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INTRODUCTION TO PLANT TISSUE CULTURE PLANT TISSUE CULTURE: THEORY AND TECHNIQUES EXPERIMENTS IN PLANT TISSUE CULTURE PLANT TISSUE CULTURE MANUAL PLANT TISSUE CULTURE CONCEPTS AND LABORATORY EXERCISES PLANT TISSUE CULTURE PLANT TISSUE CULTURE MANUAL AN INTRODUCTION TO PLANT TISSUE CULTURE INTRODUCTION TO CELL AND TISSUE CULTURE PLANT TISSUE CULTURE PLANT TISSUE CULTURE AN INTRODUCTION TO CELL AND TISSUE CULTURE PLANT CELL AND TISSUE CULTURE PLANT TISSUE CULTURE ANIMAL TISSUE CULTURE PLANT TISSUE CULTURE ENGINEERING PLANT TISSUE CULTURE AS A SOURCE OF BIOCHEMICALS PLANT TISSUE CULTURE PLANT TISSUE CULTURE HANDBOOK ON PLANT AND CELL TISSUE CULTURE M. K. RAZDAN SHAILESH KUMAR JOHN H. DODDS K. LINDSEY ROBERT N. TRIGIANO TIMIR BARAN JHA K. LINDSEY JENNIE P. MATHER EDWARD E JOHNSON B. N. SATHYANARAYANA J. REINERT MARGIT LAIMER A WILSON ARUNI S. DUTTA GUPTA E. JOHN STABA S.S BHOJWANI ROBERTA H. SMITH NIIR BOARD OF CONSULTANTS AND ENGINEERS

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INTRODUCTION AND TECHNIQUES INTRODUCTORY HISTORY LABORATORY ORGANISATION MEDIA ASEPTIC MANIPULATION BASIC ASPECTS CELL CULTURE CELLULAR TOTIPOTENCY SOMATIC EMBRYOGENESIS APPLICATIONS TO PLANT BREEDING HAPLOID PRODUCTION TRIPLOID PRODUCTION IN VITRO POLLINATION AND FERTILIZATION ZYGOTIC EMBRYO CULTURE SOMATIC HYBRIDISATION AND CYBRIDISATION GENETIC TRANSFORMATION SOMACLONAL AND GAMETOCLONAL VARIANT SELECTION APPLICATION TO HORTICULTURE AND FORESTRY PRODUCTION OF DISEASE FREE PLANTS CLONAL PROPAGATION GENERAL APPLICATIONS INDUSTRIAL APPLICATIONS SECONDARY METABOLITE PRODUCTION GERMLASM CONSERVATION

BIOTECHNOLOGY IS AN EMERGING FIELD OF SCIENCE AND AS SUCH THE GOVERNMENT OF INDIA IS LAYING A LARGE AND EXCLUSIVE IMPETUS ON IT PLANT TISSUE CULTURE IS THE BASIC AND THE MOST IMPORTANT ASPECT OF BIOTECHNOLOGY THEREFORE PLANT TISSUE CULTURE HAS BEEN INTRODUCED AS A COMPULSORY COURSE IN THE

UNDERGRADUATE AND POSTGRADUATE SYLLABI OF ALL THE AGRICULTURAL UNIVERSITIES ICAR INSTITUTES AND OTHER PLANT SCIENCE RELATED EDUCATIONAL ORGANIZATIONS THIS BOOK HAS BEEN DESIGNED TO BENEFIT THE STUDENTS THE RESEARCH SCHOLARS AND THE SCIENTISTS FOR DEVELOPING A LEVEL OF SELF CONFIDENCE TO CONDUCT THE EXPERIMENTS INDEPENDENTLY AND CAN ACQUIRE THE PRACTICAL SKILLS ALONG WITH THE BASIC KNOW HOW ABOUT THE TECHNIQUES BEING USED EACH CHAPTER IS DEVOTED TO A SEPARATE ASPECT OF PLANT TISSUE CULTURE AND THE CHAPTERS ARE ARRANGED IN THE ORDER OF INCREASING TECHNICAL COMPLEXITY THE OPENING CHAPTERS PRESENT A BRIEF HISTORICAL SURVEY OF THE FIELD OF PLANT TISSUE CULTURE A BACKGROUND IN STERILIZATION TECHNIQUES THE TEXT DEALS WITH THE EXPERIMENTAL DETAILS OF EACH AND EVERY TECHNIQUE THE PROTOCOLS HAVE BEEN SIMPLIFIED LEGIBLY TO INCLUDE DETAILS AND NOTES THAT WE HOPE WILL HELP THE USER AVOID UNNECESSARY ERRORS AND CONFUSION ALL THE APPLICATIONS OF PLANT TISSUE CULTURE HAVE BEEN VERY WELL DISCUSSED AND THE TECHNIQUES ASSOCIATED WITH THEM DESCRIBED IN DETAIL THIS BEING A COMPLETE BOOK ON PLANT TISSUE CULTURE WILL SOLVE ALL TYPES OF PROBLEM OF THE USERS WHO WILL NOT HAVE TO USE OTHER RESOURCE BOOKS FOR THE SAME PURPOSE

THE SECOND EDITION OF EXPERIMENTS IN PLANT TISSUE CULTURE MAKES AVAILABLE NEW INFORMATION THAT HAS RESULTED FROM RECENT ADVANCES IN THE APPLICATIONS OF PLANT TISSUE CULTURE TECHNIQUES TO AGRICULTURE AND INDUSTRY THIS COMPREHENSIVE LABORATORY TEXT TAKES THE READER THROUGH A GRADED SERIES OF EXPERIMENTAL PROTOCOLS AND ALSO PROVIDES AN INTRODUCTORY REVIEW OF EACH TOPIC TOPICS INCLUDE A PLANT TISSUE CULTURE LABORATORY ASEPTIC TECHNIQUES NUTRITIONAL COMPONENTS OF MEDIA CALLUS INDUCTION ORGAN FORMATION XYLEM CELL DIFFERENTIATION ROOT CULTURES CELL SUSPENSIONS MICROPROPAGATION EMBRYOGENESIS ISOLATION AND FUSION OF PROTOPLASTS HAPLOID CULTURES STORAGE OF PLANT GENETIC RESOURCES SECONDARY METABOLITE PRODUCTION AND QUANTIFICATION OF PROCEDURES THIS VOLUME OFFERS ALL OF THE BASIC EXPERIMENTAL METHODS FOR THE MAJOR RESEARCH AREAS OF PLANT TISSUE CULTURE AND IT WILL BE INVALUABLE TO UNDERGRADUATES AND RESEARCH INVESTIGATORS IN THE PLANT SCIENCES

ALTERNATING BETWEEN TOPIC DISCUSSIONS AND HANDS ON LABORATORY EXPERIMENTS THAT RANGE FROM THE IN VITRO FLOWERING OF ROSES TO TISSUE CULTURE OF FERNS PLANT TISSUE CULTURE CONCEPTS AND LABORATORY EXERCISES SECOND EDITION ADDRESSES THE MOST CURRENT PRINCIPLES AND METHODS IN PLANT TISSUE CULTURE RESEARCH THE EDITORS USE THE EXPERTISE OF SOME OF THE TOP RESEARCHERS AND EDUCATORS IN PLANT BIOTECHNOLOGY TO FURNISH STUDENTS INSTRUCTORS AND RESEARCHERS WITH A BROAD CONSIDERATION OF THE FIELD DIVIDED INTO EIGHT MAJOR PARTS THE TEXT COVERS EVERYTHING FROM THE HISTORY OF PLANT TISSUE CULTURE AND BASIC METHODS TO PROPAGATION TECHNIQUES CROP IMPROVEMENT PROCEDURES SPECIALIZED APPLICATIONS AND NUTRITION OF CALLUS CULTURES NEW TOPIC DISCUSSIONS AND LABORATORY EXERCISES IN THE SECOND EDITION INCLUDE MICROPROPAGATION OF DIEFFENBACHIA MICROPROPAGATION AND IN VITRO FLOWERING OF ROSE PROPAGATION FROM NONMERISTEMATIC TISSUE ORGANOGENESIS VARIATION IN CULTURE AND TISSUE CULTURE OF FERNS IT IS THE BOOK'S EXTENSIVE LABORATORY EXERCISES THAT PROVIDE A HANDS ON APPROACH IN ILLUSTRATING VARIOUS TOPICS OF DISCUSSION FEATURING STEP BY STEP PROCEDURES ANTICIPATED RESULTS AND A LIST OF MATERIALS NEEDED WHAT'S MORE EDITORS TRIGIANO AND GRAY GO BEYOND MERE BASIC PRINCIPLES OF PLANT TISSUE CULTURE BY INCLUDING CHAPTERS ON GENETIC TRANSFORMATION TECHNIQUES AND PHOTOGRAPHIC METHODS AND STATISTICAL ANALYSIS OF DATA IN ALL PLANT TISSUE CULTURE CONCEPTS AND LABORATORY EXERCISES SECOND EDITION IS A VERITABLE HARVEST OF INFORMATION FOR THE CONTINUED STUDY AND RESEARCH IN PLANT TISSUE CULTURE SCIENCE

PLANT TISSUE CULTURE IN ONE FORM OR ANOTHER HAS BECOME ONE OF THE MOST PROMISING BRANCHES OF PLANT SCIENCE ARISING FROM THE TOTIPOTENCY OF PLANT CELLS IT NOW OCCUPIES A KEY POSITION IN PLANT BREEDING PLANT PROPAGATION AND PLANT BIOTECHNOLOGY PLANT TISSUE CULTURE BASIC AND APPLIED BRINGS TO THE

STUDENT ACCESSIBLE UP TO DATE INFORMATION ON THIS SUBJECT BASIC KNOWLEDGE OF TISSUE CULTURE METHODS SUCH AS ISOLATION OF SUITABLE TISSUES FROM THE MOTHER PLANT MAINTENANCE OF THE TISSUES UNDER IN VITRO CONDITION IN AN UNDIFFERENTIATED OR DE DIFFERENTIATED STAGE METHODS OF GENETIC ENGINEERING AND GENE TRANSFER CHROMOSOMAL STUDIES AND THE HANDLING OF IN VITRO MICRO PLANTS ARE DESCRIBED IN DETAIL IN THIS BOOK SIMILARLY APPLICATION ASPECTS OF MICROPROPAGATION HAPLOID CELL CULTURE PROTOPLAST CULTURE EMBRYO CULTURE SOMATIC EMBRYOGENESIS AND ARTIFICIAL SEEDS ARE ALSO DISCUSSED

BASIC TECHNIQUES CELLS TISSUE CULTURE OF MODEL SPECIES TISSUE CULTURE TRANSFORMATION OF CROP SPECIES PROPAGATION CONSERVATION OF GERMPLASM DIRECT GENE TRANSFER PROTOPLAST FUSION REPRODUCTIVE TISSUES MUTANT SELECTION

IT IS A PLEASURE TO CONTRIBUTE THE FOREWORD TO INTRODUCTION TO CELL AND TISSUE CULTURE THE ORY AND TECHNIQUES BY MATHER AND ROBERTS DESPITE THE OCCASIONAL APPEARANCE OF THOUGHT FUL WORKS DEVOTED TO ELEMENTARY OR ADVANCED CELL CULTURE METHODOLOGY A PLACE REMAINS FOR A COMPREHENSIVE AND DEFINITIVE VOLUME THAT CAN BE USED TO ADVANTAGE BY BOTH THE NOVICE AND THE EXPERT IN THE FIELD IN THIS BOOK MATHER AND ROBERTS PRESENT THE RELEVANT METHOD OLOGY WITHIN A CONCEPTUAL FRAMEWORK OF CELL BIOLOGY GENETICS NUTRITION ENDOCRINOLOGY AND PHYSIOLOGY THAT RENDERS TECHNICAL CELL CULTURE INFORMATION IN A COMPREHENSIVE LOGICAL FOR MAT THIS ALLOWS TOPICS TO BE PRESENTED WITH AN EMPHASIS ON TROUBLESHOOTING PROBLEMS FROM A BASIS OF UNDERSTANDING THE UNDERLYING THEORY THE MATERIAL IS PRESENTED IN A WAY THAT IS ADAPTABLE TO STUDENT USE IN FORMAL COURSES IT ALSO SHOULD BE FUNCTIONAL WHEN USED ON A DAILY BASIS BY PROFESSIONAL CELL CULTURISTS IN A DEMIA AND INDUSTRY THE VOLUME INCLUDES REFERENCES TO RELEVANT INTERNET SITES AND OTHER USE FUL SOURCES OF INFORMATION IN ADDITION TO THE FUNDAMENTALS ATTENTION IS ALSO GIVEN TO MOD ERN APPLICATIONS AND APPROACHES TO CELL CULTURE DERIVATION MEDIUM FORMULATION CULTURE SCALE UP AND BIOTECHNOLOGY PRESENTED BY SCIENTISTS WHO ARE PIONEERS IN THESE AREAS WITH THIS VOLUME IT SHOULD BE POSSIBLE TO ESTABLISH AND MAINTAIN A CELL CULTURE LABORATORY DEVOT ED TO ANY OF THE MANY DISCIPLINES TO WHICH CELL CULTURE METHODOLOGY IS APPLICABLE

DO YOU WANT TO KNOW HOW TO TISSUE CULTURE PLANTS AND GROW MORE IN LESS SPACE IF SO THIS HOW TO GUIDE IS FOR YOU PLANT TISSUE CULTURE CAN BE DONE AT HOME WITHOUT EXPENSIVE LAB GRADE GEAR INSIDE YOU WILL FIND EASY AND AFFORDABLE ALTERNATIVES TO SUPPLIES AND EQUIPMENT THAT WOULD OTHERWISE BE UNOBTAINABLE TO MOST THE RETURN IN NUMBERS OF PLANTS FOR YOUR INVESTMENT IS VERY LUCRATIVE AND REWARDING NOT TO MENTION EASY ANYONE THAT CAN COOK DINNER CAN PRACTICE MICROPROPAGATION OF PLANTS IN A COMPACT SPACE AND IN INCREDIBLE NUMBERS ANYONE THAT HAS SEEN THE EXPLODING PRICE OF HOUSEPLANTS AND RECREATIONAL PLANTS CAN SEE WHAT A REWARD GROWING THOUSANDS OF PLANTS YOURSELF CAN BRING WHAT YOU NEED TO START A SUCCESSFUL LAB AT HOME IN A COMPACT SPACEHOW TO USE YOUR EQUIPMENT AND SUPPLIES AS EASILY AS POSSIBLEWHAT EACH STAGE DOES AND HOW TO EASILY PERFORM THE TASKSHOW TO GET YOUR FAVORITE PLANTS INTO TISSUE CULTUREWHY YOU SHOULD BE USING PLANT TISSUE CULTURE TO GROW TO YOUR POTENTIALHOW TO GROW OUT YOUR TISSUE CULTURED PLANTS FOR OUTSIDE OR SALEAQUARIUM PLANTS HOUSEPLANTS GARDEN PLANTS RECREATIONAL PLANTS CARNIVOROUS PLANTS ORCHIDS MOSSES AND MORE CAN QUICKLY AND EASILY BE MULTIPLIED MANY PLANTS YOU SEE AT GARDEN CENTERS ARE PROPAGATED BY PLANT TISSUE CULTURE AND YOU CAN DO IT TOO TURN ONE PLANT INTO THOUSANDS QUICKLY IN THE AMOUNT OF TIME IT TAKES TO GROW A CUTTING TO PRODUCE NEW SHOOTS TO MAKE MORE CUTTINGS YOU CAN HAVE HUNDREDS OF PLANTS IN MANY SPECIES PLANT TISSUE CULTURE ALLOWS THE MULTIPLICATION OF YOUR PRIZED PLANTS EXPONENTIALLY IT ALSO ALLOWS YOU TO USE A KITCHEN CORNER OR A SMALL ROOM AS A LAB AREA THAT WILL GIVE YOU POSITIVE RESULTS KEEP UP WITH THE DEMAND AND CHANGING TASTES OF THE PLANT

HOBBY PROPAGATE PLANTS FASTER WITH TISSUE CULTURE AND KEEP UP WITH YOUR DEMAND FOR MORE PLANTS

PLANT TISSUE CULTURE FORMS AN INTEGRAL BASIS OF THE PRESENT DAY BIOTECHNOLOGY PLANT TISSUE CULTURE PRACTICES AND NEW EXPERIMENTAL PROTOCOLS IS BEING BROUGHT OUT TO FILL THE EXISTING GAP IN THE AVAILABLE LITERATURE ON PLANT TISSUE CULTURE ESPECIALLY FOCUSING ON THE ASPECTS OF PRACTICAL PROCEDURES AND PROTOCOLS OF TISSUE CULTURE THIS BOOK CONTAINS IMPORTANT EXPERIMENTAL TECHNIQUES AND GIVES GUIDANCE ON CARRYING OUT HANDS ON EXPERIENCES IT HAS BEEN DESIGNED IN A SIMPLE WAY GIVING ALL THE NECESSARY PROCEDURES AS A GENERAL GUIDELINE AND ALSO NECESSARY TIPS TO MANEUVER ANY PROBLEM ENCOUNTERED THESE TIPS ARE BASED ON THE FIRST HAND EXPERIENCES OF THE AUTHOR WHILE TEACHING AND RESEARCHING THE TECHNIQUES OF PLANT TISSUE CULTURE A UNIQUE FEATURE OF THIS BOOK IS THE INCLUSION OF SEVERAL TECHNIQUES DESCRIBING THE ACTUAL PROTOCOLS EXPERIMENTED AND DEVELOPED WITH DIFFERENT PLANT SPECIES BY DIFFERENT SCIENTISTS A SUBSTANTIAL NUMBER OF ORIGINAL COLORED PLATES INCLUDING FLUORESCENCE PHOTOGRAPHS STANDOUT THE BOOK THIS PIONEERING WORK IS VALUABLE FOR THE STUDENTS WHO ARE LOOKING FOR FRESH OUTLOOK AND SEARCH

THE TECHNIQUES OF PLANT ORGAN TISSUE AND CELL CULTURE CONCENTRATED ON REPRODUCIBILITY SIMPLICITY AND ACCU ARE NOW ESTABLISHED IN MANY RESEARCH LABORATORIES RACY WITH SUFFICIENT ILLUSTRATION TO MAKE ALL MANI THROUGHOUT THE WORLD AND ARE BEING USED IN NUMEROUS PULATIONS CLEAR AREAS OF PLANT SCIENCE METHODS HAVE BEEN DEVELOPED THE DRAWINGS OF ITEMS USED IN THE BENCH LAYOUT TO PROPAGATE PLANTS AND FREE THEM FROM VIRUSES USING DIAGRAMS ARE SYMBOLIC AND ARE KEYED IN BY NUMBER TO SHOOT TIP CULTURE THE REGENERATION OF PLANTS FROM CALLUS THE LIST OF MATERIALS AND EQUIPMENT A LINE AROUND AN CULTURE HAS ALSO PROVED USEFUL COMMERCIALY ELEGANT ITEM INDICATES THAT IS STERILE TECHNIQUES HAVE BEEN USED TO SYNTHESISE SOMATIC THE ADOPTION OF AN INTEGRATED TEXT IN WHICH DIAGRAMS HYBRIDS BY THE FUSION OF PROTOPLASTS AND TO TRANSFORM ARE RELATED SPATIALLY TO THE METHODS WILL WE HOPE HELP CELLS THESE AND MANY OTHER TECHNIQUES HAVE BEEN THE STUDENT TO GRASP THE TECHNIQUES QUICKLY AND EFFEC AND CAN BE USED TO INVESTIGATE A VARIETY OF BOTANICAL TIVELY THIS IS FIRST AND FOREMOST A MANUAL WHICH HAS ITS PHENOMENA AS WELL AS TO IMPROVE CROP PLANTS AND NOW PLACE ON THE LABORATORY BENCH OPEN IN FRONT OF THE PROVIDE AN IMPORTANT PART OF THE BASIC EXPERIMENTAL STUDENT A BOOK TO BE USED SKILLS REQUIRED BY A MAJORITY OF EXPERIMENTAL BOTANISTS

CELL AND TISSUES CULTURE HAS BEEN ONE OF THE FIRST AND FOREMOST TECHNIQUES PAVING FOR RECENT CUTTING EDGE TECHNOLOGIES SUCH AS VACCINOLOGY MONOCLONAL ANTIBODY PRODUCTION THERAPEUTIC CLONING STEM CELL TECHNOLOGY ETC IT HAS PLAYED A SUBSTANTIAL ROLE IN THE DEVELOPMENTS OF HEALTH CARE AND PROPHYLACTICS INDUSTRIES THUS SERVING THE MANKIND IT HAS MADE THE DREAM OF PRODUCING COST EFFECTIVE PROPHYLACTICS DIAGNOSTICS AND THERAPEUTICS COME TRUE AND AFFORDABLE IN THE RECENT PAST WITH THE EXPLOSION OF KNOWLEDGE IN THE FIELD OF BIOTECHNOLOGY INTENSIVE RESEARCH IN BEING CARRIED OUT WHERE UNDERGRADUATE AND POST GRADUATE COURSES ARE BEING OFFERED IN THIS FIELD EVEN THROUGH MORE EMPHASIS IS BEING GIVEN TO THEORY A DEARTH OF PRACTICAL KNOWLEDGE IS LACKING DUE TO PAUCITY OF ESTABLISHED TISSUE CULTURE FACILITIES

IT IS MY PRIVILEGE TO CONTRIBUTE THE FOREWORD FOR THIS UNIQUE VOLUME ENTITLED PLANT TISSUE CULTURE ENGINEERING EDITED BY S DUTTA GUPTA AND Y IBARAKI WHILE THERE HAVE BEEN A NUMBER OF VOLUMES PUBLISHED REGARDING THE BASIC METHODS AND APPLICATIONS OF PLANT TISSUE AND CELL CULTURE TECHNOLOGIES AND EVEN CONSIDERABLE ATTENTION PROVIDED TO BIOREACTOR DESIGN RELATIVELY LITTLE ATTENTION HAS BEEN AFFORDED TO THE ENGINEERING PRINCIPLES THAT HAVE

EMERGED AS CRITICAL CONTRIBUTIONS TO THE COMMERCIAL APPLICATIONS OF PLANT BIOTECHNOLOGIES THIS VOLUME PLANT TISSUE CULTURE ENGINEERING SIGNALS A TURNING POINT THE RECOGNITION THAT THIS SPECIALIZED FIELD OF PLANT SCIENCE MUST BE INTEGRATED WITH ENGINEERING PRINCIPLES IN ORDER TO DEVELOP EFFICIENT COST EFFECTIVE AND LARGE SCALE APPLICATIONS OF THESE TECHNOLOGIES I AM MOST IMPRESSED WITH THE ORGANIZATION OF THIS VOLUME AND THE EXTENSIVE LIST OF CHAPTERS CONTRIBUTED BY EXPERT AUTHORS FROM AROUND THE WORLD WHO ARE LEADING THE EMERGENCE OF THIS INTERDISCIPLINARY ENTERPRISE THE EDITORS ARE TO BE COMMENDED FOR THEIR SKILFUL CRAFTING OF THIS IMPORTANT VOLUME THE FIRST TWO PARTS PROVIDE THE BASIC INFORMATION THAT IS RELEVANT TO THE FIELD AS A WHOLE THE FOLLOWING TWO PARTS ELABORATE ON THESE PRINCIPLES AND THE LAST PART ELABORATES ON SPECIFIC TECHNOLOGIES OR APPLICATIONS

LABORATORY CULTURE NUTRITION AND METABOLISM SECONDARY METABOLISM AND BIOTRANSFORMATION SELECTION OF PLANT CELL LINES WHICH ACCUMULATE COMPOUNDS STORAGE OF PLANT CELL LINES ENVIRONMENTAL FACTORS LIGHT TEMPERATURE AERATION AND PH MASS CULTURE SYSTEMS FOR PLANT CELL SUSPENSIONS INDUSTRIAL AND GOVERNMENT RESEARCH PRODUCT COST ANALYSIS PRODUCTS

PLANT TISSUE CULTURE THIRD EDITION BUILDS ON THE CLASSROOM TESTED AUDIENCE PROVEN MANUAL THAT HAS GUIDED USERS THROUGH SUCCESSFUL PLANT CULTURING A TUMEFACIENS MEDIATED TRANSFORMATION INFUSION TECHNOLOGY THE LATEST INFORMATION ON MEDIA COMPONENTS AND PREPARATION AND REGENERATION AND MORPHOGENESIS ALONG WITH NEW EXERCISES AND DIAGRAMS PROVIDE CURRENT INFORMATION AND EXAMPLES THE INCLUDED EXPERIMENTS DEMONSTRATE MAJOR CONCEPTS AND CAN BE CONDUCTED WITH A VARIETY OF PLANT MATERIAL THAT ARE READILY AVAILABLE THROUGHOUT THE YEAR THIS BOOK PROVIDES A DIVERSE LEARNING EXPERIENCE AND IS APPROPRIATE FOR BOTH UNIVERSITY STUDENTS AND PLANT SCIENTISTS PROVIDES NEW EXERCISES DEMONSTRATING TOBACCO LEAF INFILTRATION TO OBSERVE TRANSIENT EXPRESSION OF PROTEINS AND SUBCELLULAR LOCATION OF THE PROTEIN AND INFORMATION ON DEVELOPMENT OF A CUSTOMIZED PROTOCOL FOR PROTOPLAST ISOLATION FOR OTHER EXPERIMENTAL SYSTEMS INCLUDES DETAILED DRAWINGS THAT COMPLEMENT BOTH INTRODUCTIONS AND EXPERIMENTS GUIDES READER FROM LAB SETUP TO SUPPLIES STOCK SOLUTION AND MEDIA PREPARATION EXPLANT SELECTION AND DISINFESTATIONS AND EXPERIMENTAL OBSERVATIONS AND MEASUREMENT PROVIDES THE LATEST TECHNIQUES AND MEDIA INFORMATION INCLUDING A TUMEFACIENS MEDIATED TRANSFORMATION AND INFUSION TECHNOLOGY FULLY UPDATED LITERATURE

PLANTS CELL TISSUE CULTURE IS A RAPIDLY DEVELOPING TECHNOLOGY WHICH HOLDS PROMISE OF RESTRUCTURING AGRICULTURAL AND FORESTRY PRACTICES DURING THE LAST TWO DECADES CELL CULTURE HAVE MADE CONSIDERABLE ADVANCED IN THE FIELD OF AGRICULTURE HORTICULTURE PLANT BREEDING FORESTRY SOMATIC CELL GENETICS PHYTOPATHOLOGY ETC PLANT CELLS CAN BE GROWN IN ISOLATION FROM INTACT PLANTS IN TISSUE CULTURE SYSTEMS THE CELLS HAVE THE CHARACTERISTICS OF CALLUS CELLS RATHER THAN OTHER PLANT CELL TYPES THESE ARE THE CELLS THAT APPEAR ON CUT SURFACES WHEN A PLANT IS WOUNDED AND WHICH GRADUALLY COVER AND SEAL THE DAMAGED AREA PLANT CELLS AND TISSUE CULTURE ARE OFTEN USED FOR THE PRODUCTION OF PRIMARY AND SECONDARY METABOLITES PLANT TISSUE CULTURES CAN BE INITIATED FROM ALMOST ANY PART OF A PLANT THE PHYSIOLOGICAL STATE OF THE PLANT DOES HAVE AN INFLUENCE ON ITS RESPONSE TO ATTEMPTS TO INITIATE TISSUE CULTURE THE PARENT PLANT MUST BE HEALTHY AND FREE FROM OBVIOUS SIGNS OF DISEASE OR DECAY THE SOURCE TERMED EXPLANT MAY BE DICTATED BY THE REASON FOR CARRYING OUT THE TISSUE CULTURE YOUNGER TISSUE CONTAINS A HIGHER PROPORTION OF ACTIVELY DIVIDING CELLS AND IS MORE RESPONSIVE TO A CALLUS INITIATION PROGRAMME THE PLANTS THEMSELVES MUST BE ACTIVELY GROWING AND NOT ABOUT TO ENTER A PERIOD OF DORMANCY PLANT TISSUE CULTURE IS USED WIDELY IN PLANT SCIENCE IT ALSO HAS A NUMBER OF COMMERCIAL APPLICATIONS TISSUE CULTURE IS EMPLOYED IN MICROPROPAGATION

ELIMINATION OF PATHOGENS FROM PLANT MATERIALS GERMOPASM STORAGE PRODUCTION OF SOMACLONAL VARIANTS EMBRYO RESCUE PRODUCTION OF HAPLOIDS PRODUCTION OF ARTIFICIAL SEEDS PRODUCTION OF SECONDARY METABOLITES PRODUCTION OF TRANSGENIC PLANTS ETC SOME OF THE FUNDAMENTALS OF THE BOOK ARE PLANT TISSUE CULTURE BASIC REQUIREMENTS FOR TISSUE CULTURE LABORATORY SURFACE STERILIZATION OF EXPLANT MATERIALS DEVELOPMENT OF TISSUE CULTURE TECHNIQUES PRINCIPLES OF CELL CULTURE CELL SPECIAL FACTORS INFLUENCING GROWTH AND METABOLISM MEDIA FOR CULTURING CELLS AND TISSUES STERILISATION PROCEDURES DESIGN AND EQUIPMENT OF A TISSUE CULTURE LABORATORY ISOLATION METHOD FOR MICROORGANISMS FOR CULTURE CULTURE PRESERVATION AND STABILITY GENETIC MODIFICATION OF INDUSTRIAL MICROORGANISMS MUTATION ETC THE PRESENT BOOK DISCUSS ABOUT THE METHODS CULTURE PRESERVATION AND STABILITY PROCEDURES STORAGE AND TRANSPORTATION OF PLANT CELL TISSUE CULTURE THIS BOOK IS AN INVALUABLE RESOURCE FOR RESEARCH WORKERS STUDENTS TECHNOCRATS ENTREPRENEURS INSTITUTIONAL LIBRARIES ETC TAGS PLANT TISSUE CULTURE IN INDIA COMMERCIALIZATION OF PLANT TISSUE CULTURE IN INDIA ROLE OF PLANT TISSUE CULTURE IN AGRICULTURE PLANT TISSUE CULTURE INDUSTRY IN INDIA INDUSTRIAL PLANT TISSUE CULTURE TISSUE CULTURE IN AGRICULTURE PLANT TISSUE CULTURE TISSUE CULTURE CELL CULTURE AND TISSUE CULTURE TISSUE CULTURE AND CELL CULTURE TISSUE CULTURE IN PLANTS PLANT CELL AND TISSUE CULTURE COMMERCIAL PLANT TISSUE CULTURE IN INDIA PLANT TISSUE CULTURE BUSINESS PLAN PLANT TISSUE CULTURE AND BIOTECHNOLOGY TISSUE CULTURE PLANTS PLANT TISSUE CULTURE BUSINESS PLAN BUSINESS OPPORTUNITIES IN PLANT TISSUE CULTURE TISSUE CULTURE METHODS CYBRID PRODUCTION PROCESS OF CYBRIDS PRODUCTION PRODUCTION OF CYBRIDS PRODUCTION OF CYBRID PLANTS PRODUCTION OF HAPLOID PLANTS HAPLOID PRODUCTION PLANT SECONDARY METABOLISM PRODUCTION OF SECONDARY METABOLITES PRODUCTION OF SECONDARY METABOLITES USING PLANT CELL CULTURES PLANT TISSUE CULTURES IN PRODUCTION OF SECONDARY METABOLITES SECONDARY METABOLITES PRODUCTION PRODUCTION OF SOMATIC HYBRID PLANTS SOMATIC HYBRIDIZATION OF PLANTS SOMATIC HYBRID SOMATIC HYBRID PRODUCTION PRODUCTION OF ENRICHED BIOMASS ENRICHMENT ON BIOMASS PRODUCTION FORMULATION OF TISSUE CULTURE MEDIUM COLLECTION OF EXPLANT MATERIALS SUBCULTURE OF CALLUS REGENERATION OF PLANTS FROM CALLUS PREPARATION OF CHICK EMBRYO EXTRACT PREPARATION OF EMBRYO EXTRACT FROM YOUNG EMBRYOS PREPARATION OF BOVINE EMBRYO EXTRACT PREPARATION OF EAGLES MEDIUM MEDIA FOR PLANT TISSUES ORGAN CULTURE PREPARATION OF TRYPSINISED EMBRYONIC CARCASS ENRICHMENT CULTURE METHODS GENETIC MODIFICATION OF INDUSTRIAL MICROORGANISMS MUTATION METHODS FAVOURING FORMATION OF HYBRID DNA MOLECULES MODES OF GROWTH OF BACTERIA AND FUNGI MIXED CULTURE AND MIXED SUBSTRATE SYSTEMS SPONTANEOUS MIXED CULTURE PROCESS MAINTENANCE OF PROTOPLASTS COLLECTION OF PLANT MATERIALS STORAGE OF GERM PLASM OF POTATO MAMMALIAN EMBRYONIC TISSUES PREPARATION OF TISSUES FROM PLANTS LARGESCALE CULTURE METHODS PREPARATION AND STERILISATION OF APPARATUS PREPARATION AND STERILISATION OF MEDIA RESERVATION STORAGE AND TRANSPORTATION OF LIVING TISSUES AND CELLS CULTURE OF PLANT CELLS FOR EXTRACTION OF SECONDARY METABOLITES PREPARATION OF EXPLANT SUSPENSION CULTURE EXTRACTION OF SECONDARY METABOLITES BIOTRANSFORMATION IN PLANT CELLS IMMOBILIZATION OF PLANT CELLS SPECIAL TISSUE CULTURE MEDIA MANUFACTURING PLANT CULTURES PRODUCTS FROM PLANT TISSUE CULTURE CULTIVATION OF PLANT TISSUE CULTURES OF TOMATO ROOTS TISSUE CULTURE OF TOMATO ROOTS PREPARATION OF CARROT CALLUS CULTURE TISSUE CULTURE OF CARROT CALLUS CARROT CALLUS TISSUE FOR CULTURE CULTIVATION OF CELLS IN VIVO TRANSPLANTATION CULTURES ON AGAR NPCS NIIR PROCESS TECHNOLOGY BOOKS BUSINESS CONSULTANCY BUSINESS CONSULTANT PROJECT IDENTIFICATION AND SELECTION PREPARATION OF PROJECT PROFILES STARTUP BUSINESS GUIDANCE BUSINESS GUIDANCE TO CLIENTS STARTUP PROJECT STARTUP IDEAS PROJECT FOR STARTUPS STARTUP PROJECT PLAN BUSINESS START UP BUSINESS PLAN FOR STARTUP BUSINESS GREAT OPPORTUNITY FOR STARTUP SMALL START UP BUSINESS PROJECT BEST SMALL AND COTTAGE SCALE INDUSTRIES STARTUP INDIA STAND UP INDIA SMALL SCALE INDUSTRIES NEW SMALL SCALE IDEAS FOR HAPLOID PRODUCTION INDUSTRY CYBRID PRODUCTION BUSINESS IDEAS YOU CAN START ON YOUR OWN INDIAN SECONDARY METABOLITES PRODUCTION INDUSTRY SMALL SCALE SOMATIC HYBRID PRODUCTION GUIDE TO STARTING AND OPERATING SMALL BUSINESS BUSINESS IDEAS FOR ENRICHED BIOMASS PRODUCTION HOW TO START SECONDARY METABOLITES PRODUCTION BUSINESS

STARTING ENRICHED BIOMASS PRODUCTION START YOUR OWN SOMATIC HYBRID PRODUCTION BUSINESS SECONDARY METABOLITES PRODUCTION BUSINESS PLAN BUSINESS PLAN FOR CYBRID PRODUCTION SMALL SCALE INDUSTRIES IN INDIA HAPLOID PRODUCTION BASED SMALL BUSINESS IDEAS IN INDIA SMALL SCALE INDUSTRY YOU CAN START ON YOUR OWN BUSINESS PLAN FOR SMALL SCALE INDUSTRIES SET UP CYBRID PRODUCTION PROFITABLE SMALL SCALE MANUFACTURING HOW TO START SMALL BUSINESS IN INDIA FREE MANUFACTURING BUSINESS PLANS SMALL AND MEDIUM SCALE MANUFACTURING PROFITABLE SMALL BUSINESS INDUSTRIES IDEAS BUSINESS IDEAS FOR STARTUP

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CONCLUSION

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