

Past, Present, and Future of Electron Microscopy Chemical Processing Workflows

Steven Goodman, Mark Nelson and Thomas Strader

Microscopy Innovations, LLC, Marshfield, Wisconsin, United States

Electron microscopy of biological specimens began with the development of room temperature chemical preparation methods for TEM, receiving the 1974 Nobel Prize for Physiology or Medicine [1]. The workflow to prepare specimens required invention of ultramicrotomes and knives for ultrathin sectioning, other apparatus, and especially preparative chemistries to stabilize specimens for microtomy, vacuum, and for electron-beam irradiation, and to provide image contrast. These chemical workflows are routine today, including aldehyde fixation, OsO_4 post fixation, graded solvent dehydration, serial infiltration in epoxy resins, and metal stains.

Since the 1974 Nobel Prize, there have been remarkable workflow improvements in TEM instruments. These now include automated image acquisition and analysis, and the advent of 3D Electron Microscopies (3DEM) including serial block face, array tomography, and FIB SEM. There have also been major improvements in microtomy and other tools that reduce the time and effort for specimen preparation and improve upon the workflows developed in the 1970s.

Despite instrumentation workflow improvements, there has been much less change in the lab processes to deliver the specimen preparation chemicals. Most specimens are still processed as they were decades ago: by immersion in vials with manual reagent exchanges every few minutes or hours. Typical protocol times are 1-2 days for TEM, plus an additional day for immunogold labeling (IGL), while 3DEM requires 4-5 days (Fig. 1). Hands-on effort is also significant, and is required sporadically, making it problematic to perform other tasks. Microwave processing substantially decreases total preparation times, but requires nearly continuous hands-on effort with manual reagent exchanges every few minutes. Tissue auto-processors can prepare large numbers of specimens with less labor. These, however, are not suitable for the more complex and longer IGL or 3DEM protocols. As a result, time-consuming manual effort is required, preventing personnel from performing other work for long periods.

Around the time the 1974 Nobel was awarded for biological EM, a revolution was occurring in the apparatus used for molecular and cell biology. This was the advent of multi-channel pipettors, microwell plates and, somewhat later, fluid handling “robots.” In 2010, the mPrep system was introduced to leverage these tools for the EM lab. The mPrep System entraps individual specimens or grids in flow-through capsules that attach to pipettors or to the purpose-built EM preparation “robot”, the ASP-1000. The mPrep System enables nearly any protocol, including standard TEM preparation [2], both pre- and post-embedding IGL [3], and 3DEM preparation [4]. Automation enables a protocol to be programmed, set-up, and “run” without human intervention for hours or days, or to include automated prompts when interventions are required, such as adding a fresh reagent. Further, near continuous reagent flow can be programmed to accelerate diffusion into specimens. This enables renal biopsy TEM specimens to be ready for resin curing in 2 hrs, including *en bloc* Ur staining [2], and to prepare 3DEM specimens as rapidly as one day [4]. Automatic operation and increased processing speed improves workflow by freeing personnel (Fig. 1), and also by reducing the potential for human error.

Where can we look to future workflow enhancements for chemical preparation? EM labs spend considerable time preparing reagents from raw chemicals. Workflows would be improved with easier-to-use reagent “kits and new formulations. These would save time, improve reproducibility, and could lead

Past Present And Future Of Electron Microscopy In Agricultural Research

BM King

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Andow,2019-04-11 Recent interest in nonchemical methods of pest control has brought renewed attention to the biological control of plant pests in the fields of entomology plant pathology and weed science Ecological Interactions and Biological Control addresses issues of theory and practice common to all three fields Focusing on systems rather than on individual

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Bélanger,2017-12-06 Silicon Si is gaining increased attention in the farming sector because of its beneficial effects observed in several crop species particularly under stress conditions The magnitude of benefits is predominantly observed in plant species that can accumulate Si above a certain threshold Therefore deciphering the molecular mechanisms and genetic factors conferring a plant ability to take up silicon is necessary Along these lines several efforts have been made to identify the specific genes regulating Si uptake and distribution in plant tissues This information finds its usefulness in identifying Si competent species and could eventually lead to improving this ability in low accumulating species The successful exploitation of Si in agriculture depends highly on the understanding of different Si properties including plant available Si from the soil transport within tissues deposition in planta and Si effect on different metabolic and physiological processes In addition a better comprehension of external factors influencing Si uptake and deposition in plant tissue remains important A plant can take up Si efficiently only in the form of silicic acid and most soils despite containing high concentrations of Si are deficient in plant available Si Consequently soil amendment with fertilizers rich in plant available Si is now viewed as an affordable option to protect plants from the biotic and abiotic stresses and achieve more sustainable cropping management worldwide Articles compiled in the present research topic touch upon several aspects of Si properties and functionality in plants The information will be helpful to further our understanding of the role of Si and contribute to exploit the benefits plants derive from it **Fossil Energy Update** ,1985 **Bibliography of Agriculture** ,1976 *Sustainable Crop Productivity and Quality under Climate Change* Fulai Liu,Xiangnan Li,Petra Hög, Dong Jiang,Marian Brestic,Bing Liu,2022-06-07 Sustainable Crop Productivity and Quality under Climate Change Responses of Crop Plants to Climate Change explores the physiological biochemical and molecular basis of the responses of major crop plants to a range of climate change scenarios From the development of climate resilient crop varieties which lead to enhanced crop productivity and quality to better utilization of natural resources to ensure food security through modern breeding techniques it presents insights into improving yield while securing the environment Understanding the impact of climate on crop quality and production is a key challenge of crop science Predicted increases in climate variability necessitate crop varieties with intrinsic resilience to cooccurring abiotic

stresses such as heat drought and flooding in a future climate of elevated CO₂ This book presents a much needed mechanistic understanding of the interactions between multiple stress responses of plants that is required to identify and take advantage of acclimation traits in major crop species as a prerequisite for securing robust yield and good quality This book is an excellent reference for crop and agricultural scientists plant scientists and researchers working on crop plant ecophysiology stress physiology and future crop production Includes breeding strategies for developing climate resilient crop varieties Presents a comprehensive overview of the current challenges approaches and best practices Authored by frontline researchers and experts who work at the fields of climate change impacts on crop productivity History of Soy Nutritional Research (1946-1989) William Shurtleff; Akiko Aoyagi, 2021-02-07 The world's most comprehensive well documented and well illustrated book on this subject With extensive subject and geographic index 20 photographs and illustrations many color Free of charge in digital PDF format **Agricultural Science Review**, 1963 **IPM and Biological Control of Weeds, January 1986-April 1988** Jayne T. MacLean, 1988 Bibliography of Agriculture with Subject Index, 1988-10 **Casein** Mamdouh El-Bakry, Bhavbhuti M. Mehta, 2024-06-24 Casein Structural Properties Uses Health Benefits and Nutraceutical Applications investigates casein properties uses and applications in food and non food products in addition to exploring its health benefits and uses in manufacturing such as in cheese products along with an in depth discussion on the future scope challenges and market trends of this protein Casein Structural Properties Uses Health Benefits and Nutraceutical Applications is an excellent reference for food scientists dairy researchers pharmaceutical scientists students and researchers studying related fields Provides comprehensive coverage of casein the main milk protein that has many applications and uses Includes suggested reading for further information Addresses a wide range of related topics including non food applications of casein *Applied Plant Virology* Calum Rae Wilson, 2014-08-01 Written for advanced undergraduate students this book is a practical in depth guide to plant virology Beginning with an introduction to viruses and their classification the text describes virus pathology including how viruses enter and move through plant cells and induce disease Subsequent chapters discuss how viruses spread in the field and how to measure this Throughout the book remains reader friendly using focus boxes for clear easy to obtain information enabling students to quickly access relevant information but supply sufficient detail for advanced studies In addition to basic information on virus biology there is an additional focus on applied virology ideal for students undertaking agricultural studies for whom study of disease and its control is essential

Parasites of Cattle and Sheep Andrew B. Forbes, 2020-11-17 Understanding parasite biology and impact is essential when giving advice on parasite control in farm animals In the first review devoted to parasites of domestic cattle and sheep alone this book provides in depth focused advice which can be tailored to individual farms It considers the impact of parasites both as individual species and as co infections as well as epidemiological information monitoring and diagnostic procedures Supported throughout by diagrams and photos to aid diagnosis it also reviews the basis for control measures

such as the responsible use of parasiticides adaptive animal husbandry and other management practices **Wood**

Formation in Trees Nigel J Chaffey, 2002-01-10 Trees are a major component of the biosphere and have played an important part in the world's history and culture. With the modern challenges of global warming and dwindling fossil fuel reserves, trees and in particular their wood can provide solutions. Unfortunately, too little is known about the biology of these plants due largely to a lack of *Federal Register*, 1971-11 *Disease Problems In Vegetable Production* Gupta, S. Kumar, Thind, T.S., 2012-06-04 Vegetables are a rich source of vitamins, minerals and the much needed roughage in our daily diet. These are of primary importance for an adequate and balanced human diet and contribute significantly to regional and national economy. However, the cultivation of these crops is often affected by the ravages of pests and diseases, thereby lowering their yield potential. Diseases also cause subsequent post harvest transit and storage losses. In the past few decades, dramatic advancements have been made in understanding the nature of vegetable diseases through in-depth investigations in host-pathogen interactions, development of molecular diagnostic tools and integration of new concepts, principles and approaches for their effective management. Indiscriminate use of chemicals for the management of vegetable diseases has led to an increase in environmental pollution and development of resistant strains of the pathogens. In the recent years, several advances have been made in eco-friendly technologies for integrated management of vegetable diseases. The book on *Disease Problems in Vegetable Production* gives a comprehensive overview of economic importance, symptomatology, etiology, epidemiology and management of important diseases of vegetable crops caused by fungi, bacteria, viruses, virus-like organisms, mycoplasmas and nematodes. The integration of more than one management practice, including genetic resistance, cultural, biological and chemical methods, has been suggested to make their use more effective, economical and eco-friendly. A total of 17 chapters dealing with important diseases of vegetables like potato, tomato, crucifers, cucurbits, pea, French beans, chillies, onion, garlic, egg plant, carrot, sugarbeet, colocasia, okra and leafy vegetables have been compiled in this book. The book also includes chapters on common pathogens of vegetable crops, disease problems in nurseries, post harvest diseases and disease problems caused by nematodes. Each chapter contains disease cycles of important diseases that will help in better understanding of the perpetuation and spread of the disease-causing pathogens. Coloured photographs of disease symptoms have been included for easy identification of different diseases. The book will serve as a useful guide for students, scientists, extension workers and others associated with the discipline of vegetable pathology **Handbook of Starch Science and Technology** Ming Miao, Long Chen, James N. BeMiller, 2025-04-01 Fifteen years have passed since the last major treatise on starch was published. Since then, knowledge of the molecular and macromolecular structures of starch, exploration of new sources of commercial starch, modification of the properties of starches via chemical, enzymic, genetic and physical means and investigations into potential uses of new products have proliferated. The *Handbook of Starch Science and Technology* explores new developments in starch science and technologies to achieve new paradigms in the development of natural

glucose polymers New developments of starches with enhanced nutritional and health benefits and specialized starch derivatives are discussed in terms of novel applications for the design of functional products and recent developments for structuring starch that have not been covered in the previous literature Further it discusses the uses of starch in the manufacture of starch inclusion complexes and nanoparticles and as a key component in carrier delivery applications Features Explores the genetics and physiology of starch biosynthesis Covers the source isolation structure and properties of starches Identifies the structure and behavior of typical components in starch amylose amylopectin and phytoglycogen Includes specific information on the modification and application of starch derivatives Presents current and emerging trends for starch science and technology This timely guide is for scientists and technologists working in the fields of agriculture biotechnology food pharmaceuticals chemical engineering nutrition and human health

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