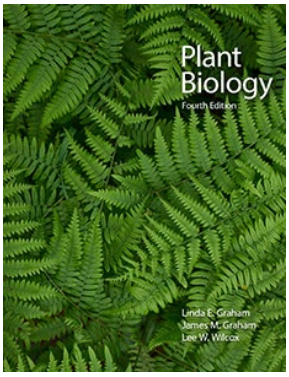
New Features of *Plant Biology* 4th Edition Graham, Graham, Wilcox



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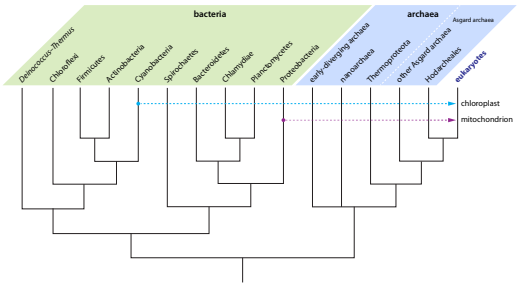
Instructors interested in receiving a complimentary examination copy as well as free book-related, in-class active learning exercises are invited to contact us.

Updated JPEGs of figures and tables are available to instructors adopting the book.

Extensively updated, the new 4th edition maintains the organization of the 3rd edition and incorporates new content reflecting scientific advances. New or improved features include:

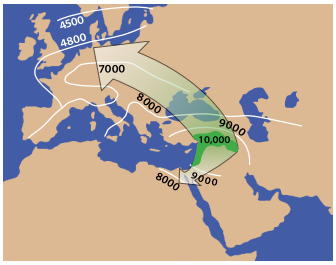
- Many new photos, e.g., Fig. 1.12 (example of dispersal co-evolution), Chapter 5 opener (liverwort cells); Essay Fig. 12.1 showing *Ginkgo* leaf stomata, Fig. 14.1 strawberry sexual reproduction; Fig. 22.6 early-divergent moss *Takakia*; Fig. 22.22 *Selaginella* rhizophore.

- Incorporation of recent research results linking the origin of eukaryotes with a particular lineage of archaea, which influences a simple introductory depiction of a tree of life (Chapter 1) and a deeper look at relationships of bacteria, archaea and eukaryotes (Fig. 19.3):



- Description has been added to Essay 1.2 of the 2022 United Nations Biodiversity Conference agreement involving 190 countries to protect 30% of Earth's land and water by 2030, known as "30 by 30."

- Updated depiction of the spread of agriculture (Fig. 2.4) based on new archeological and DNA information:



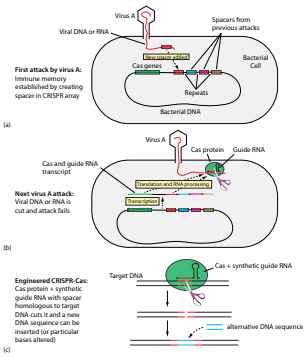
- A new essay about past and present medicinal uses of *Cannabis* (Essay 2.1) (first paragraph shown below):

> Essay 2.1 | Medicinal Weed: Past and Present
>
> Chemical analyses of dried bits of plants and residues within containers excavated from archeological sites reveal that people have long used plants for their medical, including psychoactive, properties. An example is *Cannabis*, a plant whose fiber has long been used to make rope and other parts for mind-altering properties. More than 5000 years ago, Yamnaya migrants carried *Cannabis* from the plant's East and Central Asian homeland to Europe and the Middle East. 5000-year-old charred seeds and

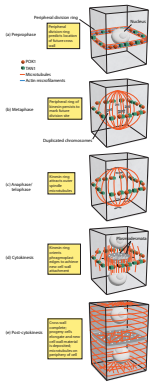
other plant parts indicate that people in the Caucasus used *Cannabis*, and there is 3000-year-old evidence for use of this plant in Mesopotamia. Today, people value the chemical components of *Cannabis* known as phytocannabinoids (plant cannabinoids), which include tetrahydrocannabinol (THC) and cannabidiol (CBD)(Figure E2.1a).

- Integration of information from recent NASA and other space missions with discussions of the molecules of life (Essay 3.1) and Earth history (Chapter 19).

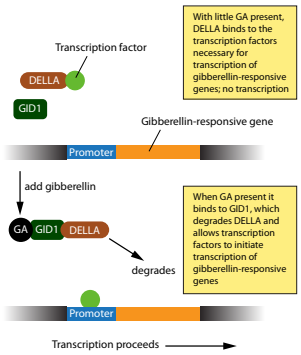
- New information about the cellular roles of non-coding RNAs and the evolution and uses of CRISPR technology (Figure 16.2):



- Updated depictions of protein control of cell cycle events and the roles of proteins in determining the direction of plant cytokinesis (Fig. 8.15):



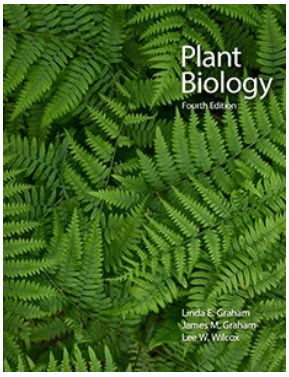
- New diagram showing how gibberellins influence gene expression (Fig. 13.6):



- New essay on breeding crops for resilience to climate change (Essay 15.2)(first paragraph shown below):

Essay 15.2 | Breeding crop plants for resilience to climate change

Global environmental change presents challenges to farmers worldwide. Whether agriculture occurs as large-scale industrial operations or in the form of small family farms, abnormal levels of heat, cold, drought, flooding, disease, and animal herbivores can cause crop losses resulting in economic stress to human populations. Farmers



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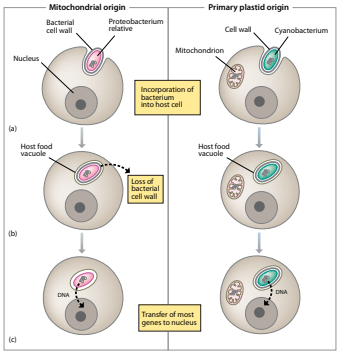
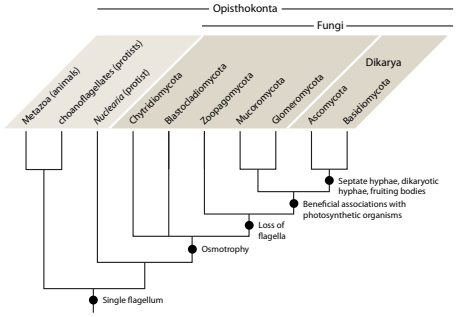
need new types of hybrid seeds that yield crops genetically adapted to cope with these challenges. Improving drought resistance is of particular importance. Drought is defined as a deficit of water available to a crop whose requirements are known. Drought is particularly problematic at key times in a plant's life, such as when flowers and fruit are produced.

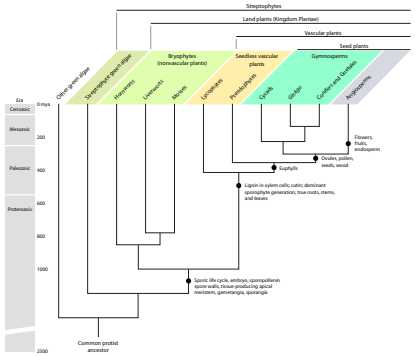
- Revised diagram of primary plastid origins (Fig. 20.17), reflecting building evidence for evolutionary retention by land plants and related green algae of the ancestral cyanobacterial cell wall or related genes:



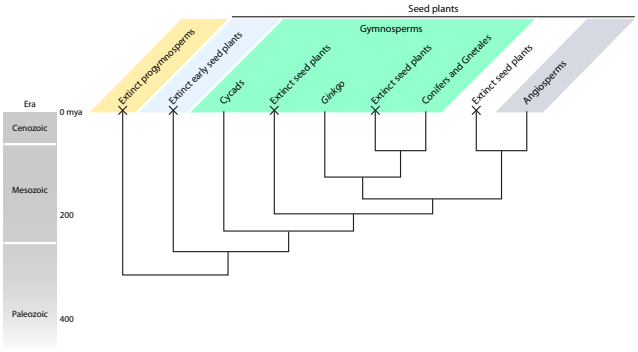
- Updated fungal phylogeny (Fig. 21.5), showing the sequence of appearance of distinctive fungal traits:

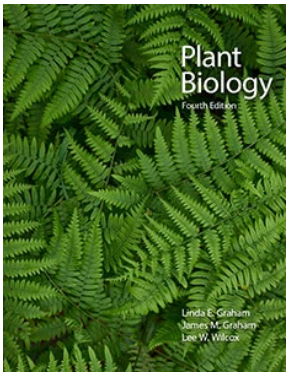


- Revised phylogeny/timescale of land plants (Fig. 22.3), reflecting evidence for monophyletic bryophytes:



- Updated seed plant phylogeny and timescale (Fig. 23.6):





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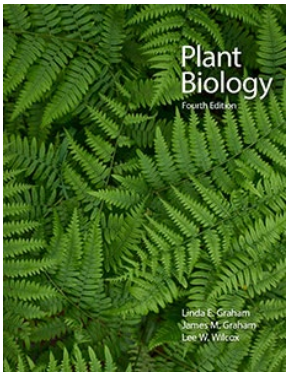

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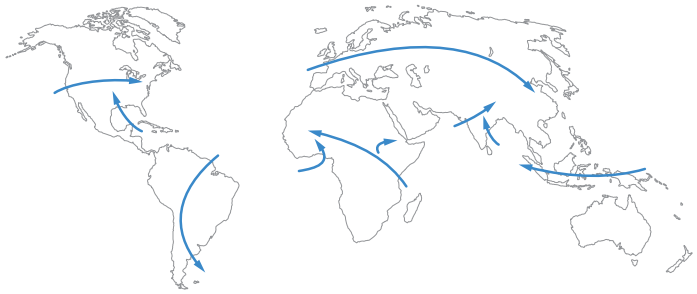
- New depiction of flying (atmospheric) rivers (Fig. 26.26) that influence global climate:



- Revised Essay 28.1 on indigenous people's uses of temperate forest plants, incorporating information about the key role of anthropologist Frances Dinsmore in recording indigenous music and uses of plants by Great Lakes societies.

- New images showing drying of the Great Salt Lake, Utah, USA, and discussion of global lake drying occurrences (Chapter 29).

- A new essay (Essay 30.1) on diversifying human food sources to cope with climate variation and increase sustainability, derived from research led by the Royal Botanical Gardens at Kew, UK (first paragraph below):

> Essay 30.1 | New Food Directions
>
> Today's human populations rely on a relatively few crop plants. Wheat, rice, and maize—generally grown as monocultures (Chapter 1)—make up about 50% of the world's food. Experts recommend diversifying the human diet by incorporating more types of food plants. Advantages of the new food directions include reducing dependence on crops that might suffer losses to disease and pests, and better tailoring of crops to local environmental conditions of soil and climate. More food options could help human agriculture cope with increasing climate variation, such as warming and drought occurring in many places.

- We have used bulleted lists to break up long paragraphs, for increased readability (the example below is from Chapter 4, Molecules of Life):

  - Some secondary compounds are so strong (compression resistant) that they provide plants with structural support, which explains why trees can grow so tall.
  - Other secondary compounds are distasteful or poisonous to animals that might feed on plants, reducing the extent to which plants are eaten.
  - Yet other secondary compounds absorb UV radiation in sunlight (thereby preventing "sunburn") or prevent microbe attack.
  - Secondary compounds also include beautiful flower pigments that aid in reproduction by attracting insects and other animals to carry pollen between plants, and fruit pigments that attract animals to transport plant seeds (Chapter 25).

- Navigation is aided by inclusion of a complete, clickable TOC.

- Text, captions, and most figure labels have larger font sizes for easier full-screen viewing.

- Pedagogical elements have been updated: these include **Learning Goals** that start each chapter section, section ending **Summary** and **Testing Yourself** question(s), and **Self-test** and **Applying Concepts** questions at the ends of chapters.

- End-of-book answers and keyword glossary have been updated.