

Preface

For genetics researchers, genetics instructors, and the students who choose to study genetics, these are wonderful times to be practicing our craft. The first years of the 21st century have seen unprecedented expansion of our knowledge in genetics. Data on topics that were seemingly impenetrable just a few years ago are now abundant. Novel approaches to old problems have provided profound insights on the development and evolution of members of all three domains of life. And advancements in genomics, proteomics, transcriptomics, and other enterprises of the "omic" world have opened avenues for research that were unimaginable in years past. The dawn of the 21st century was something of a milestone for genetics—it inaugurated the second century of genetics. One hundred years after the foundational genetic principles of Gregor Mendel were rediscovered the genomics era accomplished the major feat of completing the human genome sequence. Genetics barely seemed to pause to acknowledge this triumph, and the field has been "full speed ahead" in its second century. New genome sequences are published weekly, and we now have not just complete genome sequences of ourselves and thousands of other living organisms, but also the genome sequences of two archaic human ancestors, Neandertals and Denisovans, both of which died out more than 30,000 years ago. These are great times to be a geneticist or a student studying genetics!

Our Integrated Approach

Both the first edition of our textbook and this second edition carry the unique subtitle *An Integrated Approach*. This phrase embodies our pedagogical approach that has three principles: (1) integrating problem solving throughout the text—not relegating it to the end of the chapter—and consistently modeling a powerful, three-step problem-solving approach (Evaluate, Deduce, and Solve) in every worked example; (2) integrating an evolutionary perspective and evolutionary evaluation throughout the book; and (3) integrating descriptions of Mendelian genetic and molecular genetic analysis designed to make it clear that these approaches are two sides of the same coin—different approaches to investigating the same basic sets of observations. In our second edition, we adhere to and strengthen the integrated approach that has resonated strongly with instructors and students.

New to This Edition

The overarching goals that have driven our revision are improving student learning, making the job of learning genetics easier and more effective for students, and

incorporating the new information in genetics that is helping to define its future growth. To that end, we highlight key new features and information designed to accomplish our revision goals.

- **Enhanced problem solving** Because so many students struggle with formulating an approach to solving genetics problems, we have added a new "Break It Down" component to each of the Genetic Analysis worked examples throughout the text. "Break It Down" models the concept of breaking down problem solving by deciphering the essential information needed to start solving the problem.
- **Enhanced integration of Mendelian and molecular genetics** Strong coverage of Mendel's principles of segregation and independent assortment using Mendel's own data is maintained, and more discussion of the molecular basis of four identified genes Mendel studied has been added. For instance, Table 2.6 provides a synopsis of the wild-type and mutant functions of the four known genes; Experimental Insight 12.1 describes the base substitutions or deletions responsible for mutations of three of the genes; and Experimental Insight 13.2 describes the transposition event that is the cause of mutation of the fourth gene.
- **New and expanded Foundation Figures** These one- or two-page figures combine visuals and words to help students master key concepts. These figures were well received in the first edition, and we have modified and expanded some Foundation Figures and we added three new ones to this edition: Foundation Figure 7.14 DNA Replication; Foundation Figure 8.6 Bacterial Transcription; and Foundation Figure 9.9 Bacterial Translation Elongation.
- **Expanded coverage of archaea molecular biology** Recent advancements in understanding the genetics and molecular biology of archaea—one of three domains of life—are described. These recent findings allow insightful comparisons to the genetics of bacteria and eukaryotes, particularly in relation to molecular genetic processes and to evolution. New archaea discussions and descriptions appear in Chapters 7, 8, 9, 11, 12, and 14.
- **Extending the integration of evolution throughout the text** The evolutionary perspective takes an even more prominent role in several discussions throughout the book, including in discussions of the archaea where evolutionary comparisons to bacteria and to eukaryotes is a significant component of the discussion. In addition, Chapter 22 (Population Genetics and

Evolution at the Population, Species and Molecular Levels) has been substantially modified to feature additional discussion of natural selection in Darwin's finches, broader discussion of molecular genetic support for natural selection, new discussion of the evolution of the vertebrate steroid receptor family, and new discussion of the Neandertal genome and its contributions to the modern human genome.

- **Revised epigenetic coverage** It is abundantly clear that epigenetics is at the heart of the evolution and regulation of gene expression in eukaryotes. Coverage of epigenetics has been revised in Chapter 11 (Chromosome Structure), and Chapter 15 (Regulation of Gene Expression in Eukaryotes) has been substantially rewritten to expand coverage of epigenetics and to describe new information. Chapter 15's discussion focuses on the histone code and chromatin states and on epigenetic readers, writers, and erasers.
- **Integrating coverage of genomics throughout** Genomic investigations are rapidly expanding and changing what we know about genetics. Coverage of important techniques and findings is integrated throughout the text, such as a new discussion of the impact of lateral gene transfer on bacterial genomes in Chapter 6 (Genetic Analysis and Mapping in Bacteria and Bacteriophages); a new Experimental Insight of cancer genomics in Chapter 12 (Gene Mutation, DNA Repair, and Homologous Recombination); discussions of new genome methods and analyses in Chapter 18 (Genomics: Genetics from a Whole-Genome Perspective); and updated coverage of the human genome, including data on interaction with Neandertals and Denisovans in Chapter 22 (Population Genetics and Evolution at the Population, Species, and Molecular Levels).
- **Enhanced coverage of molecular evolution** The text's focus on evolution in genetics now includes more coverage of molecular evolution integrated into appropriate chapters. Chapters 7 (DNA Structure and Replication), 8 (Molecular Biology of Transcription and RNA Processing), and 9 (The Molecular Biology of Translation) have expanded discussions of the evolution of these molecular processes. Chapter 11 (Chromosome Structure) discusses the evolution of histone proteins in archaea and eukaryotes. Chapter 14 (Regulation of Gene Expression in Bacteria and Bacteriophage) describes evolutionary comparisons of regulatory mechanisms in archaea and bacteria. Chapter 15 (Regulation of Gene Expression in Eukaryotes) contains expanded coverage of the evolution of regulatory functions. Chapter 22 (Population Genetics and Evolution at the Population, Species, and Molecular Levels) contains new discussions of evolution at the population, species, and molecular levels.

- **New Case Studies** Case Studies at the end of each chapter connect examples of research to central ideas and concepts in the chapter, reminding students of the practical applications of genetics. New Case Studies include: The Modern Human Family Mystery (Chapter 1); The (Degenerative) Evolution of the Mammalian Y Chromosome (Chapter 3); Mapping the Gene for Cystic Fibrosis (Chapter 5); and Detecting the Major Gene Influencing Crohn's Disease (Chapter 21).

New and Updated Coverage

We revisited each chapter with fresh eyes and helpful feedback from users and reviewers of the text. Here are some of the highlights of chapter-by-chapter changes in the second edition.

Chapter 1: The Molecular Basis of Heredity, Variation, and Evolution

- New discussion of the role of genomics, proteomics, and other "omic" investigative strategies
- New Case Study on the Neandertal genome and human–Neandertal genome comparison

Chapter 2: Transmission Genetics

- New Experimental Insight on plant breeding and evolution
- Additional end-of-chapter problems
- Revised and updated coverage of the molecular basis of Mendel's traits

Chapter 3: Cell Division and Chromosome Heredity

- New Genetic Analysis worked example on X-linked inheritance
- New Case Study of the evolution of the mammalian Y chromosome
- Additional end-of-chapter problems

Chapter 4: Inheritance Patterns of Single Genes and Gene Interaction

- New section on the dominant mutant pattern of mouse coat color and recessive lethality of the yellow allele
- Revised discussion of gene interactions in metabolic pathways

Chapter 5: Genetic Linkage and Mapping in Eukaryotes

- New section on hotspots and cold spots of recombination in genomes

- Revisions to sections on correction of map distances and the evolutionary favorability of recombination
- New Case Study of the mapping of the human cystic fibrosis (*CFTR*) gene

Chapter 6: Genetic Analysis and Mapping in Bacteria and Bacteriophage

- New Research Technique box on microbial genotyping using growth characteristics
- New section on lateral gene transfer and evolution
- New section on identification and assessment of lateral gene transfer in genomes
- New end-of-chapter problems

Chapter 7: DNA Structure and Replication

- New Foundation Figure featuring an overview of DNA replication
- New material on DNA replication in archaea and comparison of archaeal replication components to those in bacteria and eukaryotes
- New Genetic Analysis worked example on the function of critical proteins in DNA replication
- Discussion of PCR and dideoxy sequencing is retained and a new section introducing next generation sequencing has been added

Chapter 8: Molecular Biology of Transcription and RNA Processing

- New Foundation Figure on bacterial transcription
- New material on transcription in archaea and comparisons of archaeal, bacterial, and eukaryotic transcription processes and molecules
- New section on archaea promoters
- New discussion of the torpedo model of transcription termination in eukaryotes
- New end-of-chapter problems

Chapter 9: The Molecular Biology of Translation

- New section on amino acids and polypeptide structures
- New material on archaeal ribosomes and comparison with bacterial and eukaryotic ribosomes
- New material on archaeal translation initiation and comparison with the processes in bacteria and eukaryotes
- New Foundation Figure on bacterial translation
- New Genetic Analysis worked example on translation
- Additional end-of-chapter problems

Chapter 10: The Integration of Genetic Approaches: Understanding Sickle Cell Disease

- New material on the pathophysiology of sickle cell disease and on the identification of the molecular basis for the condition
- Additional end-of-chapter problems

Chapter 11: Chromosome Structure

- New section on viral structure and viral genomes
- New Genetic Analysis worked example on detecting chromosome variation
- New section on archaeal chromosomes, the role of chromatin in archaea, and the evolutionary implications of this new information
- Additional end-of-chapter problems

Chapter 12: Gene Mutation, DNA Repair, and Homologous Recombination

- New Experimental Insight describing the molecular basis of mutations produced by three of genes studied by Mendel—pod color, stem length, and flower color—whose mutations result from base substitutions
- New Experimental Insight on the *BROCA* system, a genome sequence-based assessment of risk for inherited susceptibility to breast and ovarian cancer
- Updated discussion of DNA damage repair in bacteria and eukaryotes
- New discussion of DNA damage repair and homologous recombination in archaea species
- New discussion of the bacterial RecBCD system
- Additional end-of-chapter problems on DNA damage repair systems
- A revised Foundation Figure more clearly explains processes at work in meiotic recombination

Chapter 13: Chromosome Aberrations and Transposition

- New Experimental Insight discussing the molecular basis and molecular genetic analysis of Mendel's round and wrinkled seed trait that is caused by transposition
- Updated discussion of transposition in eukaryotes and bacteria

Chapter 14: Regulation of Gene Expression in Bacteria and Bacteriophage

- New section on transcriptional regulation in archaeal species

- New discussion comparing and contrasting bacterial and archaeal transcription regulation and its evolutionary implications

Chapter 15: Regulation of Gene Expression in Eukaryotes

- An integrated view of chromatin modification, with a focus on how readers, writers, and erasers modulate and maintain chromatin architecture
- A discussion of the roles of long noncoding RNAs in gene regulation, using Xist and X-chromosome inactivation as an example

Chapter 16: Analysis of Gene Function by Forward Genetics and Reverse Genetics

- A reorganized discussion of how genes and their function are identified via forward and reverse genetics
- A discussion of using genomics approaches to clone genes identified via forward genetics

Chapter 17: Recombinant DNA Technology and Its Applications

- Reorganized presentation of the nuts and bolts of recombinant DNA technology and how to construct transgenic organisms
- A discussion of genome editing as a future direction of genetics

Chapter 18: Genomics: Genetics from a Whole-Genome Perspective

- Expanded coverage of copy number variants and their origins
- New Experimental Insight on the human microbiome
- New Genetic Analysis problem on the determination of homology, paralogy, and orthology based on interpreting phylogenetic trees

Chapter 19: Organelle Inheritance and the Evolution of Organelle Genomes

- Provides an up-to-date account of the diversity in organelle inheritance in several lineages of eukaryotes

Chapter 20: Developmental Genetics

- Provides in-depth coverage of the genetics of animal development and a vignette of how plants are both similar but also differ

Chapter 21: Genetic Analysis of Quantitative Traits

- New discussion of human GWAS analysis, including an introduction to Manhattan plot assessment
- New Case Study on GWAS analysis of Crohn's disease

Chapter 22: Population Genetics and Evolution at the Population, Species, and Molecular Levels

- New discussion of convergent evolution of lactase persistence in humans
- New Genetic Analysis worked example on determination of relative fitness and the operation of natural selection in *Drosophila*
- A new section on contemporary evolution in Darwin's finches
- A new section on gene and genome evolution focusing on the vertebrate steroid receptor gene family
- New discussion of the variability and evolution of the human genome
- A new Case Study on the evidence for interbreeding between Neandertals and modern humans
- New end-of-chapter problems

A Problem-Solving Approach

To help train students to become more effective problem solvers, we employ a unique problem-solving feature called Genetic Analysis that gives students a consistent, repeatable method to help them learn and practice problem solving. Genetic Analysis teaches how to start thinking about a problem, what the end goal is, and what kind of analysis is required to get there. The three steps of this problem-solving framework are *Evaluate*, *Deduce*, and *Solve*.

Evaluate: Students learn to identify the topic of the problem, specify the nature or format of the answer, and identify critical information given in the problem.

Deduce: Students learn how to use conceptual knowledge to analyze data, make connections, and infer additional information or next steps.

Solve: Students learn how to accurately apply analytical tools and to execute their plan to solve a given problem.

Irrespective of the type of problem a student faces, this framework guides students through the stages of problem solving and gives them the confidence to undertake new problems.

Each Genetic Analysis is organized in a two-column format to help students easily follow each enumerated

step of the Solution Strategy in the left-hand column along with its corresponding enumerated execution event of the Solution Step in the right-hand column. We enhanced the Genetic Analysis examples by adding *Break It Down* callouts to the problem statement of each example. This new element is designed to aid students who often struggle with identifying the concepts and information contained in a problem that are critical to starting the problem-solving process. We also include problem-solving Tips to highlight critical steps and Pitfalls to avoid, gathered from our teaching experience. It is also important to note that Genetic Analysis examples are integrated throughout each chapter, right after discussions of important content, to help students immediately apply concepts they are learning to the context of problem solving. Each chapter includes two or three Genetic Analysis features, and the book contains 50 in all.

We pair Genetic Analysis with strong end-of-chapter problems that are divided into two groups. Chapter Concept problems come first and review the critical information, principles, and analytical tools discussed in the chapter. These are followed by Application and Integration problems that are more challenging and give students practice in solving problems that are broader in scope. All solutions to the end-of-chapter problems in the *Study Guide and Solutions Manual* use the evaluate-deduce-solve model to reinforce the approach.

An Evolutionary Perspective

Geneticists are acutely aware of evolutionary relationships between genes, genomes, and organisms. Evolutionary processes at the organismal level discovered through comparative biology can also shed light on the function of genes and organization of genomes at the molecular level. Likewise, the function of genes and organization of genomes informs the evolutionary model. The integration of evolution and the evolutionary perspective remains a central organizing theme of the second edition, and this approach has been greatly enhanced through coverage of the molecular biology of archaeal species. Details of archaeal processes are described in a context that compares and contrasts archaea with bacteria and eukaryotes.

Connecting Transmission and Molecular Genetics

Experiments that shed light on principles of transmission genetics preceded the discovery of the structure and function of DNA and its role in inherited molecular variation by several decades. Yet biologists recognize that DNA variation is the basis of inherited morphological variation observed in transmission genetics. Understanding how these two approaches to genetics are connected is vital to thinking like a geneticist. We have retained the integration of transmission genetics and molecular genetics in

the text and have enhanced this feature in two ways: first, through additional discussion of the molecular basis of hereditary variation, including the mutations that underlie the four identified genes examined by Mendel, and second, with a much more robust genomic approach.

Pathways Through the Book

This book is written with a Mendel-first approach that many instructors find offers the most effective pedagogical approach for teaching genetics. We are cognizant, however, that the scope of information covered in genetics courses varies and that instructor preferences differ. We have kept differences and alternative approaches in mind while writing the book. Thus, we provide *five pathways* through the book that instructors can use to meet their varying course goals and objectives. Each pathway features integration of problem solving through the inclusion of Genetic Analysis features in each chapter.

1. Mendel-First Approach

Ch 1–22

This pathway provides a traditional approach that begins with Mendelian genetics and integrates it with evolutionary concepts and connects it to molecular genetics. As examples, we discuss genes responsible for four of Mendel's traits (Chapter 2), Chapter 12 and Chapter 13, as well as gene structure in relation to dominance and functional level (Chapter 5). We draw together hereditary variation, molecular variation, and evolution in the discussion of sickle cell disease (Chapter 10).

2. Molecular-First Approach

Ch 1 → Ch 7–10 → Ch 2–6 → Ch 11–22

This pathway provides a molecular-first approach to develop a clear understanding of the molecular basis of heredity and variation before delving into the analysis of hereditary transmission.

3. Integration of Molecular Analysis

Ch 1 → Ch 10 → Ch 2–15 → Ch 16–22

This pathway focuses on the parallels of transmission and molecular genetic analyses right from the start, and it best reflects the way a geneticist would approach study of the field. We recommend this pathway for students who already have a strong genetics background and are familiar with some common molecular techniques.

4. Quantitative Genetics Focus

Ch 1–2 → Ch 21 → Ch 3–20 → Ch 22

This pathway incorporates quantitative genetics early in the course by introducing polygenic inheritance (Chapter 2) and following it up with a comprehensive discussion of quantitative genetics (Chapter 21).

5. Population Genetics Focus

Ch 1–2 → Ch 22 → Ch 3–21

This pathway incorporates population genetics early in the course. Instructors can use the introduction to evolutionary principles and processes (Chapter 1) and the role of genes and alleles in transmission (Chapter 2) and then address evolution at the population level and at higher levels (Chapter 22).

Chapter Features

A principal goal of our writing style and chapter organization is to engage the reader both intellectually and visually to invite continuous reading, all the while clearly explaining complex and difficult ideas. Our conversational tone encourages student reading and comprehension, and our attractive design and realistic art program visually engage students and put them at ease. Experienced instructors of genetics know that students are more engaged when they can relate concepts to the real world. To that end, we use real experimental data to illustrate genetic principles and analysis as well as to familiarize students with exciting research and creative researchers in the field. We also discuss a broad array of organisms—such as humans, bacteria, yeast, plants, fruit flies, nematodes, vertebrates, and viruses—to exemplify genetic principles.

Careful thought has been given to our chapter features; each one serves to improve student learning. The following features illustrate how we highlight central ideas, problems, and methods that are important for understanding genetics.

- **Genetic Analysis:** This is our key problem-solving feature that guides students through the problem-solving process by using the *evaluate-deduce-solve* framework.
- **Foundation Figures:** Highly detailed illustrations of pivotal concepts in genetics.
- **Experimental Insights:** Discuss critical or illustrative experiments, the data derived from the experiments, and the conclusions drawn from analysis of experimental results.
- **Research Techniques:** Explore important research methods and visually illustrate the results and interpretations.
- **Case Studies:** Short, real-world examples, at the end of every chapter, highlight central ideas or concepts of the chapter with interesting examples that remind students of some practical applications of genetics.

MasteringGenetics

A key reviewing and testing tool is MasteringGenetics, the most powerful online homework and assessment system available. Tutorials follow the Socratic method,

coaching students to the correct answer by offering feedback specific to a student's misconceptions as well as providing hints students can access if they get stuck. The interactive approach of the tutorials provides a unique way for students to learn genetics concepts while developing and honing their problem-solving skills. In addition to tutorials, MasteringGenetics includes animations, quizzes, and end-of-chapter problems from the textbook. This exclusive product of Pearson greatly enhances learning genetics through problem solving, and new features include:

- A new category of Practice Problems are like end-of-chapter questions in scope and level of difficulty and are found only in MasteringGenetics. Solutions are not available in the Study Guide and Solutions Manual, and the bank of questions extends your options for assigning challenging problems. Each problem includes specific wrong answer feedback to help students learn from their mistakes and to guide them toward the correct answer.
- Nearly 90% of the end-of-chapter questions are now included in the item library for assignments. The questions use a broad range of answer types in addition to multiple choice, such as sorting, labeling, numerical, and ranking.
- LearningCatalytics is a “bring your own device” (smartphone, tablet, or laptop) assessment and active classroom system that expands the possibilities for student engagement. Instructors can create their own questions, draw from community content shared by colleagues, or access Pearson's new library of question clusters that explore challenging topics through a series of two to five questions that focus on a single scenario or data set, build in difficulty, and require higher-level thinking.

Student Supplements

MasteringGenetics

ISBN: 0133983501 / 9780133983500

Study Guide and Solutions Manual

ISBN: 0133795586 / 9780133795585

Heavily updated and accuracy-checked by Peter Mirabito from the University of Kentucky, the *Study Guide and Solutions Manual* is divided into four sections: Genetics Problem-Solving Toolkit, Types of Genetics Problems, Solutions to End-of-Chapter Problems, and Test Yourself. In the “toolkit,” students are reminded of key terms and concepts and key relationships that are needed to solve the types of problems in a chapter. This is followed by a breakdown of the types of problems students will encounter in the end-of-chapter problems for a particular chapter; they learn the key strategies to solve each type,

variations on a problem type that they may encounter, and a worked example modeled after the Genetic Analysis feature of the main textbook. The solutions also reflect the *evaluate-deduce-solve* strategy of the Genetic Analysis feature. Finally, for more practice, we've included five to 10 Test Yourself problems and accompanying solutions.

Instructor Supplements

MasteringGenetics

ISBN: 0133983501 / 9780133983500

MasteringGenetics engages and motivates students to learn and allows you to easily assign automatically graded activities. Tutorials provide students with personalized coaching and feedback. Using the gradebook, you can quickly monitor and display student results. MasteringGenetics easily captures data to demonstrate assessment outcomes. Resources include:

- In-depth tutorials that coach students with hints and feedback specific to their misconceptions.
- An item library of thousands of assignable questions including reading quizzes and end-of-chapter problems. You can use publisher-created prebuilt assignments to get started quickly. Each question can be easily edited to match the precise language you use.
- A gradebook that provides you with quick results and easy-to-interpret insights into student performance.

TestGen TestBank

ISBN: 0133999696 / 9780133999693

Test questions are available as part of the TestGen EQ Testing Software, a text-specific testing program that is networkable for administering tests. It also allows instructors to view and edit questions, export the questions as tests, and print them out in a variety of formats.

Instructor Resource DVD

ISBN: 0134005856 / 9780134005850

The Instructor Resource DVD offers adopters of the text convenient access to the most comprehensive and innovative set of lecture presentation and teaching tools offered by any genetics textbook. Developed to meet the needs of veteran and newer instructors alike, these resources include:

- The JPEG files of all text line drawings with labels individually enhanced for optimal projection results (as well as unlabeled versions) and all text tables.
- Most of the text photos, including all photos with pedagogical significance, as JPEG files.
- A set of PowerPoint® presentations consisting of a thorough lecture outline for each chapter augmented by key text illustrations and animations.

- PowerPoint® presentations containing a comprehensive set of in-class Classroom Response System (CRS) questions for each chapter.
- In Word and PDF files, a complete set of the assessment materials and study questions and answers from the test bank.

We Welcome Your Comments and Suggestions

Genetics is continuously changing, and textbooks must also change continuously to keep pace with the field and to meet the needs of instructors and students. Communication with our talented and dedicated users is a critical driver of change. We welcome all suggestions and comments and invite you to communicate with us directly. Please send comments or questions about the book to us at mfsanders@ucdavis.edu or john.bowman@monash.edu.

Acknowledgments

In our first edition, we described the adage that begins with the words "It takes a village..." as aptly applying to the development and assembly of the first edition of our textbook. As was the case in the first edition, this second edition has been a true team effort, and we are grateful to all of our teammates. We particularly wish to thank our editorial team led by our executive editor Michael Gillespie, our developmental editor Moira Lerner Nelson, and our project coordinator Crystal Clifton for their guidance and assistance in bringing this new edition to life. We also thank our compatriot Peter Mirabito, author of the Study Guide and Solutions Manual, for his work assembling an exceptionally useful supplement. Beth Wilbur, Paul Corey, and Deborah Gale have also been essential supporters that have made this new edition a reality.

On the production side, we thank the fine artists at Precision who have managed to turn our rudimentary cartoons into instructive pieces of art. We thank the production team at Pearson Education led by Margaret Young.

The Pearson Education marketing team led by Lauren Harp has provided expert guidance in bringing our textbook to the attention of genetics instructors throughout North America and indeed around the world.

Finally, and perhaps most importantly, we thank the scores of gifted genetics instructors and the thousands of genetics students who used the first edition of our book and the many reviewers and accuracy checkers whose contributions have been invaluable. Many of our users and all of our reviewers have provided comments and feedback that have immeasurably improved this second edition. We are humbled and gratified by their praise and encouraged by their support and the generosity with which they apply their expertise.

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