

Daniela Pinzani, Cristina Panero, Giuseppe Bagni  
**Scoprire la chimica**

## Fonti iconografiche

### Note di metodo

Apertura shutterstock/halfmax.ru  
Figura 1A shutterstock/anyaivanova  
Figura 1B SPL/AGF/MAURO FERMARIELLO  
Figura 1C shutterstock/Matej Kastelic  
Figura 6A shutterstock/irin-k  
Figura 6B shutterstock/Hanzi-mor  
Figura 7 SPL/AGF/SHEILA TERRY

### Capitolo 1 - Dentro la materia miscugli e sostanze

Apertura shutterstock/Olga Danylenko  
Figura 1.2 (lavagna) shutterstock/marekuliasz  
Figura 1.2 (penna) shutterstock/cosma  
Figura 1.2 (matita) shutterstock/hxdbzxy  
Figura 1.4 Carlo Gardini, Parma  
Figura 1.5A shutterstock/whitehoune  
Figura 1.5B shutterstock/Ventin  
Figura 1.5C SPL/AGF/ANDREW LAMBERT PHOTOGRAPHY  
Figura *Il mio laboratorio* a pagina 5 shutterstock/gosphotodesign  
Figura 1.7A shutterstock/Africa Studio  
Figura 1.7B shutterstock/Sea Wave  
Figura 1.9 Carlo Gardini, Parma  
Figura 1.10 shutterstock/Ralf Herschbach  
Figura 1.11A SPL/AGF/DIRK WIERSMA  
Figura 1.11B shutterstock/Boykung  
Figura 1.11C SPL/AGF/NATURAL HISTORY MUSEUM, LONDON  
Figura 1.12 SPL/AGF/PASCAL GOETGHELUCK  
Figura 1.13 Carlo Gardini, Parma  
Figura 1.14B SPL/AGF/MARTYN F. CHILLMAID  
Figura 1.17 Carlo Gardini, Parma  
Figura 1.18A shutterstock/Lena Lir  
Figura *Il mio laboratorio* a pagina 16 shutterstock/Sea Wave  
Figura esercizio 6 a pagina 20 SPL/AGF/MARTYN F. CHILLMAID  
Figura esercizio 7 a pagina 20 shutterstock/wavebreakmedia  
Figura esercizio 9A a pagina 20 shutterstock/Dmitri Gristsenko  
Figura esercizio 9B a pagina 20 shutterstock/Andreas Kraus  
Figura esercizio 9C a pagina 20 shutterstock/Andrey Shtanko  
Figura esercizio 9D a pagina 20 shutterstock/Stephen Mcsweeny  
Figura esercizio 9E a pagina 20 shutterstock/Dmitrij Skorobogatov

### Capitolo 2 - Le trasformazioni della materia

Apertura shutterstock/kaca kaca  
Figura 2.1A shutterstock/NOBUHIRO ASADA

Figura 2.1B shutterstock/Bogdan Wankowicz  
Figura 2.2A shutterstock/XiXinXing  
Figura 2.2B shutterstock/Syda Productions  
Figura 2.5 shutterstock/mangostock  
Figura 2.8 shutterstock/Swapan Photography  
Figura *Il mio laboratorio* a pagina 28 shutterstock/logoboom  
Figura *Il mio laboratorio* a pagina 29 Carlo Gardini, Parma  
Figura *Il mio laboratorio* a pagina 33 shutterstock/Scott Bolster  
Figura 2.13 shutterstock/huyangshu  
Figura 2.14 shutterstock/Vadim Ratnikov  
Figura 2.17B shutterstock/Kellis  
Figura 2.17C SCIENCE PHOTO LIBRARY/AGF  
Figura 2.18 Carlo Gardini, Parma  
Figura *Il mio laboratorio* a pagina 40 shutterstock/Chiociolla  
Figura 2.19A shutterstock/angellodeco  
Figura 2.19B shutterstock/Iakov Filimonov  
Figura 2.19C shutterstock/Cyril Hou  
Figura *Il mio laboratorio* a pagina 41 fotolia/haller  
Figura 2.20B shutterstock/StockPhotosArt  
Figura 2.20C shutterstock/Gavran333  
Figura 2.23 Carlo Gardini, Parma  
Figura 2.24B shutterstock/photomaster  
Figura 2.25 Fundamental Photographs/Chip Clark  
Figura *Il mio laboratorio* a pagina 45 shutterstock/art\_of\_sun  
Figura 2.26 SCIENCE PHOTO LIBRARY/AGF/MAURO FERMARIELLO  
Figure 2.27, 2.28 e 2.29 Carlo Gardini, Parma  
Figura 2.30 SCIENCE PHOTO LIBRARY/AGF/MARTYN F. CHILLMAID  
Figura 2.33 Carlo Gardini, Parma  
Figura esercizio 16 a pagina 52 shutterstock/Menna  
Figura esercizio 24 a pagina 52 shutterstock/Buquet Christophe  
Figura esercizio 34 a pagina 53 shutterstock/pirtuss  
Figura esercizio 36 a pagina 54 shutterstock/Ioan Florin Cnejevici

### **Capitolo 3 - La chimica diventa scienza: le leggi quantitative**

Apertura shutterstock/Nenov Brothers Images  
Figura 3.1 SCIENCE PHOTO LIBRARY/AGF  
Figura *Il mio laboratorio* a pagina 56 shutterstock/kriangkrai wangjai  
Figura 3.2 Carlo Gardini, Parma  
Figura 3.3 (legna) shutterstock/Givaga  
Figura 3.3 (fuoco) shutterstock/Peter Gudella  
Figura 3.3 (cenere) shutterstock/Fabiok  
Figura 3.7 Carlo Gardini, Parma  
Figura 3.8 shutterstock/Phichai  
Figura 3.9 SCIENCE PHOTO LIBRARY/AGF  
Figura 3.10 shutterstock/Ilya Avdyushev  
Figura *Il mio laboratorio* a pagina 63 shutterstock/ Mike Flippo  
Figura *Il mio laboratorio* a pagina 63 (tazzina con due piattini) Carlo Gardini, Parma  
Figura 3.11 SCIENCE PHOTO LIBRARY/AGF/MARTYN F. CHILLMAID  
Figura 3.12 Carlo Gardini, Parma

Figura 3.13 SCIENCE PHOTO LIBRARY/AGF/CHEMICAL HERITAGE FOUNDATION  
Figura *Il mio laboratorio* a pagina 67 shutterstock/Bugtiger  
Figura *Il mio laboratorio* a pagina 67 (tazzina con un piattino) Carlo Gardini, Parma  
Figura 3.14 Carlo Gardini, Parma  
Figura 3.15 SCIENCE PHOTO LIBRARY/AGF  
Figura 3.16 (cascata) shutterstock/oorka  
Figura 3.16 (decolorante per capelli) shutterstock/schankz  
Figura in tabella 3.2 (acqua) shutterstock/VladisChern  
Figura in tabella 3.2 (acqua ossigenata) Carlo Gardini, Parma  
Figura esercizio 4 a pagina 78 shutterstock/Nejron Photo  
Figura esercizio 26 a pagina 80 shutterstock/Olivier Le Queinec

## **Capitolo 4 - Le leggi dei gas**

Apertura shutterstock/CCat82  
Figura 4.1A shutterstock/Micha Rosenwirth  
Figura 4.2B SCIENCE PHOTO LIBRARY/AGF/FRANS LANTING, MINT IMAGES  
Figura 4.5A SCIENCE PHOTO LIBRARY/AGF/SHEILA TERRY  
Figura 4.6A shutterstock/mariakraynova  
Figure 4.7 e 4.8A SCIENCE PHOTO LIBRARY/AGF  
Figura 4.8B shutterstock/DutchScenery  
Figura 4.8C SCIENCE PHOTO LIBRARY/AGF/MARTYN F. CHILLMAID  
Figura 4.8D SCIENCE PHOTO LIBRARY/AGF/AJ PHOTO  
Figura 4.8E SCIENCE PHOTO LIBRARY/AGF/ANDREW LAMBERT PHOTOGRAPHY  
Figura 4.12A SCIENCE PHOTO LIBRARY/AGF/DAVID PARKER  
Figura 4.12B SCIENCE PHOTO LIBRARY/AGF/RICHARD FOLWELL  
Figura *Il mio laboratorio* (palloncini) a pagina 91 shutterstock/INSAGO  
Figura *Il mio laboratorio* (moneta) a pagina 91 shutterstock/ MLArduengo  
Figura *Il mio laboratorio* a pagina 94 shutterstock/michaket  
Figura 4.22 SCIENCE PHOTO LIBRARY/AGF/SPUTNIK  
Figura esercizio 18 a pagina 102 shutterstock/emberiza  
Figura esercizio 28 a pagina 102 shutterstock/TippaPatt

## **Capitolo 5 - La massa nel mondo microscopico: masse atomiche e molecolari**

Apertura shutterstock/optimarc  
Figura 5.1 Archivio Zanichelli  
Figura 5.2A SCIENCE PHOTO LIBRARY/AGF/J-L CHARMET  
Figura 5.2B SCIENCE PHOTO LIBRARY/AGF/SHEILA TERRY  
Figura *Il mio laboratorio* a pagina 105 SCIENCE PHOTO LIBRARY/AGF/UIG/Dorling Kindersley  
Figura 5.3 SCIENCE PHOTO LIBRARY/AGF  
Figura 5.3 (ingrandimento) Carlo Gardini, Parma  
Figure 5.7 e 5.8 SCIENCE PHOTO LIBRARY/AGF  
Figura 5.9 SCIENCE PHOTO LIBRARY/AGF/NATURAL HISTORY MUSEUM, LONDON  
Figura 5.15 Carlo Gardini, Parma

## **Capitolo 6 - La massa nel mondo macroscopico: la mole**

Apertura shutterstock/Marina99  
Figura *Il mio laboratorio* a pagina 122 shutterstock/AN NGUYEN

- Figura 6.1 Alamy Stock Photo/IPA/BSIP SA  
Figura 6.3 SCIENCE PHOTO LIBRARY/AGF/MARTYN F. CHILLMAID  
Figura 6.4 SCIENCE PHOTO LIBRARY/AGF  
Figura 6.5 (Londra) shutterstock/PHOTOCREO Michal Bednarek  
Figura 6.5 (Terra) shutterstock/MarcelClemens  
Figura 6.5 (mole) Carlo Gardini, Parma

## **Capitolo 7 - La scoperta della periodicità**

- Apertura shutterstock/ Nataliya Hora  
Figura 7.1A SCIENCE PHOTO LIBRARY/AGF/SHEILA TERRY  
Figure 7.1B, 7.1C e 7.1D SCIENCE PHOTO LIBRARY/AGF/ROYAL INSTITUTION OF GREAT BRITAIN  
Figura 7.2 SCIENCE PHOTO LIBRARY/AGF  
Figura *Il mio laboratorio* a pagina 142 shutterstock/Syda Productions  
Figura 7.4A SCIENCE PHOTO LIBRARY/AGF  
Figura 7.4C SCIENCE PHOTO LIBRARY/AGF/BRITISH LIBRARY  
Figura 7.6 SCIENCE PHOTO LIBRARY/AGF/GARY BROWN  
Figura 7.8A SCIENCE PHOTO LIBRARY/AGF/SPUTNIK  
Figura 7.8B SCIENCE PHOTO LIBRARY/AGF/AMERICAN INSTITUTE OF PHYSICS/EMILIO SEGRE VISUAL ARCHIVES  
Figure 7.9, 7.10 e 7.11 SCIENCE PHOTO LIBRARY/AGF  
Figura 7.12 Reuters/Contrasto  
Figura 7.13 Alamy Stock Photo/IPA/Sean O'Neill  
Figure A e B, esercizio 3 a pagina 149 shutterstock/niwat chaiyawoot  
Figura C, esercizio 3 a pagina 149 shutterstock/Gloszilla Studio

## **Capitolo 8 - Mettiamo ordine tra i composti**

- Apertura shutterstock/Viktor Gladkov  
Figura *Il mio laboratorio* a pagina 152 Carlo Gardini, Parma  
Figura 8.1 SCIENCE PHOTO LIBRARY/AGF/ANDREW LAMBERT PHOTOGRAPHY  
Figura 8.2A Carlo Gardini, Parma  
Figura 8.2B shutterstock/Gelpi JM  
Figura 8.2C shutterstock/hxdbzxy  
Figura 8.3A shutterstock/AndrisA  
Figura 8.3B shutterstock/Diego Cervo  
Figura 8.6A SCIENCE PHOTO LIBRARY/AGF/NATURAL HISTORY MUSEUM, LONDON  
Figura 8.6B SCIENCE PHOTO LIBRARY/AGF/DIRK WIERSMA  
Figura 8.6C Alamy Stock Photo/IPA/PHOTOTAKE Inc.  
Figura 8.8 Wikimedia Commons/BXXXD  
Figura 8.9A SCIENCE PHOTO LIBRARY/AGF/MARTYN F. CHILLMAID  
Figura 8.9B SCIENCE PHOTO LIBRARY/AGF/GUSTOIMAGES  
Figura 8.10 SCIENCE PHOTO LIBRARY/AGF/MARTYN F. CHILLMAID  
Figura 8.11 SCIENCE PHOTO LIBRARY/AGF/ANDREW LAMBERT PHOTOGRAPHY  
Figure 8.12 e 8.13A SCIENCE PHOTO LIBRARY/AGF/MARTYN F. CHILLMAID  
Figura 8.13B shutterstock/vgstudio  
Figura 8.13C shutterstock/Victor I. Makhankov  
Figura 8.14 Alamy Stock Photo/IPA/sciencephotos  
Figura 8.15 Carlo Gardini, Parma  
Figura 8.16 shutterstock/Ildi Papp

Figura *Il mio laboratorio* a pagina 164 SCIENCE PHOTO LIBRARY/AGF/ANDREW LAMBERT PHOTOGRAPHY

Figura 8.18A SCIENCE PHOTO LIBRARY/AGF/HERVE CONGE, ISM

Figura 8.18B SCIENCE PHOTO LIBRARY/AGF/DIRK WIERSMA

Figura 8.20A shutterstock/Nneirda

Figura 8.20B shutterstock/Wlad74

Figura 8.20C SCIENCE PHOTO LIBRARY/AGF/DIRK WIERSMA

Figura 8.21A shutterstock/Kenishirotie

Figura 8.21B shutterstock/Africa Studio

Figura 8.21C shutterstock/D. Pimborough

## **Capitolo 9 - Dall'atomo di Dalton ai giorni nostri**

Apertura Corbis/Charles & Josette Lenars

Figura 9.1 shutterstock/Aleksandrs Samuilovs

Figura 9.2 SCIENCE PHOTO LIBRARY/AGF/AMERICAN PHILOSOPHICAL SOCIETY

Figura 9.3A SCIENCE PHOTO LIBRARY/AGF/ANDREW LAMBERT PHOTOGRAPHY

Figura 9.4 SCIENCE PHOTO LIBRARY/AGF/LIBRARY OF CONGRESS

Figura 9.5 SCIENCE PHOTO LIBRARY/AGF/ANDREW LAMBERT PHOTOGRAPHY

Figura 9.7 SCIENCE PHOTO LIBRARY/AGF/JOSE ANTONIO PEÑAS

Figura 9.9 SCIENCE PHOTO LIBRARY/AGF/AMERICAN INSTITUTE OF PHYSICS

Figura 9.10A shutterstock/MarcelClemens

Figura 9.10B SCIENCE PHOTO LIBRARY/AGF/ROBERTO DE GUGLIELMO

Figura 9.10C SCIENCE PHOTO LIBRARY/AGF/ASTRID & HANNS-FRIEDER MICHLER

Figura 9.11 SCIENCE PHOTO LIBRARY/AGF

Figura 9.12 SCIENCE PHOTO LIBRARY/AGF/LIBRARY OF CONGRESS

Figura 9.13 shutterstock/Antonio S

Figura 9.18 SCIENCE PHOTO LIBRARY/AGF/JAMES KING-HOLMES

Figura 9.21 shutterstock/Adam Middleton

Figura 9.22 shutterstock/bogdan ionescu

Figura 9.25 e 9.26 Alamy Stock Photo/IPA/Phil Degginder

Figura 9.27 SCIENCE PHOTO LIBRARY/AGF/DEPT. OF PHYSICS, IMPERIAL COLLEGE

Figura 9.32 SCIENCE PHOTO LIBRARY/AGF

Figura I) e II), esercizio 3 a pagina 191 SCIENCE PHOTO LIBRARY/AGF/DEPT. OF PHYSICS, IMPERIAL COLLEGE

Figura *Il mio laboratorio* a pagina 193 fotolia/shertut

## **Capitolo 10 - Gli elementi e la tavola periodica**

Apertura shutterstock/magnetix

Figura 10.1 fotolia/Comugnero Silvana

Figura 10.2 shutterstock/Quanthem

Figura 10.3 SCIENCE PHOTO LIBRARY/AGF/MARTYN F. CHILLMAID

Figura 10.4 SCIENCE PHOTO LIBRARY/AGF/ANDREW LAMBERT PHOTOGRAPHY

Figura 10.5 Carlo Gardini, Parma

Figura 10.6 SCIENCE PHOTO LIBRARY/AGF

Figura 10.7A shutterstock/Platslee

Figura 10.7B shutterstock/Fotografiche

Figura 10.7C shutterstock/Daniele Silva

Figura 10.8A SCIENCE PHOTO LIBRARY/AGF/ANDREW LAMBERT PHOTOGRAPHY

Figura 10.8B SCIENCE PHOTO LIBRARY/AGF/MARTYN F. CHILLMAID

Figura 10.8C shutterstock/SIHASAKPRACHUM  
Figura 10.9 SCIENCE PHOTO LIBRARY/AGF/ANDREW LAMBERT PHOTOGRAPHY  
Figura 10.10A SCIENCE PHOTO LIBRARY/AGF/DIRK WIERSMA  
Figura 10.10B SCIENCE PHOTO LIBRARY/AGF/ANDREW LAMBERT PHOTOGRAPHY  
Figura 10.10C SCIENCE PHOTO LIBRARY/AGF/MARTYN F. CHILLMAID  
Figura 10.11 shutterstock/Sean Pavone  
Figura 10.12 shutterstock/Meliksetyan Marianna  
Figura 10.20 SCIENCE PHOTO LIBRARY/AGF/AMERICAN INSTITUTE OF PHYSICS  
Figura 10.23 shutterstock/Lola Tsvetaeva  
Figura esercizio 1 a pagina 220 shutterstock/Coprid  
Figura esercizio 15 a pagina 220 shutterstock/metwo  
Figura esercizio 20 a pagina 220 shutterstock/bjul  
Figura esercizio 25 a pagina 221 SCIENCE PHOTO LIBRARY/AGF

## Il laboratorio delle competenze

Figure alle pagine 222, 223 e 224 Carlo Gardini, Parma

## Capitolo 11 - Gli atomi si uniscono

Apertura shutterstock/MarcelClemens  
Figura *Il mio laboratorio* a pagina 226 shutterstock/Jacek Chabraszewski  
Figura 11.1A SCIENCE PHOTO LIBRARY/AGF/DAVID SCHARF  
Figura 11.1B shutterstock/Alexey V Smirnov  
Figura 11.2A SCIENCE PHOTO LIBRARY/AGF/DIRK WIERSMA  
Figura 11.5A SCIENCE PHOTO LIBRARY/AGF/LAWRENCE LAWRY  
Figura 11.5B shutterstock/MarcelClemens  
Figura 11.5C shutterstock/lapas77  
Figura 11.6A shutterstock/Katarish  
Figura 11.6B shutterstock/Mark Yuill  
Figura 11.6C shutterstock/Chubykin Arkady  
Figura *Il mio laboratorio* a pagina 231 SCIENCE PHOTO LIBRARY/AGF/UIG/Dorling Kindersley  
Figura 11.7 shutterstock/kurhan  
Figura 11.12A SCIENCE PHOTO LIBRARY/AGF/ASTRID & HANNS-FRIEDER MICHLER  
Figura 11.12B SCIENCE PHOTO LIBRARY/AGF/SPUTNIK  
Figura 11.13 LAWRENCE BERKELEY NATIONAL LABORATORY  
Figura 11.14A shutterstock/Vitalii Nesterchuk  
Figura 11.14B SCIENCE PHOTO LIBRARY/AGF/POWER AND SYRED  
Figura *Il mio laboratorio* a pagina 241 SCIENCE PHOTO LIBRARY/AGF/ANDREW LAMBERT PHOTOGRAPHY  
Figura 11.17A SCIENCE PHOTO LIBRARY/AGF/PHIL HILL  
Figura 11.17B SCIENCE PHOTO LIBRARY/AGF/SPUTNIK  
Figura 11.18 shutterstock/melowilo  
Figura 11.19A SCIENCE PHOTO LIBRARY/AGF  
Figura 11.19B shutterstock/Nikolich  
Figura 11.21 shutterstock/Jasenka Luksa  
Figura 11.22A shutterstock/Pi-Lens  
Figura 11.22B shutterstock/Albert Russ  
Figura A, esercizio 37 a pagina 246 shutterstock/MarcelClemens  
Figura B, esercizio 37 a pagina 246 shutterstock/ChiccoDodiFC

## **Capitolo 12 - Forze di attrazione tra molecole**

- Apertura shutterstock/Elizabeth C. Zurek  
Figura 12.1 shutterstock/Marcel Jancovic  
Figura *Il mio laboratorio* a pagina 256 shutterstock/AlexussK  
Figura 12.7 shutterstock/gorillaimages  
Figura 12.8 shutterstock/Lukiyanova Natalia / frenta  
Figura 12.9 SCIENCE PHOTO LIBRARY/AGF/GUSTOIMAGES  
Figura 12.11A SCIENCE PHOTO LIBRARY/AGF/VOLKER STEGER  
Figura 12.11B SCIENCE PHOTO LIBRARY/AGF/FRANS LANTING, MINT IMAGES  
Figura 12.15 shutterstock/Denis Burdin  
Figura 12.18A shutterstock/Thum Chia Chieh  
Figura esercizio 18 a pagina 265 shutterstock/Plus69  
Figura esercizio 31 a pagina 266 shutterstock/Joerg Beuge

## **Capitolo 13 - Le soluzioni**

- Apertura shutterstock/EpicStockMedia  
Figura 13.1A SCIENCE PHOTO LIBRARY/AGF/MAURO FERMARIELLO  
Figura 13.1B SCIENCE PHOTO LIBRARY/AGF/CRISTINA PEDRAZZINI  
Figura 13.1C SCIENCE PHOTO LIBRARY/AGF/CLaire PAXTON & JACQUI FARROW  
Figura 13.2A shutterstock/Maram  
Figura 13.2B shutterstock/Franco Volpato  
Figura 13.2C shutterstock/elina  
Figura *Il mio laboratorio* a pagina 269 shutterstock/morrowlight  
Figura 13.3A SCIENCE PHOTO LIBRARY/AGF/JIM VARNEY  
Figura 13.3B shutterstock/Ivan Vukovic  
Figura 13.4A shutterstock/Dobermaraner  
Figura 13.4B shutterstock/aquapix  
Figura *Il mio laboratorio* a pagina 276 shutterstock/Elena Schweitzer  
Figura 13.7 SCIENCE PHOTO LIBRARY/AGF/MARTYN F. CHILLMAID  
Figura 13.9A shutterstock/Marzolino  
Figura 13.9B shutterstock/MaraZe  
Figura 13.9C shutterstock/Robert Hoetink  
Figura *Il mio laboratorio* a pagina 280 shutterstock/StudioSmart  
Figura *Il mio laboratorio* a pagina 282 shutterstock/ifong  
Figura 13.11 shutterstock/Lestertair  
Figura *Il mio laboratorio* a pagina 284 shutterstock/Sergieiev  
Figura 13.12 Carlo Gardini, Parma  
Figura 13.15 SCIENCE PHOTO LIBRARY/AGF/PHOTOSTOCK-ISRAEL  
Figura esercizio 4 a pagina 291 shutterstock/Marie C Fields

## **Capitolo 14 - Velocità ed equilibrio**

- Apertura shutterstock/Rocksweeper  
Figura 14.1 shutterstock/John Evans  
Figura 14.2 shutterstock/cynoclub  
Figura 14.3 SCIENCE PHOTO LIBRARY/AGF/ANDREW LAMBERT PHOTOGRAPHY  
Figura *Il mio laboratorio* a pagina 296 shutterstock/r.classen  
Figura 14.4 SCIENCE PHOTO LIBRARY/AGF/PHILIPPE PLAilly  
Figura 14.5A shutterstock/Kokhanchikov  
Figura 14.5B shutterstock/nayneung1

Figura 14.6A shutterstock/seeyou  
Figura 14.6B shutterstock/Wesley Guijt  
Figura a pagina 299SCIENCE PHOTO LIBRARY/AGF/NATURAL HISTORY MUSEUM, LONDON  
Figura *Il mio laboratorio* a pagina 300 shutterstock/Kues  
Figura 14.7A shutterstock/JIANG HONGYAN  
Figura 14.7B shutterstock/ptnphoto  
Figura 14.8 shutterstock/Bogdan Wankowicz  
Figura 14.9A SCIENCE PHOTO LIBRARY/AGF/PHILIPPE PSAILA  
Figura 14.9B JIM VARNEY  
Figura *Il mio laboratorio* a pagina 302 shutterstock/denio109  
Figura 14.10 shutterstock/Wichy  
Figura 14.14 SCIENCE PHOTO LIBRARY/AGF/PLANETARY VISIONS LTD  
Figura 14.19A shutterstock/sickmoo  
Figura 14.19B iStock/vm  
Figura 14.20 iStock/Stellajune3700  
Figura 14.26 shutterstock/Alex Sun  
Figura 14.27 shutterstock/Charles Brutlag  
Figura 14.28 SCIENCE PHOTO LIBRARY/AGF  
Figura esercizio 7 a pagina 316 shutterstock/Artur\_eM

## **Capitolo 15 - Gli acidi e le basi**

Apertura shutterstock/SJ Allen  
Figura 15.1 SCIENCE PHOTO LIBRARY/AGF/PATRICK LANDMANN  
Figura 15.2 SCIENCE PHOTO LIBRARY/AGF/CHEMICAL HERITAGE FOUNDATION  
Figura 15.4 SCIENCE PHOTO LIBRARY/AGF/ANDREW LAMBERT PHOTOGRAPHY  
Figura 15.6 SCIENCE PHOTO LIBRARY/AGF/AMERICAN INSTITUTE OF PHYSICS/EMILIO SEGRE VISUAL ARCHIVES  
Figura 15.9 shutterstock/Ruslan Guzov  
Figura 15.10 SCIENCE PHOTO LIBRARY/AGF/UIG/Dorling Kindersley  
Figura 15.11 shutterstock/YuryZap  
Figura 15.12 shutterstock/photong  
Figura 15.13 shutterstock/Foodpictures  
Figura 15.14 shutterstock/HSNphotography  
Figura 15.15A shutterstock/Elsa Hoffmann  
Figura 15.15B SCIENCE PHOTO LIBRARY/AGF/MARTYN F. CHILLMAID  
Figura 15.16 SCIENCE PHOTO LIBRARY/AGF/KEVIN CURTIS  
Figura 15.17 shutterstock/Paolo Bona  
Figura 15.18 shutterstock/Yuriy Kulik  
Figura 15.19A shutterstock/Evgeny Dubinchuk  
Figura 15.19B shutterstock/Yasonya  
Figura 15.20 e 15.21A SCIENCE PHOTO LIBRARY/AGF/ANDREW LAMBERT PHOTOGRAPHY  
Figura 15.21B Alamy Stock Photo/IPA/Chris Pearsall  
Figura 15.21C SCIENCE PHOTO LIBRARY/AGF/ANDREW LAMBERT PHOTOGRAPHY  
Figura 15.22 shutterstock/Decha Thapanya  
Figura 15.23 SCIENCE PHOTO LIBRARY/AGF

## **Capitolo 16 - Dalle reazioni di ossido-riduzione all'energia elettrica**

Apertura shutterstock/CCat82  
Figura 16.1 SCIENCE PHOTO LIBRARY/AGF/ANDREW LAMBERT PHOTOGRAPHY  
Figura *Il mio laboratorio* a pagina 347 shutterstock/ILeysen  
Figura 16.2 SCIENCE PHOTO LIBRARY/AGF/ANDREW LAMBERT PHOTOGRAPHY  
Figura 16.3A shutterstock/wawritto  
Figura 16.3B shutterstock/phloen  
Figura *Il mio laboratorio* a pagina 350 shutterstock/Coprid  
Figura 16.4A shutterstock/itakefotos4u  
Figura 16.4B shutterstock/Marko Poplasen  
Figura 16.5 SCIENCE PHOTO LIBRARY/AGF/GARY BROWN  
Figura 16.6 Wikimedia Commons/Golle95  
Figura 16.7A SCIENCE PHOTO LIBRARY/AGF  
Figura 16.8 SCIENCE PHOTO LIBRARY/AGF/MAYNARD & BOUCHER, VISUALS UNLIMITED/SCIENTIFICA  
Figura *Il mio laboratorio* a pagina 359 shutterstock/Krasowit  
Figura 16.10 shutterstock/Oleksandr Chub

## **Capitolo 17 - Elementi di chimica organica**

Apertura shutterstock/nito  
Figura 17.1A shutterstock/Iuliia Azarova  
Figura 17.1B shutterstock/Yuganov Konstantin  
Figura 17.1C shutterstock/JPC-PROD  
Figura 17.2 shutterstock/Bogdan VASILESCU  
Figura 17.3B shutterstock/file404  
Figura 17.4 SCIENCE PHOTO LIBRARY/AGF/ALFRED PASIEKA  
Figura 17.5 SCIENCE PHOTO LIBRARY/AGF/MIKKEL JUUL JENSEN  
Figura 17.6 shutterstock/sima  
Figura 17.7 shutterstock/Danny E Hooks  
Figura 17.9 (vigneto) shutterstock/artjazz  
Figura 17.9 (uva) shutterstock/Kim D. Lyman  
Figura 17.9 (mosto)shutterstock/Oleg Golovnev  
Figura 17.10A shutterstock/ittipon  
Figura 17.10B shutterstock/Sea Wave  
Figura 17.10C shutterstock/Shulevskyy Volodymyr  
Figura 17.12A SCIENCE PHOTO LIBRARY/AGF/JEAN-Loup CHARMET  
Figura 17.12B SCIENCE PHOTO LIBRARY/AGF/SHEILA TERRY  
Figura 17.13A shutterstock/nunosilvaphotography  
Figura 17.13B shutterstock/Chamille White  
Figura 17.13C shutterstock/gvictoria  
Figura 17.15 shutterstock/AG-PHOTOS  
Figura pagina 376 (burro) shutterstock/yamix  
Figura 17.16 shutterstock/Peter Zijlstra  
Figura 17.17 shutterstock/molekuul.be  
Figura 17.18 shutterstock/Rob Byron  
Figura 17.19A shutterstock/HLPhoto  
Figura 17.19B shutterstock/Zerbor  
Figura 17.19C shutterstock/Africa Studio  
Figura 17.19D shutterstock/life\_in\_a\_pixel  
Figura 17.20A shutterstock/Zorandim

Figura 17.20B shutterstock/Avatar\_023  
Figura 17.20C shutterstock/Sea Wave  
Figura 17.21 shutterstock/Alexandra Giese  
Figura 17.22A shutterstock/Lisa A  
Figura 17.22B shutterstock/watin  
Figura 17.22C shutterstock/Sinelev  
Figura 17.23 shutterstock/marmo81

## **Capitolo 18 - La radioattività**

Apertura SCIENCE PHOTO LIBRARY/AGF  
Figura 18.1A SCIENCE PHOTO LIBRARY/AGF/NATIONAL LIBRARY CONGRESS  
Figura 18.1B SCIENCE PHOTO LIBRARY/AGF/ARNO MASSEE  
Figura 18.1C shutterstock/Dwight Smith  
Figura 18.5 SCIENCE PHOTO LIBRARY/AGF/JOSH SHER  
Figura 18.8A shutterstock/tinta  
Figura 18.8B SCIENCE PHOTO LIBRARY/AGF/DIGITAL GLOBE  
Figura 18.10 SCIENCE PHOTO LIBRARY/AGF  
Figura 18.11 SCIENCE PHOTO LIBRARY/AGF/AMERICAN INSTITUTE OF PHYSICS/UNIVERSITY OF CHICAGO  
Figura 18.12 SCIENCE PHOTO LIBRARY/AGF/AMERICAN INSTITUTE OF PHYSICS/EMILIO SEGRE VISUAL ARCHIVES  
Figura 18.14A SCIENCE PHOTO LIBRARY/AGF/PATRICK LANDMANN  
Figura 18.14B SCIENCE PHOTO LIBRARY/AGF/US DEPARTMENT OF ENERGY

## **Capitolo 19 - La termodinamica**

Apertura shutterstock/Poznyakov  
Figura 19.2A shutterstock/Kekyalyaynen  
Figura 19.2B SCIENCE PHOTO LIBRARY/AGF/MAXIMILIAN STOCK LTD  
Figura 19.2C shutterstock/Andrey Ezhov  
Figura 19.17 SCIENCE PHOTO LIBRARY/AGF/MIKKEL JUUL JENSEN  
Figura 19.19 (divano ordinato) shutterstock/anekoho  
Figura 19.19 (divano con vestiti in disordine) shutterstock/Africa Studio  
Figura 19.24 shutterstock/Ferumov  
Figura 19.25 (cellulare a basso costo) shutterstock/bogdandimages  
Figura 19.25 (smartphone) shutterstock/Maxx-Studio

## **Il laboratorio delle competenze**

Figure alle pagine 426 e 427 Carlo Gardini, Parma

## **Sostanze chimiche e sicurezza**

Apertura shutterstock/Kotin  
Figura 1 SCIENCE PHOTO LIBRARY/AGF/SHEILA TERRY  
Figura 2 SCIENCE PHOTO LIBRARY/AGF/ANTONIA REEVE  
Figura 3A shutterstock/loraks  
Figura 3B shutterstock/Wolfgang Zwanzger  
Figura 3C shutterstock/fotohunter