. Ability to create pressure by piston	2	
7	Ability to make observation	a. Ability to observe different sets of beakers b . Ability to label the beakers c. Ability to record time of turgidity in each set of expt. d. Ability to write inferences for each set	4	
8	Ability to draw conclusions	Ability to understand factors for osmosis ie., a. Temperature b . Pressure c. Concentration	3	
9	Ability to draw experimental diagram	a. Ability to sketch b. Ability to label	2	
		Total	26	

Scoring sheet

Practical -I - Use and Care Of Compound Microscope

Major Skill: Microscopy ; Sub skills 1-8.

Name of the Student	Skill Observation														Max. Score	Obt. Score
	1a	1b	1c	2a	2b	2c	2d	3a	4a	5a	5b	6a	7a	8a		
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Scoring sheet

Practical – II - Observation of Permanent Slide of Monocot Stem

Name of the Student	Skill Observation																												Mx. Sc.	Ob. Sc.
	1a	1b	1c	2a	2b	2c	2d	3a	3b	3c	4a	4b	4c	5a	5b	5c	6a	6b	6c	7a	7b	7c	7d	8a	8b	8c	8d	9a	9b	9c		
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Scoring Sheet

Practical –III- Making transverse sections of Dicot stem and study of different tissues under microscope

Major skill : Section cutting and mounting; Sub skills 1-8

Name of student	Skill observation																					Max. sc.	Obt. Sc.
	1a	1b	1c	2a	3a	3b	3c	3d	3e	4a	4b	4c	5a	5b	5c	5d	6a	6b	7a	7b	8a	8b	
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Scoring sheet

Practical-IV- To prepare temporary mount of onion root tip to study various stages of mitosis

Major skill: Mounting ; Sub skills 1-8

Name of the Student	Skill Observation																							Max. Score	Obt. Score
	1a	1b	1c	1d	2a	2b	2c	3a	3b	4a	4b	4c	5a	5b	5c	6a	6b	6c	6d	6e	7a	7b	8a	8b	
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Scoring sheet

Practical – V - Preparation of Reagents

Major Skill – A -Preparation of Reagents ; Sub skills 1-6.

Name of the Student	Skill Observation																						Mx. Sc.	Ob. Sc.
	1a	1b	1c	2a	2b	2c	2d	3a	3b	3c	3d	3e	3f	4a	4b	4c	4d	5a	5b	5c	6a	6b	6c	
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Scoring sheet

Practical – VI – Test for Sugar and Albumin

Major Skill – B – Explanation ; Sub skill 1-6.

Name of the student	Skill Observation																					Mx. Sc.	Ob. Sc.
	1a	1b	1c	1d	2a	2b	2c	2d	2e	3a	3b	3c	4a	4b	5a	5b	5c	5d	6a	6b	6c	6d	
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Scoring sheet

Practical – VII – Identification and description of China Rose

Major Skill: Description ; Sub skill 1-9

Name of the student	Skill Observation																																		Mx. Sc.	Ob. Sc.
	1a	1b	1c	1d	1e	2a	2b	2c	2d	2e	2f	3a	4a	4b	5a	5b	5c	5d	5e	6a	6b	6c	6d	7a	7b	7c	7d	7e	7f	8a	8b	8c	8d	8e	9a	9b		
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Scoring sheet

Practical –VIII- To study effect of temperature, pressure and solute concentration on osmotic movement of water

Major Skill : Experimentation ; Sub skills 1-9.

Name of the student	Skill observation																									Mx. Sc.	Ob. Sc.
	1a	1b	2c	2a	3a	3b	3c	4a	4b	4c	4d	4e	4f	5a	5b	6a	6b	7a	7b	7c	7d	8a	8b	8c	9a	9b	
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Diagnostic Test

Practical -I- Use and care of compound microscope

Major Skill: Microscopy

I. Answer the following questions in a word phrase or sentence.

1. What is the use of microscope?
1. What is resolving power?
2. What is the work of condenser?
3. How to carry a microscope?
4. Why oil immersion lens is used?

II. Fill up the blanks.

1. Resolving power of human eye is ---------- microns.
2. The microscope consists of -------- lenses.

III. Match the following.

A	B
Dissecting Microscope	Ultra structure of Cell organelles
Ocular Lens	Single lens
Oil immersion Lens	Close to eyes
Electron Microscope	Bacteria and Algae

IV. Mark the correct answer.

1. The resolving power of light microscope is

a) 0.03microns b) 0.3microns c) 3microns d) 30microns

2. The microscope used to study the transparent living cells is

a) Electron microscope b) Interference microscope c) Phase contrast microscope d) Fluorescent microscope

Diagnostic Test

Practical – II- Observation of Permanent slides of Monocot stem

Major Skill: Observation

I. Answer the fallowing questions in a word phrase or sentence.

1.Why monocots have thin and non-woody stems?

2. What is good focusing?

3.What is function of epidermis?

II. Fill up the blanks.

1.---------- pith is present in monocot stems.

2. ---------- is absent between xylem and phloem in a monocot stem.

III. Match the following.

A	B
Epidermis	Parenchyma
Hypodermis	Closed
Cortex	Reduced
Vascular bundles	Outer most layer
Pith	Sclerenchyma

IV. Mark the correct answer.

1.This gives mechanical support to the Monocot stem

a) Epidermis b) Hypodermis c) Cortex d)Vascular bundles

2. Endarch condition means

a) Protoxylem towards pith b) Protoxylem towards periphery

c) Protoxylem in the center d) none

Diagnostic Test

Practical –III- Making transverse sections of dicot stem and study of different tissues under microscope

Major Skill: Section cutting and mounting

I. Answer the fallowing questions in a word phrase or sentence.

1.What is a good section?

2.What is use of pith in section cutting?

3.Why staining is required?

II. Fill up the blanks.

1.The cutting material should be held in ---------- hand.

2.The razor should be held in ---------- hand.

III. Match the following.

A	B
Section cutting	Glycerine
.Staining	Microscope
Mounting	Razor
Focusing	Coloring tissue

IV. Mark the correct answer.

1.Good section is

a). Thin b). Uniform c).Complete d). All three

2. A section should be mounted on a slide in the

a) centre b) right end c) left end d) any where

Diagnostic Test

Practical – IV - To prepare temporary mount of onion root tip to study various stages of Mitosis

Major Skill: Teasing and Mounting

I. Answer the fallowing questions in a word phrase or sentence.

5. What is mitosis?
6. Which stage of mitosis shows thickest chromosomes with two chromatids?
7. Which stain is used to study the mitosis in onion root tips?
8. Why do we select root tip to study mitosis?
9. Why fixatives are used in the study of mitosis?

II. Fill up the blanks.

1. ---------- daughter cells are formed as a result of mitotic division.
2. The uncontrolled mitotic division leads to ----------

III. Match the following.

A	B
1. Prophase	Chromatids gets separated from each other and move towards the opposite poles
2. Metaphase	Two daughter nuclei are seen on opposite poles
3. Anaphase	Nucleolus disappears
4. Telophase	Chromosomes are linearly arranged on the equator

IV. Mark the correct answer.

1. To study mitosis in onion root tips, the roots should be harvested between

a). 6 to 8 AM b). 8 to 10 AM c). 6 to 8 PM d). 8 to 10 PM

2. The cell division involves

a) karyo-kinesis b) cytokinesis c) both a & b d) none

Diagnostic Test

Practical – V - Preparation of Reagents

Major Skill – A - Preparation of Reagents

I. Answer the fallowing questions in a word phrase or sentence.

1. What are fixatives?
2. What is staining?
3. What is a solution?
4. What is a molar solution?

II. Fill up the blanks.

1. ---------- is a good fixative and preservative for Plant and Animal specimens.
2. One gram equivalent weight of a compound dissolved in 1litre of solution is ---------- solution.

III. Match the following.

A	B
Saffranin	Bacteria and Protozoa
Acetocarmine	Lignified and Cutinized tissue
Eosin	Chromosomes
Crystal violet	Animal tissue

Diagnostic Test

Practical – VII - Test for Sugar and Albumin

Major Skill – B - Explanation

I. Answer the fallowing questions in a word phrase or sentence.

1.How to handle Pipette in a laboratory?

2.What is the proper use of test tube holders?

3.What is solution?

4.What is precipitation?

II. Fill up the blanks.

1.While heating test tube it should be kept ---------- from the body.

2.The holder should be fitted at ---------- position of test tube.

III. Mark the correct answer.

1.For better heating we should ensure constant

a) Blue flame b) Red flame c) Green flame d) Yellow flame

2. To identify the precipitation, test tube should be held against a

a) black background b)Red background c)White background d) none

Diagnostic Test

Practical – VII – Identification and description of China Rose

Major Skill : Description

I. Answer the fallowing questions in a word phrase or sentence.

1. What is the botanical name of China rose?

2.China rose belongs to which family?

3.What is the type of root system in China rose?

4.What is floral formula?

II. Fill up the blanks.

1.China rose belongs to ---------- order.

2. ---------- inflorescence is present in china rose.

III. Match the following.

A	B
Leaf	Pedicellate
Flower	Gamopetalous
Calyx	Petiolate
Corolla	Monadelphous stamen
Androecium	Gamosepalous

IV. Mark the correct answer.

1.China rose is a

a) Herb b) Shrub c) Tree d) Creeper

2. Pentacarpellary syncarpous is a condition seen in

a) Calyx b) Corolla c) Androecium d) Gynoecium

Diagnostic Test

Practical –VIII- To study effect of temperature, pressure and solute concentration on osmotic movement of water

Major Skill: Experimentation

I. Answer the fallowing questions in a word phrase or sentence.

1.What is osmosis?

2. What is diffusion?

3.What is a semi permeable membrane?

4.Why it is necessary to take dry grapes of equal size?

II. Fill up the blanks.

1.Diffusion of water into the dry grape is ---------- process.

2. ---------- is used to create pressure on water in a beaker.

III. Match the following.

A	B
Exosmosis	Turgid raisin
Endosmosis	Flaccid raisin
Semi-permeable	Polytene membrane
Non permeable	Cell membrane

IV. Mark the correct answer.

1.Selectively permeable membrane is/are

a) Egg membrane b) Sheep bladder c) Cell membrane d) All three

2. Osmosis is the function of

a) Temperature b) Pressure c) Solute concentration d) All three

Answer Key To Diagnostic Test

Practical – I - Use and care of compound microscope

Major Skill: Microscopy

I. Answer the following questions in a word phrase or sentence.

1. What is the use of microscope?

Ans. Microscope is used to observe the small organisms, tissues and cells which human eye can't see.

2. What is resolving power?

Ans. The ability to distinguish two close points is known as resolving power.

3. What is the work of condenser?

Ans. The condenser directs the light on the specimen with the help of mirror.

4. How to carry a microscope?

Ans. Always carry the microscope with one hand on handle and other under its base.

5. Why oil immersion lens is used?

Ans. It is a special lens of 90X used for seeing small organisms like bacteria and algae.

II. Fill up the blanks.

1. Resolving power of human eye is ---------- microns.

Ans. 100 microns.

2. The compound microscope consists of -------- lenses.

Ans. Two.

III. Match the following.

A	B
Dissecting Microscope	Single lens
Ocular Lens	Close to eyes
Oil immersion Lens	Bacteria and Algae
Electron Microscope	Ultra structure of Cell organelles

IV. Mark the correct answer.

1. The resolving power of light microscope is

a) 0.03microns b) 0.3microns√ c) 3microns d) 30microns

2. The microscope used to study the transparent living cells is

a) Electron microscope b) Interference microscope c) Phase contrast microscope√
d) Fluorescent microscope

Answer Key To Diagnostic Test

Practical – II - Observation and identification of Permanent slide of Monocot stem

Major Skill: Observation

I. Answer the fallowing questions in a word phrase or sentence.

1.Why monocots have thin and non-woody stems?
Ans. Because cambium is absent in monocot stems so no secondary growth takes place.
2. What is good focusing?
Ans. Good focusing involves selection of a clear slide, appropriate light adjustment and clarity of profile section.
3.What is function of epidermis?
Ans. It is protective in function.

II. Fill up the blanks.

1.---------- pith is present in monocot stems.
Ans. reduced
2. ---------- is absent between xylem and phloem in a monocot stem.
Ans. Cambium

III. Match the following.

A	B
Epidermis	Outer most layer
Hypodermis	Sclerenchyma
Cortex	Parenchyma
Vascular bundles	Closed
Pith	Reduced

IV. Mark the correct answer.

1.This gives mechanical support to the Monocot stem

a) Epidermis b) Hypodermis√ c) Cortexd)Vascular bundles

2. Endarch condition means

a) Protoxylem towards pith √ b) Protoxylem towards periphery

c) Protoxylem in the center d) none

Answer Key To Diagnostic Test

Practical – III - Making transverse sections of dicot stem and study of different tissues under microscope

Major Skill: Section cutting and mounting

I. Answer the fallowing questions in a word phrase or sentence.

1.What is a good section?

Ans. A good section is a thin, uniform and complete one.

2.What is use of pith in section cutting?

Ans. Pith keeps the delicate cutting material erect and gives a firm hold.

3.Why staining is required?

Ans. Staining helps in the proper differentiation and identification of tissues.

II. Fill up the blanks.

1.The cutting material should be held in ---------- hand.

Ans. left

2.The razor should be held in ---------- hand.

Ans. right

III. Match the following.

A	B
Section cutting	Glycerine
Staining	Microscope
Mounting	Razor
Focusing	Coloring tissue

IV. Mark the correct answer.

1.Good section is

a). Thin b). Uniform c).Complete d). All three√

2. A section should be mounted on a slide in the

a) centre√ b) right end c) left end d) any where

Answer Key To Diagnostic Test

Practical – IV - To prepare temporary mount of onion root tip to study various stages of Mitosis

Major Skill: Teasing and Mounting

I. **Answer the fallowing questions in a word phrase or sentence.**

1. What is mitosis?

Ans. The cell division which results in the production of two daughter cells which are exactly similar to the parent cell thereby maintaining the chromosome number constant.

2. Which stage of mitosis shows thickest chromosomes with two chromatids?

Ans. Metaphase.

3. Which stain is used to study the mitosis in onion root tips?

Ans. Acetocarmine.

4. Why do we select root tip to study mitosis?

Ans. At the root tip meristematic tissues are found which keep dividing, hence various stages of mitosis can be easily studied.

5. Why fixatives are used in the study of mitosis?

Ans. Fixatives are used to preserve the morphological organization and chemical composition of the cells for future studies.

II. **Fill up the blanks.**

1. ---------- daughter cells are formed as a result of mitotic division.

Ans. Two.

2. The uncontrolled mitotic division leads to ----------

Ans. Cancer.

III. **Match the following.**

A	B
Prophase	Nucleolus disappears
Metaphase	Chromosomes are linearly arranged on the equator
Anaphase	Chromatids gets separated from each other and move towards the opposite poles
Telophase	Two daughter nuclei are seen on opposite poles

IV. **Mark the correct answer.**

1. To study mitosis in onion root tips, the roots should be harvested between

a). 6 to 8 AM b). 8 to 10 AM √ c). 6 to 8 PM d). 8 to 10 PM

2. The cell division involves

a) karyo-kinesis b) cytokinesis c) both a & b√ d) none

Answer Key To Diagnostic Test

Practical – V - Preparation of Reagents

Major Skill – A - Preparation of Reagents

I. Answer the fallowing questions in a word phrase or sentence.

1. What are fixatives?

Ans. Fixatives are the chemicals used to preserve the morphological organization and chemical composition of the cells for future studies.

2. What is staining?

Ans. The process of colouring cells, tissues or animal and plant bodies by certain organic and inorganic dyes is known as staining.

3. What is a solution?

Ans. Solution is a homogenous mixture of two or more substances.

4.What is a molar solution?

Ans. It is 1 gm molecular weight of a substance dissolved in 1 litre of solution.

II. Fill up the blanks.

1. ---------- is a good fixative and preservative for Plant and Animal specimens.

Ans. Formalin 40%

2. One gram equivalent weight of a compound dissolved in 1litre of solution is ---------- solution.

Ans. 1 Normal solution.

III. Match the following.

A	B
Saffranin	Lignified and Cutinized tissue
Acetocarmine	Chromosomes
Eosin	Animal tissue
Crystal violet	Bacteria and Protozoa

Answer Key To Diagnostic Test

Practical –VI – Test for Sugar and Albumin

Major Skill – B - Explanation

I. **Answer the fallowing questions in a word phrase or sentence.**

1.How to handle pipette in a laboratory?

Ans. Solution should be sucked in a proper way by holding the pipette with index and thumb and exact amount of solution is drawn to marked level before pouring.

2.What is the proper use of test tube holders?

Ans. Test tube holders are used to hold test tubes firmly so that they can be hold in slant and away from the body while heating.

3.What is solution?

Ans. Solution is a homogenous mixture of two or more substances.

4.What is precipitation?

Ans. Precipitation is the formation of a precipitate layer at the top in a solution.

II. **Fill up the blanks.**

1.While heating test tube it should be kept ---------- from the body.

Ans. away

2.The holder should be fitted at ---------- position of test tube.

Ans. top

III. **Mark the correct answer.**

1.For better heating we should ensure constant

a) Blue flame b) Red flame c) Green flame d) Yellow flame

2. To identify the precipitation, test tube should be held against a

a) black background b)Red background c)White background √ d) none

Answer Key To Diagnostic Test

Practical – VII – Identification and description of China Rose

Major Skill : Description

I. Answer the fallowing questions in a word phrase or sentence.

1. What is the botanical name of China rose?

Ans. *Hibiscus rosa sinensis.*

2.China rose belongs to which family?

Ans. Malvaceae.

3.What is the type of root system in China rose?

Ans. Tap root.

4.What is floral formula?

Ans. Floral formula is a combination of abbreviations, simple diagrams and symbols used explain the floral charectors.

II. Fill up the blanks.

1.China rose belongs to ---------- order.

Ans. Malvales.

2. ---------- inflorescence is present in china rose.

Ans. Raceme.

III. Match the following.

A	B
Leaf	Petiolate
Flower	Pedecilate
Calyx	Gamopetalous
Corolla	Gamosepalous
Androecium	Monadelophous stamen

IV. Mark the correct answer.

1.China rose is a

a) Herb b) Shrub√ c) Tree d) Creeper

2. Pentacarpellary syncarpous is a condition seen in

a) Calyx b) Corolla c) Androecium d) Gynoecium√

Answer Key To Diagnostic Test

Practical – VIII - To study effect of temperature, pressure and solute concentration on osmotic movement of water

Major Skill: Experimentation

I. Answer the fallowing questions in a word phrase or sentence.

1.What is osmosis?
Ans. Diffusion of water across a selectively permeable membrane from an area of low solute concentration to an area of high solute concentration is called osmosis.
2. What is diffusion?
Ans. Movement of water from an area of high concentration to an area of low concentration is called diffusion.
3.What is a semi permeable membrane?
Ans. A membrane which allows only certain particles to pass through it is called a semi permeable membrane.
4.Why it is necessary to take dry grapes of equal size?
Ans. Variable size will affect the turgidity time and the result.

II. Fill up the blanks.

1.Diffusion of water into the dry grape is ---------- process.

Ans. endosmosis

2. ---------- is used to create pressure on water in a beaker.

Ans. Piston

III. Match the following.

A	B
Exosmosis	Flaccid raisin
Endosmosis	Turgid raisin
Semi-permeable	Cell membrane
Non permeable	Ploytene membrane

IV. Mark the correct answer.

1.Selectively permeable membrane is/are

a) Egg membrane b) Sheep bladder c) Cell membrane d) All three

2. Osmosis is the function of

a) Temperature b) Pressure c) Solute concentration d) All three

GENERAL QUESTIONNAIRE

Max. time: 15 mins.

Bio-data of the parents:

Name of the father & mother: _____

Age of the father & mother: _____

Occupation: _____

Income: _____

Educational qualification: _____

Teacher competencies

Tick the answers to the following questions with (/) mark, If your answer is; always-**A**, if it is some times-**B**; and if rarely-**C**.

01. Teacher is able to explain properly

i. **A** ii. **B** iii. **C**

02. Teacher knows the content

i. **A** ii. **B** iii. **C**

03. Teacher apologizes for a mistake

i. **A** ii. **B** iii. **C**

04. Teacher writes neatly on black board

i. **A** ii. **B** iii. **C**

05. Teacher derives formula and calculations

i. **A** ii. **B** iii. **C**

06. Teacher is able to demonstrate the experiment

i. **A** ii. **B** iii. **C**

07. Teacher is prepared properly for the class

i. **A** ii. **B** iii. **C**

08. Teacher is able to answer all the questions

i. **A** ii. **B** iii. **C**

09. Teacher is fluent in giving the instructions

i. **A** ii. **B** iii. **C**

Instructional strategies

Tick the answers to the following questions with (/) mark, if your answer is; always-**A**,
if it is some times-**B**; and if rarely-**C**.

01. The teacher/instructor explained the procedure of experiment

i. **A** ii. **B** iii. **C**

02. The teacher/instructor explained how to carry out experiment

i. **A** ii. **B** iii. **C**

03. The teacher/instructor explained how to handle the apparatus

i. **A** ii. **B** iii. **C**

04. The teacher/instructor demonstrated the entire experiment

i. **A** ii. **B** iii. **C**

05. The teacher/instructor demonstrated how to handle the apparatus

i. **A** ii. **B** iii. **C**

06. The teacher/instructor gave sufficient time to carry out the experiment

i. **A** ii. **B** iii. **C**

07. The teacher/instructor took personal interest in students

i. **A** ii. **B** iii. **C**

08. Instructor met the students voluntarily and cleared their doubts

i. **A** ii. **B** iii. **C**

09. Activities in the class were clearly and carefully planned
i. **A** ii. **B** iii. **C**

10. Teacher sticks to class work and doesn't get sidetracked
i. **A** ii. **B** iii. **C**

11. Teacher allows student to ask questions in the class
i. **A** ii. **B** iii. **C**

12. One teacher explained theory and another explained the lab experiments; there is a difference in teaching methods
i. **A** ii. **B** iii. **C**

Lack of Instruction materials

1. Do you have trouble obtaining materials that you need for study?	**Yes/No**
2. Is it clearly mentioned /explained usage of lab instruments?	**Yes/No**
3. Was the availability of place to conduct the activities sufficient?	**Yes/No**
4.Was there proper utilization of teaching aids by the teacher?	**Yes/No**
5. Whether individual access to instruments/gadgets/glasswares were provided?	**Yes/No**
6. Whether experimental protocol/lab manual was given well in advance?	**Yes/No**
7. Whether the instruments were in proper working condition?	**Yes/No**
8. Was the experimental procedure too lengthy and complicated one?	**Yes/No**
9. Would dictation of a set of instructions have helped?	**Yes/No**

Student background

Answer the following questions in one or two sentences.

01. Do you have any personal problems e.g. Health, finance, home, social or emotional problems which keep you from being able to study effectively?

02. Are your vocational goals defined clearly enough to give definite direction to your study efforts?

03. What do you like about your courses?

04. How interested are you in doing your class work?

05. Are you looking forward to some courses in your major area?

06. What are some of the reasons for these areas of interest?

07. Which subject do you like most in school science/ maths, etc

08. Do you feel nervous and afraid when you have to participate in class discussion?

09. Do you need written instructions?

Information processing:

Tick the answers to the following questions with(/) mark if your answer is, always-**A**, if it is some times-**B**; if it is usually-**C**; and is never-then **D**.

1. Do you have a plan of work for each day?
i. **A** ii. **B** iii. **C** iv. **D**

2. If so do you stick to it?
i. **A** ii. **B** iii. **C** iv. **D**

3. If an instructor asks whether there are any questions about what he has just presented, would you ask about something that you do not understand?
i. **A** ii. **B** iii. **C** iv. **D**

4. Do you attend the class only if you feel like attending it?
i. **A** ii. **B** iii. **C** iv. **D**

5. Do you place your study in accordance with the classes taken in the school?
i. **A** ii. **B** iii. **C** iv. **D**

6. Do you work without a fixed time schedule even right before an examination/classes?
i. **A** ii. **B** iii. **C** iv. **D**

7. Do you have problem in following the language spoken by the teacher during class hours?
i. **A** ii. **B** iii. **C** iv. **D**

8. Whether teacher is fast/slow in explaining the things in class?
   i. **A** ii. **B** iii. **C** iv. **D**
9. Are you able to grasp the relevant things from the lecture given by a teacher?
   i. **A** ii. **B** iii. **C** iv. **D**
10. Are you able to follow, read, write and comprehend what is taught in the class?
   i. **A** ii. **B** iii. **C** iv. **D**
11. Are you able to take down what is taught in the class with sufficient speed?
   i. **A** ii. **B** iii. **C** iv. **D**
12. Is it difficult to work without written instructions?
   i. **A** ii. **B** iii. **C** iv. **D**

Lack of ability to solve problems

01. Do you feel incapable of doing your work? **Yes/No**
02. Do you participate when there is classroom discussion? **Yes/No**
03. Do you feel nervous and afraid when you have to participate in the class discussion? **Yes/No**
04. When you do not understand something that has been explained in class do you ask questions when given the opportunity? **Yes/No**
05. When you are having trouble in a course do you try to take it to the instructor after class or
to have conference with him? **Yes/No**
06. Do you cut classes during school term? **Yes/No**
07. Are you late to class? **Yes/No**
08. Do you hand in term reports as other papers on or before the due dates? **Yes/No**
09. Do you have lack of interest in work? **Yes/No**
10. Do you have lack of concentration in work? **Yes/No**
11. Do you learn for the examination what you review to know? **Yes/No**
12. Do you copy the notes of a fellow student when you miss a class? **Yes/No**
13. Do you summarize parts of the subject matter in key words and learn list of these key words by heart? **Yes/No**
14. Do you skip passages in a book, which seem interesting but are not required for the examination in order to save time for other things, which are required? **Yes/No**

Lack of content back up

Select your answers (given below) to each of the following questions.

01. Were you explained the contents in your theory classes?
a) in detail b) in brief c) in experiment point of view
02. Content was difficult to understand
a) Not studied properly b) studied but can not recall c) studied but terms/words were difficult.
03. Instruction given by the teacher was ----
a) Proper b) improper c) proper but not understood
04. Where do you get the reading materials from? ---
a) Home b) school library c) friends
05. When do you read?
a) During holidays b) during schooldays c) during free time
06. How much time do you spend per day for reading?
a) 2 hrs b) 4 hrs c) more
07. Does any body encourage you in reading?
a) Parents b) teachers c) friends
08. Do you take notes in your classes?
a) In all classes b) in difficult subjects c) never

09. Do you recopy your notes after a lecture?
a) Yes b) not all subjects c) never

10. Do you write as fast and as much as you can during lecture/experiments?
a) Only few point b) all the points c) never

11. Do you look and edit your notes after classes
a) Yes b) no c) some time

Problems in language components

Tick the answers to the following questions with(/) mark if your answer is, always-**A**, if it is some times-**B**; if it is usually-**C**; and is never-then **D**.

1. Whether you can read the given instructions?
i. **A** ii. **B** iii. **C** iv. **D**

2. Whether you can write legibly and without spelling mistakes?
i. **A** ii. **B** iii. **C** iv. **D**

3. Whether you can understand what is given in the instructions?
i. **A** ii. **B** iii. **C** iv. **D**

4. Whether you are able to use rules, steps and facts given to you?
i. **A** ii. **B** iii. **C** iv. **D**

5. Whether you are able to ignore irrelevant instructional material?
i. **A** ii. **B** iii. **C** iv. **D**

6. Whether you are able to recognize relevant information?
i. **A** ii. **B** iii. **C** iv. **D**

CONTENT QUESTIONNAIRE

Max. time: 30 mins.

(Choose the correct answer from the given choices).

Practical 2 : Observation of Permanent slide of monocot stem.
Sub skill: Diagnostic features of monocot stem.

1. Monocot stem has
   a) Parenchyma b) Sclerenchyma c) Chlorenchyma d) All of these.
2. The Vascular bundles in a monocot stem are
   a) Conjoint collateral and open b) Conjoint collateral and closed c) Radial d) none of these.
3. The pith in the monocot stem is
   a) Large b) small c) lacking d) reduced.
4. The vascular bundles in a monocot stem are
   a) scattered b) in a single ring c) in two rings d) none of these.
5. Major tissues in a monocot stem are
   a) epidermis, hypodermis and ground tissue b) epidermis, cortex and stele c) epidermis, hypodermis and stele d) epidermis and vascular tissue.
6. Monocot stem
   a) shows the presence of vascular cambium b) shows the absence of vascular cambium c) has interfascicular cambium d) none of these.

Practical 3 : Making transverse sections of Dicot stem and study of different tissues under microscope.
Sub skill: Use of cover slips and glycerin.

1. Glycerin is a
   a) mounting medium b) stain c) fixative d) none of these.
2. During microscopy, glycerin is used instead of water because
   a) glycerin is available easily b) glycerin facilitates easy staining of the mounted material c) glycerin will not evaporate d) none of these.
3. Cover slips should not be touched in center
   a) to avoid finger prints on it b) to avoid breakage of cover slips c) both d) none of these.

Sub skill: Ability to sketch as seen under the microscopy.

1. Condenser directs the light on the specimen with the help of
   a) Eye piece b) cover slip c) mirror d) objective lens.
2. During microscopy light can be controlled using
   a) Coarse adjustment b) fine adjustment c) mirror d) diaphragm.
3. Oil immersion lens increases the resolving power of the microscope because
   a) the refractive index of glass and oil is same b) the refractive index of glass and oil is different c) both d) none of these.
4. The micro preparation (T.S) should be
   a) clean b) hazy c) full of air bubbles d) none of these.

Practical 4 : To prepare temporary mount of onion root tip to study various stages of Mitosis.
Sub skill: Observation and Identification of stages.

1. Are you familiar with all the stages of Mitosis and Meiosis? **Yes/No**
2. Interphase is characterized by appearance of distinct chromatin fibre **Yes/No**
3. Disappearance of nuclear membrane and nucleolus takes place during prophase. **Yes/No**
4. In metaphase, centromere attaches to the equator of mitotic spindle. **Yes/No**

5. V shaped chromosomes characterizes anaphase. **Yes/No**
6. During telophase of meiosis II eight daughter nuclei occurs. **Yes/No**

Sub skill: Preparation of fixatives.

1. Fixative is a compound made up of alcohol and acetic acid in the ratio of
   a) 3:1 b) 1:3 c) 2:1 d) 2:4
2. For the preparation of fixative one takes 10 ml of acetic acid in a measuring cylinder and adds to it
   a) 30 ml alcohol b) 30 ml alcohol and make the volume to 100 ml c) 90 ml acetic acid d) 90 ml alcohol.

Sub skill: Heating and use of spirit lamp.

1. Spirit lamp is used for
   a) Warming slides b) preparing hot water bath c) making rectified spirit d) for getting light.
2. Solvent used in spirit lamp is
   a) Acetone b) Benzene c) Chloroform d) Ethanol.
3. The slide or test tube to be heated has to be held
   a) at the tip of the flame b) middle of the flame c) over the wick d) over the blue part of the flame.

Sub skill: Ability to wash, root.

1. Tip of the roots are
   a) transparent b) opaque c) translucent d) None of these.
2. Roots are dipped in 1 N
   a) HCl b) H_2SO_4 c) Na_2SO_4 d) HNO_3
3. Further washing of the roots is done with
   a) HCl b) Alcohol c) Water d) None of these.
4. Washing of the roots is done
   a) on the slides b) by dipping in a bottle c) in an embryo cup d) any of the above.
5. Washing with water is done to ensure
   a) Removal of HCl b) Removal of stain c) To remove debris d) Proper staining.
6. After washing the roots, the used water is
   a) drained off b) is reutilized c) poured into a container d) none of the above.

Practical 5 : Preparation of Reagents.

Sub skill: Accurate weighing of chemicals.

1. A molar solution is
   b) a gram molecular weight of salt made up to 100 ml b) a gram molecular weight of salt dissolved in exactly 1000 ml c) a gram molecular weight of salt made up to 950 ml d) none of these.
2. 58.5 grams of NaCl in one litre of solution makes
   a) 10 Molal NaCl solution b) 58.5 Molal NaCl solution c) 1000 Molal NaCl solution d) 1 Molal NaCl solution.
3. 1 Molar NaCl solution contains
   a) 58.5 gms of NaCl made up to 1 litre b) 58.5 gms of NaCl made up to 100 ml c) 58.5 gms of NaCl made up to 500 ml d) none of these.
4. One gram equals
   a) 1 mg b) 10 mg c) 100 mg d) 1000mg.

Practical 6 : Test for Sugar and Albumin.

Sub skill: Ability to infer.

1. Turbidity in Coagulation test indicates
   a) Precipitation of albumin b) pH change c) both d) none of these.

2. Benedict's reagent contains
   a) Sodium citrate b) Sodium carbonate c) Sodium citrate + sodium carbonate + $CuSO_4$ d) none of these.
3. Albumin precipitates in addition of acetic acid in coagulation test because
   a) Protein is denatured b) protein changes c) both d) none of these.
4. Clear solution in Benedict's test indicates
   a) Glucose is absent b) glucose is present c) glucose is present but has not precipitated d) none of the above.
5. Deeper the precipitate colour (red) in Benedict's test shows
   a) more sugar b) no sugar c) less sugar d) none of these.

Practical 7 : Identification and description of China Rose.

Sub skill: Knowledge of writing the floral formula and diagram.

1. Whether the essential and non-essential parts of a flower were taught to you in the class? **Yes/No**
2. Whether you had an idea on the symbols used in writing a floral formula? **Yes/No**
3. Whether the significance of the components of floral diagram was explained in the class? **Yes/No**
4. Whether fresh material was supplied which could have helped you to locate the floral parts easily? **Yes/No**
5. In a floral diagram, circle denotes
   a) Stalk b) stem c) thalamus d) none of these.
6. In a floral diagram, bracketed structure denotes
   a) Calyx b) corolla c) Androecium d) Gynoecium.
7. In a floral diagram, sickle shaped structure denotes
   a) Calyx b) corolla c) Androecium d) Gynoecium.
8. In a floral diagram, epipetalous stamens are drawn attached to
   a) Calyx b) corolla c) Androecium d) Gynoecium.
9. T.S of ovary in floral formula is
   a) T.S b) L.S c) Sagittal section d) none of these.

Sub skill: Ability to distinguish Androecium, Gynoecium and Fruit.

2. Was the flower too small in size, which made you unable to distinguish Androecium and Gynoecium? **Yes/No**
3. Whether the distinguishing features in a flower taught to you before the class? **Yes/No**
4. Were the instruments provided in good condition? **Yes/No**
5. Whether a binocular stereo microscope was provided? **Yes/No**
6. Did the dissection microscope have sufficient magnification? **Yes/No**
7. Stamen is a unit of Gynoecium **Yes/No**
8. Pistil is a unit of calyx **Yes/No**
9. Carpel is a unit of Androecium **Yes/No**
10. Fruit is a
    a) mature flower b) mature carpel c) mature ovary d) none of these.
11. Fruit contains
    a) fruit wall b) fruit wall and seeds c) only seeds d) none of these.
12. L. S. of a flower
    a) gives all floral parts b) gives an idea of only accessory whorls c) gives an idea of only reproductive whorls d) none of these.

Sub skill: Identifying the type of inflorescence and flower.

1. How many types of inflorescences are there?
   a) 2 b) 3 c) 4 d) 5

2. What are the essential parts of a flower?
    a) Androecium & Gynoecium
    b) Androecium & Calyx
    c) Gynoecium & Corolla
    d) Calyx & Corolla
3. The stalk of the flower is called
    a) Pedicel b) Petiole c) Peduncle d) None of these.
4. The stalk of the inflorescence is called
    a) Petiole b) Peduncle c) Pedicel d) None of these.
5. When all the four sets of members are present in a flower it is called
    a) complete flower b) incomplete flower c) both d) none of these.
6. A whorl of sepaloid green bracteoles just below the calyx is
    a) Calyx b) Corolla c) Epicalyx d) Androecium
7. Cymose inflorescence has flowers in
    a) basipetalous succession b) acropetalous succession c) whorled arrangement d) none of these.
8. *Hibiscus* shows
    a) Cymose inflorescence b) racemose inflorescence c) capitulum d) none of these.
9. Bract is found at
    a) the base of leaf b) the base of inflorescence c) near the sepal d) none of these.
10. Bisexual flower has
    a) no sexual whorls b) both male and female whorls fused c) male and female whorls separate d) none of the above.
11. Racemose inflorescence has an axis of
    a) limited growth b) unlimited growth c) condensed axis d) none of these.

Sub skill: Ability to distinguish between Calyx and Corolla.

1. The lowermost whorl of a flower is
    b) Calyx b) Corolla c) Pedicel d) None of these.
2. Calyx is composed of
    a) Carpels b) Stamens c) Petals d) Sepals.
3. The second axillary whorl of flower is called
    a) Androecium b) Gynoecium c) Corolla d) Calyx.
4. Corolla is composed of
    a) Calyx b) Pedicel c) Petals d) Carpels.
5. If calyx and corolla cannot be distinguished, then it is known as
    a) Pedicel b) Perianth c) Petiole d) Petal.
6. If the petals are free, it is
    a) gamopetalous b) polypetalous c) gamosepalous d) polysepalous.
7. If the edges of petals are fused with stamen then it is called
    a) gamopetalous b) polypetalous c) epipetalous d) gamosepalous.
8. Unit of perianth is
    a) petal b) tepal c) sepal d) carpel.
9. Actinomorphic corolla is
    a) regular b) irregular c) whorled d) none of these.
10. Pentamerous condition means
    a) multiple of 5 b) multiple of 3 c) multiple of 2 d) none of these.
11. If sepals are in the condition of one in and one out then the aestivation is
    a) valvate b) twisted c) imbricate d) quinquincial.

Sub skill: Finding root system.

1. A root is
   a) positively geotropic c) negatively geotropic
   b) positively phototropic d) none of these.
2. Tap root system is in
   a) dicots b) monocots c) both d) none of these.
3. Monocots possess
   a) Taproot system b) Fibrous root system c) both d) none of these.
4. Tap root has
   a) limited growth b) unlimited growth c) is stunted d) none of these.
5. Adventitious root system
   a) is external b) is deep c) from any part of the plant d) none of these.

Sub skill: Identifying the type of leaf.

1. A simple leaf has
   a) no leaflets b) leaflets c) a single leaflet d) none of the above.
2. Venation represents
   a) vasculature b) lines c) design on leaf d) none of these.
3. Stalk of leaf is called
   a) Pedicel b) Perianth c) Petiole d) Petal.

Sub skill: Classification ability.

1. China rose belongs to family
   a) Rutaceae b) Annonaceae c) Malvaceae d) Myrtaceae
2. Botanical name of China rose is
   a) Lathyrus odoratus b) *Mimosa pudica* c) *Hibiscus rosa sinensis* d) *Michelia champaca*
3. Polypetalae is a
   a) Division b) order c) genus d) family.
4. Thalamiflorae is
   a) Series b) order c) division d) none of these.
5. Gamopetalae is characterized by
   a) no petals b) fused petals c) free petals d) fused petals and epipetalous stamens.

ANSWER KEYS FOR THE CONTENT QUESTIONNAIRE

Practical 2 : Observation of Permanent slide of monocot stem.
Sub skill: Diagnostic features of monocot stem.
1. d **2. b** **3. d** **4. a** **5. a** **6. b**

Practical 3: Making transverse sections of Dicot stem and study of different tissues under microscope.
Sub skill: Use of cover slips and glycerin.
1. a **2. c** **3. c**
Sub skill: Ability to sketch as seen under the microscopy.
1. c **2. d** **3. a** **4. a**

Practical 4: To prepare temporary mount of onion root tip to study various stages of Mitosis.
Sub skill: Observation and Identification of stages.
2. Yes **3. Yes** **4. Yes** **5. Yes** **6. Yes**
Sub skill: Preparation of fixatives.
1. a **2. a**
Sub skill: Heating and use of spirit lamp.
1. a **2. d** **3. d**
Sub skill: Ability to wash, root.
1. c **2. a** **3. c** **4. c** **5. a** **6. a**

Practical 5: Preparation of Reagents.
Sub skill: Accurate weighing of chemicals.
1. b **2. d** **3. a** **4. d**

Practical 6: Test for Sugar and Albumin.
Sub skill: Ability to infer.
1. a **2. c** **3. a** **4. a** **5. a**

Practical 7: Identification and description of China rose.
Sub skill: Knowledge of writing the floral formula and diagram.
5. a **6. a** **7. b** **8. b** **9. a**
Sub skill: Ability to distinguish androecium, gynoecium and fruit.
7. No **8. No** **9. No** **10. c** **11.b** **12. a**
Sub skill: Identifying the type of inflorescence and flower.
1. b **2. a** **3. a** **4. b** **5. a** **6. c** **7.a** **8. a** **9. a** **10. c** **11. b**
Sub skill: Ability to distinguish between calyx and corolla.
1. a **2. d** **3. c** **4. c** **5. b** **6. b** **7. c** **8. b** **9. a** **10. a** **11. b**
Sub skill: Finding root system.
1. a **2. a** **3. b** **4. b** **5. c**
Sub skill: Identifying the type of leaf.
1. a **2. a** **3. c**
Sub skill: Classification ability.
1. c **2. c** **3. a** **4. a** **5. d**

Format used for answering IQ tests

STANDARD
PROGRESSIVE MATRICES
Sets A, B, C, D, & E

Name: _____ **Ref:** _____

Place: _____ **Date:** _____

Age: _____ **Birthday:** _____

Test Begun: _____ **Test ended:** _____

A	B	C	D	E
1	1	1	1	1
2	2	2	2	2
3	3	3	3	3
4	4	4	4	4
5	5	5	5	5
6	6	6	6	6
7	7	7	7	7
8	8	8	8	8
9	9	9	9	9
10	10	10	10	10
11	11	11	11	11
12	12	12	12	12

Time	Total	Grade

Notes

Tested by _____

Table used for determining acceptability of total standard progressive matrices score

Reference Material
Table SPM2
Normal (Expected) Score composition (standard)

Total	A	B	C	D	E
10	6	2	1	1	0
11	7	2	1	1	0
12	8	2	1	1	0
13	8	3	1	1	0
14	8	3	1	1	0
15	8	3	2	1	1
16	8	4	2	1	1
17	9	4	2	1	1
18	9	4	2	2	1
19	9	5	2	2	1
20	9	5	2	2	1
21	9	5	3	2	1
22	9	5	4	3	1
23	9	6	4	3	1
24	9	6	4	4	1
25	9	6	5	4	1
26	9	6	5	5	1

Total	A	B	C	D	E
27	9	7	5	5	1
28	10	7	5	5	1
29	10	7	6	5	1
30	10	7	6	5	2
31	10	8	6	5	2
32	10	8	6	6	2
33	10	8	6	7	2
34	10	8	7	7	2
35	10	9	7	7	2
36	11	9	7	7	2
37	11	9	7	8	2
38	11	10	7	8	2
39	11	10	8	8	2
40	11	10	8	8	3
41	11	10	8	9	3
42	11	10	8	9	4
43	11	10	8	9	4

Total	A	B	C	D	E
44	11	11	9	9	4
45	12	11	9	9	4
46	12	11	9	9	5
47	12	11	9	10	5
48	12	11	9	10	6
49	12	11	10	10	6
50	12	11	10	10	7
51	12	11	10	10	8
52	12	12	10	10	8
53	12	12	11	10	8
54	12	12	11	10	9
55	12	12	11	11	9
56	12	12	11	11	10
57	12	12	12	11	10
58	12	12	12	11	11
59	12	12	12	12	11
60	12	12	12	12	12

List of correct answers used for determining raw IQ scores

STANDARD
PROGRESSIVE MATRICES
Sets A, B, C, D, & E

Name: _____ **Ref:** _____

Place: _____ **Date:** _____

Age: _____ **Birthday:** _____

Test Begun: _____ **Test ended:** _____

	A		B		C		D		E
1	4	1	2	1	8	1	3	1	7
2	5	2	6	2	2	2	4	2	6
3	1	3	1	3	3	3	3	3	8
4	2	4	2	4	8	4	7	4	2
5	6	5	1	5	7	5	8	5	1
6	3	6	3	6	4	6	6	6	5
7	6	7	5	7	5	7	5	7	1
8	2	8	6	8	1	8	4	8	6
9	1	9	4	9	7	9	1	9	3
10	3	10	3	10	6	10	2	10	2
11	4	11	4	11	1	11	5	11	4
12	5	12	5	12	2	12	6	12	5

Time	Total	Grade

Notes

Tested by _____

Reporting the results: Reporting overall in individual assessment as discussed more fully in the general section and research supplement no 3, in the most satisfactory way of assessing the significance of a person 's total score is to identify the percentage of a number of reference groups of the same birth cohort who obtain Lower (or higher) scores. As shown in research supplements No.3 (where the problem inherent in the use of deviation IQs are discussed income details) this has the advantage that no a prior assumption is made that, in childhood, the development of intellectual capacity is necessary uniform or distributed symmetrically for practical purposes it is convenient to consider certain percentage of the population and to group people scores accordingly. In this Way it is possible to classify a person according to the score attained as shown below.

Grade I : "Intellectually superior," if a score lies at or above the 95 percentile for people of the same age group.

Grade II : "Definitely above the average in intellectual capacity" if a score lies at or above the 75 percentile.(it may be designated II + if lies at or above the 90 percentile)

Grade III: " Intellectually average," if a score lies between the 25 and 75 percentile.(It may be designated III+, if it is above 50 percentile, and III -, if it is below it)

Grade IV: " Definitely below average in intellectual capacity": if a score lies at or below the 25 percentile. (It may be designated IV if lies at or below the 10 percentile)

Grade V:" Intellectually impaired," if a score lies at or below 5 percentile for that age group.

The total score obtained, the consistency of an estimate and the grade reached are conveniently summarized in the following examples

Total	46
Discrepancies	0, +1, -2, +2, -1
Grade	III +
Time	38 Minutes

In order to avoid the test becoming too long or unwieldy and thus to retain a test of maximum usefulness certain compromises have been made in its development as a result ability to differentiate clearly among the less able has been restored through the development of SPM Plus, if more differentiation is required at the lower or upper end, the CPM (Respectively) should be used if a shorter (but necessarily less reliable) assessment is required APM set. I may be used on its own, other attempts to over come the limitations of the SPM by lengthening it, dividing it arranging the items in as single continuous order, and re-arranging the items have been found seriously to limit the usefulness of the test as a whole. The development of such variations by individual users should therefore be avoided, while they may result in a test, which is norms for the test administered individually by a psychologist or test administrator tend to lag behind those obtained through either individual self administration or group administration. However, the only norms now available for the test administered individually come from the 1943 standardization among children. These lag same 10 row score points behind current norms and are less appropriate than simply making an allowance for the effect of individual testing. Comparison of the early norms suggests that it might be appropriate, in the case of individual administration.

Table used for percentile determination in SPM Test (Page SPM 74)
Table SPM 9
Standard Progressive matrices
Smoothed Summary norms for children and Young people in the United States of America

Percentile	6.5	7	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19
	6.3 to 5.8	6.9 to 7.2	7.3 to 7.8	7.9 to 8.2	8.3 to 8.8	8.9 to 9.2	9.3 to 9.8	9.9 to 10.2	10.3 to 10.8	10.9 to 11.2	11.3 to 11.8	12.9 to 12.2	12.3 to 12.8	12.9 to 13.2	13.3 to 13.8	13.9 to 14.2	14.3 to 14.8	14.9 to 15.2	15.3 to 15.8	15.9 to 16.2	16.3 to 16.8	16.9 to 17.2	17.3 to 17.8	18.3 to 18.2	18.3 to 18.8	18 to 19
95	30	33	36	38	40	42	46	47	48	49	50	51	52	53	54	55	56	57	57	58	58	59	59	59	59	59
90	27	30	33	36	38	40	42	44	45	46	47	48	49	50	51	52	52	53	54	56	56	57	57	58	58	58
75	21	25	28	31	34	36	38	40	41	43	44	45	46	47	48	49	49	50	51	53	54	55	55	56	56	56
50	14	17	20	23	26	29	32	34	36	37	38	39	40	41	42	43	44	45	46	48	44	50	51	52	52	52
25	12	13	14	16	18	21	24	26	28	30	32	33	34	35	36	37	38	39	40	42	43	44	45	46	47	47
10	9	10	11	13	14	16	17	19	21	23	25	27	28	30	31	32	33	35	35	37	38	39	40	41	41	41
05	7	8	9	10	11	12	13	15	17	18	19	21	22	24	26	27	28	29	29	31	32	33	34	35	35	35

These overall norms were derived from the local norms collected in 1984-87 and published in research supplement no.3 giving the norms obtained in the various districts different weights according to the frequency with which districts with those demographic data occur in the US as a whole. The norms from 17-19 year old have been interpolated using the figures from the 1993 US adult standardization as will be seen from the supplement the norms vary markedly from one school district to another and, within districts, between groups, users are therefore urged to ensure that the norms they use are appropriate to the purpose for which they wish to use them, In addition to regional and ethnic norms, research supplement no.3 includes a table giving the percentile equivalent of every raw score, atable to convert percentile to deviation IQ and stanines, confidence in intervals, and additional studies of the tests internal consistency and validity.