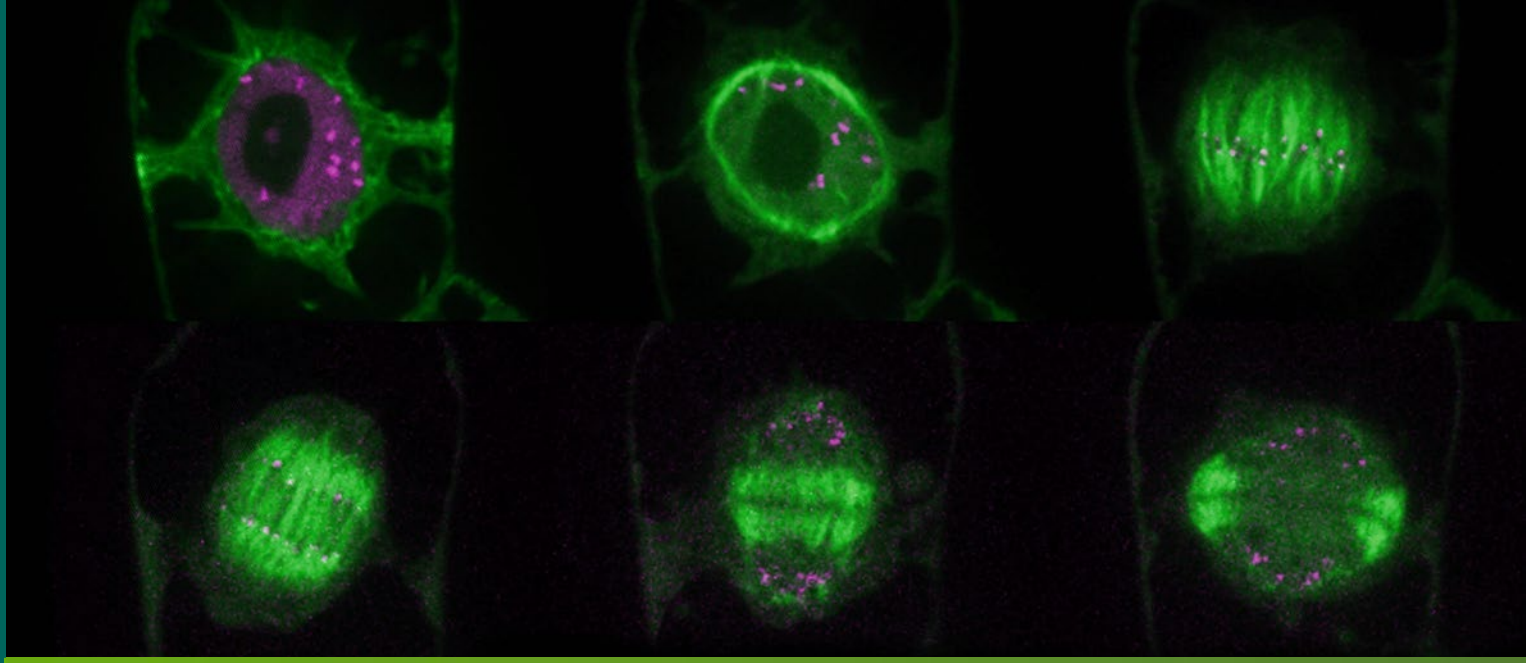

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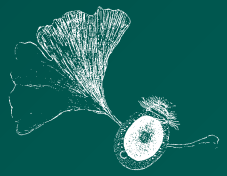
Atlas of Plant Cell Structure



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Preface

This is a photo catalog of the world's cellular diversity, which plant morphologists have been studying for over a quarter of a century. We assembled this atlas for science students, their teachers, and anyone who is curious about the extraordinary variety of living things studied in the field of plant morphology. Much of the knowledge described here, particularly about flowering plants, mosses, liverworts, algae, fungi, and lichens, has been gathered only in the past quarter century and represents the frontiers of research.

"Seeing is believing" is an idiom first recorded in 1639 that means "only physical or concrete evidence is convincing" and is a popular saying throughout the world. It is extremely difficult to describe in full any given state via text alone. Properly shot photos, on the other hand, can show such states with vastly more precision and detail. The saying leads to the mistaken belief that "seen evidence" can be easily and correctly interpreted, when in fact, interpretation may be difficult. An advanced transmission electron microscopy (TEM) technology, 3D images reconstructed from a series of TEM images, provides many insights into structural differences of organelles in a single cell and between cell types. As further evidence that seeing is believing, fluorescence microscopy is an excellent methodology for analyzing mitochondrial dynamics, for instance. A particularly important methodology is to use fluorescent dyes to stain special cell structures in many types of living cells, either by natural affinity or by tagging. Today, the use of green fluorescent protein (GFP) for visualizing a particular protein in living cells has been applicable to the research of cell organelle dynamics. Some variants of GFP contain unique optical properties which can provide marvelous, elegant experiments and lead to breakthrough findings by cell biologists.

Morphological research on plant bodies and their structures began in ancient Greece over 2,000 years ago. It is the biologist's drive to see and learn more about the formation of individual plants and organs that has paved the way to various microscopes and visualization techniques. In the seventeenth century, the light microscope was invented, which led to Robert Hooke's presenting his observations of what he called "cells" in cork, a dead plant organ, in 1655. In the nineteenth century, nuclei, mitochondria, chloroplasts, and vacuoles were identified in living cells, and 46 years after the first observation of the nucleus, the behavior of chromosomes during mitosis was reported. With the development of electron microscopy, biologists came to understand that individual organelles have the same basic ultrastructure, and discovered that organelles such as the endoplasmic reticulum, plant Golgi body, and cytoskeleton microtubules and actin filaments are common to all vegetative cells. Today, the resolution of these microscopes is greatly advanced and the techniques for specimen preparation have improved. With transgenic techniques, high-resolution fluorescent microscopy, and so on, we can detect not only the behaviors of organelles but also the dynamic movements of molecules to carry out a variety of functions that are critical for life.

The main concept of this book is visualization: seeing is believing. It presents beautiful photographs and 3D-reconstruction images of cellular structures in plants, algae, fungi, and related organisms taken by a variety of microscopes and visualization techniques. The book is subdivided into nine chapters: 1. Nuclei and Chromosomes, 2. Mitochondria, 3. Chloroplasts, 4. The Endoplasmic Reticulum, Golgi Apparatuses, and Endocytic Organelles, 5. Vacuoles and Storage Organelles, 6. Cytoskeletons, 7. Cell Walls, 8. Generative Cells, and 9. Meristems.

The topics in each chapter are restricted with the hope that they will be interesting, useful, and comprehensible. Each photo plate is accompanied by an explanation to introduce readers to the cell morphology, structures, and functions depicted. The explanations are intended to be the minimum necessary, because we hope readers will deeply consider and understand the minute ultrastructure within cells directly from the photographs. The references that are included will help readers to understand the topics in depth, but references are avoided in some photo plates showing popular cell structures.

This *Atlas of Plant Cell Structure* is published to celebrate the 25th anniversary of the Japanese Society of Plant Morphology. The Society was founded in 1988 to promote studies of plant morphology and discussion among researchers in this academic field. The members are scientists in plant morphology (micro- and macro-structure, function, and development), all levels of organization (molecular to macro-structure), and all plant groups and related organisms (cyanobacteria, algae, fungi, and lichens).

Included are 92 beautiful photographs, contributed mostly by members of the Society. Some of the photographs are originals, made especially for this atlas, and some have been featured on the cover of journals such as *Plant Morphology* (the official journal of the Society), the *Journal of Cell Science*, the *Journal of Plant Research*, *Molecular Biology of the Cell*, and *Nature*. We hope readers will enjoy this visual tour within cells and get new insights into plant cell structure.

Nara, Japan — Tetsuko Noguchi
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Tokyo, Japan — Hirokazu Tsukaya
Chiba, Japan — Sachihiro Matsunaga
Nara, Japan — Atsushi Sakai
Toyama, Japan — Ichirou Karahara
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September 2014

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The photographs in this book were taken by 66 members of the Japanese Society of Plant Morphology using the best methods and techniques available to capture the objects in cells and tissues: by light and fluorescent microscopy, by transmission and scanning electron microscopy, and by other processes. In addition, 25 non-members of the society kindly agreed to allow their photographs to be reproduced in the book.

Morphologists recognize how important it is for them to observe objects closely. In addition, they always try to capture real images of cell structures that reflect active functions being carried out by complex molecular mechanisms. The photographs in this book were taken by such plant morphologists.

We deeply thank Reiko Suzuki and Kayoko Morita of Nara Women's University for their help in digital processing of the images and preparation of the manuscripts for this book.

We extend our thanks to all those who have encouraged the publication of this atlas.

September 2014

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