

Boldface numbers correspond to **key terms** in the text.
Terms that occur in figures (*f*) and tables (*t*) are also indicated.

A

abnormal development, 87, 87*f*
absorption of solar radiation, 320*f*, 320*t*
acetic acid, 220, 221*f*
acid leaching, 344–245
acid precipitation, 236, 236*f*, 239–243, 242*f*, 243*f*
acid spills, 238, 238*f*
acid-base indicators, 231–234, 231*f*, 232*f*, 233*f*, 234*f*
acidified lakes, 240–241, 241*t*, 243, 243*f*
acids, 219–227, **220**
 detecting, 217
 in foods, 219, 220
 formulas, writing, 224
 in nature, 221*f*
 neutralizing, 237–238
 pH scale, 230, 230*f*
 properties, 234*t*
 reactions, 236–245
Activities
 acid-base detection, 217
 acidity and coral reefs, 293
 air pollution and lakes, 244
 apparent depth, 471
 carbon stores, 336
 cell structure of a leaf, 62
 chemical reactions, 137, 177, 188, 194
 climate change, 267, 349, 375
 climatograph, making, 281
 concave mirror, 421
 conservation of mass, 177
 converging lenses, comparing, 491
 convex mirror, 434
 coral reefs and acidity, 293
 decomposition reaction, 188
 electron sharing, 143
 field of view, 485
 genetic testing, ethics of, 21
 global warming, 329, 375
 glowing slime, making, 401
 internal reflection of light, 463
 ionic compounds, modelling, 143
 ions and acids, matching, 225
 law of reflection, 413
 light, properties of, 459
 matter and energy, flow of, 309
 message transfer, cell to cell, 5
 mitosis, modelling, 36
 molecular compounds, modelling, 154
 non-metal reactivity, 194
 phloem function, 71
 plant growth, observing, 55
 properties of light, 459

pulse rate, 101
refraction, 447
skin cloning, 83
solar energy heating Earth, 315
synthesis reaction, 188
tissue characteristics, 89
toxic material removal, 200
tree rings, analyzing, 352
universal indicator, 232
volcanic eruptions, effects of, 276
water vapour movement, simulating, 365
activity series, **192**–194, 192*f*
adenine, 17*f*
adhesion, of water, 74
adipose tissue, 89*t*
aerosols (from volcanoes), 276
AIDS, 112–113
air bags, 136, 187*f*
air pollution, 244
albedo, 268, **275**, 312–313
 changing, 321, 390
 energy budget, 321, 321*f*
 feedback loops, 312, 312*f*, 313, 313*f*, 325
aluminum carbonate, 149*t*
aluminum chloride, 143, 143*f*
aluminum fluoride, 145*t*
aluminum sulfide, 144*f*
alveoli, 104, 104*f*, 106
ammonia, 165, 165*f*, 182, 182*f*, 205, 337
ammonium, 148, 148*t*, 337
ammonium sulfate, 149*t*, 166
amniocentesis, 19, 109
amoeba, 85, 85*f*
amylase, 97
anaphase, **35**, 35*f*, 56
angioplasty, 102, 103*f*
angle of incidence, **412**
 different materials, through, 477
 and glass surfaces, 458, 461*f*, 459
 large, 460–461, 461*f*
 and mirrors, 413*f*, 416, 420, 420*f*, 460, 460*f*
 prism, through, 464, 464*f*
 small, 462, 462*f*
 and water, 458, 458*f*, 462, 462*f*, 476, 480
angle of reflection, **412**, 413*f*
angle of refraction, **452**, 452*f*
 different materials, through, 477
 and glass surfaces, 459
 and water, 451, 451*f*, 452, 452*f*, 462, 462*f*, 476, 480
animal cells, 46*f*
 cytokinesis, 37, 37*f*

mitosis, 34–35*f*, 37, 37*f* 48–49, 48*f*, 49*f*
organelles, 10*f*, 11, 12, 12*f*, 14, 85, 85*f*
specialization, 85–87
anions, **140**
 in displacement reactions, 194, 195, 196
 forming ionic compounds, 140
 naming ionic compounds, 142, 147, 147*t*, 148, 223
 writing chemical formulas, 144, 145*t*, 149, 227
ant stings, 221
antacids, 150, 225, 225*f*, 237
anthropogenic, **277**
anthropogenic climate change, 277, 368, 368*f*, 374
anthropogenic greenhouse effect, **329**, 344, 376, 377*f*
antibodies, 110, 111
antigen, 110, 111
anus, 97*f*, 99
aorta, 99*f*, 100, 100*f*
apparent depth, **470**, 471
Aqua (satellite), 362*f*, 363, 363*f*
aqueous solutions, 162*t*
 acids, 220, 230
 bases, 226, 230
 classifying, 230
 conductivity of, 220, 226
 displacement reactions, 191, 191*f*, 193, 195, 195*f*, 212*f*
 gold in, 202–203, 202*f*
argon, 405
Aristotle, 279
arteries, 104*f*, 116*f*
 aorta, 99*f*, 100, 100*f*
 blocked, 102, 102*f*, 103*f*, 131
 in closed circulatory system, 101
 and heart disease, 102
 pulmonary, 100, 100*f*
arteriosclerosis, 102, 116*f*
astatine, 194
asthma, 294
astigmatism, **509**
atmosphere, **269**
 carbon cycle, 334, 335*f*, 336
 carbon dioxide, 323, 324, 324*f*, 325, 325*f*, 334, 335*f*, 336
 climate, 273–274, 273*f*, 274*f*
 composition, 324*f*
 concentration of gases, 323, 323*t*, 324
 feedback loops, 312–313, 312*f*, 313*f*, 315
 solar energy, 273, 273*f*, 311
 water vapour, 273, 325
Atmospheric Infrared Sounder (AIRS), 363

atom economy, 167*f*
Aura (satellite), 362, 362*f*, 363*f*
auxin, 59, 59*f*
axis of symmetry, 490, 490*f*, 494, 495*t*, 496*f*, 497*t*, 498*f*
 converging lenses, 489, 489*f*, 490, 490*f*, 495*t*, 496*f*, 498*t*
 diverging lenses, 489, 489*f*, 490, 490*f*, 497*f*

B

bacteria, 7, 23*t*, 27
baking soda, 137, 150, 225
balanced chemical equation, 161, 179, 181, 182, 187
barium X rays, 95, 95*f*
bases, 219, **225**–227
 indicators, 231–234, 231*f*, 232*f*, 233*f*, 234*f*
 neutralizing, 237
 pH scale, 230, 230*f*
Basur, Dr. Sheela, 112*f*
Beverly Swamp, 298*f*
bias, **372**
biconcave lens, 489
Bild-Enkin, Simon, 242
bile, 98*f*
binary acids, **222**
binary ionic compounds, **142**, 144–145, 184
binary molecular compounds, **154**–157, 154*t*, 155*t*, 156*t*
binoculars, 464, 464*f*, 504, 504*f*
bioclimate profiles, 286
biogeochemical cycle, **333**
bioluminescence, **407**, 408*f*
biomes, **283**, 283*f*, 284, 284*f*, 297–298, 297*f*
biophotonics, **108**, 109*f*
black dragonfish, 408*f*
bladder, 99, 99*f*
bleach and ammonia, 205, 205*f*
blood, 89*t*, 99, 100–102, 104
blood cells, red, 7, 7*f*, 11*f*, 26*f*, 104, 104*f*
blood clots, 102, 102*f*
blood vessels, 83*f*, 99
Bodnar, BJ, 292
bogs, 298
Bohr-Rutherford water model, 153, 153*f*
bone, 89*t*
boreal forest, 283*f*, 284*f*
Boreal Forest eozone, 303*f*
Boreal Shield ecoregions, 287*f*
boundary, 450
breast cancer, 21
Briand-Lemay, Maude, 415
brightfield/darkfield microscope, 8*f*
“broken telephone” game, 5

- bromine, 142*t*, 155*t*, 164, 181
bromine monochloride, 155*t*
bromothymol blue, 218, 233*f*, 233*t*
bronchiole, 103*f*, 104, 104*f*
bronchus/bronchi, 103*f*, 104
buds, 59, 59*f*
butterfly, number of chromosomes, 16*t*
- C**
- calcium carbonate, 148, 148*f*, 150, 162, 188, 242
calcium hydroxide, 149, 149*f*, 226*t*
calcium oxide, 139, 145
camera lenses, 487, 492, 492*f*, 507, 507*f*, 521
Canada-U.S. Air Quality Agreement, 241
Canada-Wide Acid Rain Strategy, 239
cancer, 42–44, 43*f*, 50, 67, 114, 114*f*
cancer screening, 114
cap-and-trade system, 379
capillaries, 102, 102*f*, 104*f*
car exhaust and environment, 200
carbon cycle, 334, 335*f*, 336
carbon dioxide, 103, 153*f*, 154, 162, 180
 atmosphere, 323, 324, 324*f*, 325, 325*f*, 329*t* 334, 335*f*, 336
 cellular respiration, 14, 14*f*, 63
 climate, 354–355, 355*f*, 367
 global warming potential, 330*t*
carbon footprint, 373–374
carbon monoxide, 176
carbon offsets, 374
carbon sinks, 325, 325*f*
carbon stores, 336
carbon-tax systems, 379
carbonate, 148, 148*t*
carbonic acid, 162, 221*f*, 223*t*
cardiac muscle, 88*t*
Case Studies
 acid precipitation, 240–241
 cloning animals, 24–25
 energy efficiency, 378–379
 green medicines, 166–167
 hydrogen fuel, 182–183
 laser eye surgery, 508–509
 ocean's forests, overheating, 312–313
 phytoplankton, 312–313
 solar ovens, 428–429
 UV radiation, 472–473
 vaccinations, 110–111
 Walkerton water tragedy, 294–295
 wheat rust, 66–67
CAT scan, 94*t*
- catalyst, 201
catalytic converters, 201, 201*f*
cataract eye surgery, 484
cations, 140, 142*f*, 144, 145*t*, 149*t*
cause and effect, identifying, 178, 350
cause-and-effect maps, 350, 486
cell cycle, 40–44, 40*f*, 41*f*
cell cycle checkpoints, 41, 41*f*
cell differentiation, 57, 57*f*, 86, 86*f*
cell division, 29, 30, 37, 37*f* 40*f*
cell membrane, 12*f*, 13*f*, 30, 31, 31*f*
cell plate, 38
cell specialization, 57–59, 57*f*, 85–87
cell theory, 11
cell wall, 13*f*
cells, 7, 29–38
 animal, 12, 12*f*, 14, 34–35*f*, 37, 37*f*, 48–49, 48*f*, 49*f*, 85–87
 average life span, 40*t*
 cancer, 42–44, 43*f*, 50, 67, 114, 114*f*
 cellular respiration, 14, 14*f*, 63
 chemical concentrations, 30, 31
 cytokinesis, 32, 37–38, 37*f*, 38*f*, 40, 40*f*
 daughter, 29, 32, 33, 35*f*, 37, 37*f*, 38*f*, 40, 40*f*, 43*f*
 death, 42
 division, 29, 29*f*, 40, 40*f*
 glucose, 12*f*, 13*f*, 14
 membrane, 12*f*, 13*f*, 30–31, 31*f*
 mitosis, 34–35*f*, 37, 37*f*, 48–49, 48*f*, 49*f*
 organelles, 10, 10*f*, 11, 12–14, 12*f*, 13*f*, 85, 85*f*
 osmosis, 30, 31, 31*f*, 73, 73*f*
 parent, 29, 33, 34–35*f*, 37, 37*f*, 38, 38*f*
 permeability of membranes, 31
 plant, 38*f*, 57
 red blood, 7, 7*f*, 11*f*, 26*f*, 104, 104*f*
 reproduction, 29, 29*f*, 34–35*f*, 37, 37*f*, 48–49, 48*f*, 49*f*
 sickle, 26, 26*f*
 size, 30, 32, 32*f*
 structure, 7, 10, 10*f*
 suicide, 42
 walls, 38
 water, 14
 white blood, 11*f*, 89, 110, 110*f*, 111
 see also tissue
cellular respiration, 14, 14*f*, 63
centre of curvature, 421, 420, 420*f*, 423, 423*f*, 424, 424*f*
centromere, 33*f*, 34*f*, 35*f*, 56
centrosome, 33, 34*f*, 35*f*,
CERES, 321
- chemical equations, 161, 163–165
chemical reactions, 137, 160, 199
car exhaust, 200–201, 200*f*, 201*f*
 evidence of 180, 180*f*, 207
decomposition reactions, 179, 185–188, 185*f*, 186*f*, 197*t*
displacement reactions, 190–197
in household cleaning products, 204–205, 204*f*, 205*f*
gold, recovering, 202–203, 202*f*
pools, cleaning and disinfecting, 203, 203*f*
synthesis reactions, 181–183, 181*f*, 182*f*, 183*f*, 197*t*
chemiluminescence, 407, 407*f*
chicken, number of chromosomes, 16*t*
chlor-alkali process, 226, 226*f*
chloric acid, 223*t*
chloride, 142*t*
chlorination, 203
chlorine, 164, 203
chlorofluorocarbons (CFCs), 328, 329*t*, 330*t*
chlorophyll, 63*f*
chloroplasts, 13*f*, 14, 57*f*, 61, 63, 63*f*
chromatic aberration, 492, 492*f*, 502, 504
chromatids, 33, 33*f*, 34*f*, 35*f*, 56
chromosomes, 16–17, 16*t*, 19, 23*t*, 29, 29*f*, 56
 cytokinesis, 37
 DNA, 17, 32–34
 mitosis, 34–35
 number, 16, 16*f*
cilia, 103
cigarette smoking, 105, 105*f*
circulatory system, 95*f*, 96, 96*f*, 100–102, 100*f*, 102*f*
citric acid, 137, 219, 219*f*, 220
cladding, 465
climate, 266, 269
 atmosphere, 273–274, 273*f*
 classifying, 266, 282, 282*t*
 describing, 279–288
 health effects, 294
 human activity, 277
 solar radiation, 270
 tectonic plates, 275–276
 volcanic activity, 276
 zones, 279, 279*f*, 284–285*f*
climate change, 266*f*, 267, 290, 348, 349
 carbon cycle, 334–335
 factors affecting, 269–277
 greenhouse gases, 323–331
 melting sea ice, 266, 291–292, 290*f*, 291*f*, 317
 modelling, 364–368
 monitoring, 360–363
- nitrogen cycle, 337–339
oceans, affecting, 293*t*, 316–317, 318–319*f*, 341–342
 past patterns, 351–358
 taking action, 370–380
 vegetation, affecting, 286, 288, 397–398
climate model, 364–368
climate zones in Canada, 284*f*
climatograph, 268, 280, 280*f*, 281, 284–285*f*
cloning, 24–25, 24*f*, 25*f*, 82, 83
closed circulatory system, 101
closed system (climate), 311
Cloud Gate, 431, 431*f*
Clout, Jerri, 113
coefficient, 161
cohesion, 74
colon, 97*f*, 99
columnar epithelia, 88*t*
comprehension, 178
concave mirrors, 419–429, 420, 420*f*
concentration, 323, 323*t*
concrete, 188
conduction, 314*t*, 315, 315*f*
cone cells, 506
connective tissue, 88, 89*t*
conservation of mass, 159–167
continental rebound, 395
convection, 314*t*, 315, 315*f*
converging lenses, 488, 488*f*, 489–490, 489*f*, 490*f*, 495*t*, 496, 496*f*, 499
convex mirrors, 431–437, 432*f*, 433*t*, 436*f*, 437*f*
copper(I) nitride, 147*t*
copper(I) oxide, 146, 146*f*
copper(II) nitrate, 191, 191*f*
copper(II) oxide, 146, 146*f*
corn, number of chromosomes, 16*t*
cornea, 506, 506*f*, 507*f*
corrosion, 179, 179*f*
cortex, 65, 65*f*
covalent compounds, 153
cow, number of chromosomes, 16*t*
Crick, Francis, 17
critical angle, 462, 462*f*
cross sections, interpreting, 56
cryptosporidiosis, 294
crystal lattices, 144, 144*f*
CT scans, 94, 94*f*, 94*t*
cuticle, 60*f*, 61
cyanide, 202, 203
cystic fibrosis, 21
cytokinesis, 32, 37–38, 37*f*, 38*f*, 40, 40*f*
cytoplasm, 11, 12*f*, 13*f*, 85
cytosine, 17*f*
cytoskeleton, 12*f*, 13*f*, 34*f*
cytosol, 11

D

Dalton, John, 160
dandelions, 65f
daughter cells
 animal cells, 37, 37f
 cell division, 29, 40, 40f
 cytokinesis, 32, 33, 35f, 37, 37f, 43f
 DNA replication, 33
 mitosis, 32, 33, 35f, 37, 37f, 43f, 85
 plant cells, 38f
 single-celled organisms, 29
 telophase, 35f
dead zones, 338
decomposition reactions, 179, 185–188, 185f, 186f, 197t
decomposition of water, 185
deep-sea sea star, 408f
deforestation, 297f, 298
deoxyribonucleic acid (DNA), 17–21, 17f, 18f, 32–34, 38
dermal tissue, 56, 58, 58f, 61, 65f
desert, 283f, 285
desertification, 296
diagrams, interpreting, 402
diaphragm, 103f
diatomic molecules, 164f
diffusion across cell membranes, 30–31, 31f
digestive system, 84, 96–99, 96f, 97f, 237, 237f
digestive vacuoles, 85
dihydrogen monoxide, 152, 152f
dinitrogen pentoxide, 157
dinitrogen tetroxide, 155, 155t
diseases, 112–114
disinfecting pools, 203, 203f
dispersion, 453, 453f
displacement reactions, 190–197
dissociation, 226
distortion, 428, 428f
disulfur dinitride, 156t
Diurnering, Adrienne, 166
diverging lenses, 488, 488f, 489, 489f, 490, 490f, 497, 497f, 497t
DNA, 17–21, 17f, 18f, 32–34, 38
DNA screening, 19–21
Dolly (cloned sheep), 25
double displacement reactions, 176, 195–197, 195f, 197t
double helix, 17f
Down syndrome, 19, 19f, 21
Drive Clean program, 378
droughts, 296, 296f
drug research, ethical issues, 21–22
duodenum, 97f, 98, 98f

E

E. coli, 23t, 99f, 110f, 294
Earth, 270–272, 271f, 272f
 orbit, 270, 271, 271f, 270f
 tilt of axis, 271, 271f, 272, 272f
Earth observing system (EOS), 362

Eastern Canada Acid Rain program, 239
ecoregions, 286, 287
ecozones, 286, 287
Einstein, Albert, 500
El Niño, 317, 318f, 319f, 341–342, 362
electric discharge, 404, 404f, 405
electromagnetic radiation, 314
electromagnetic spectrum, 409, 409f
electromagnetic waves, 409, 409f
embryonic stem cells, 91
endocrine system, 96f
endodermis, 56, 65, 65f, 73f
endoplasmic reticulum, 12f, 13f
endoscope, 466, 466f, 487
endoscopy, 95, 95f, 108, 108f
energy budget, 320, 321, 321f
Energy Star®, 378–379
energy transfer, 315, 316
environment, 87, 139, 176, 199, 200
environmental clean-up, 167f
enzymes, 18, 19, 97, 98
epidermal cells, 58f, 60f
epidermis, 83f
epiglottis, 103f
epithelial tissue, 88, 88t, 104
Erasmus, Bill, 377, 377f
esophagus, 97, 97f
etching, 222f
ethical issues in drug research, 22
ethylene, 68, 68f
European Project for Ice Coring in Antarctica, 352
excretory system, 96f, 99, 99f
explosions as decomposition reactions, 186, 186f
extinction, 297
eyepiece, 502, 503
eyes, 492, 492f, 506–510

F

far-sightedness, 486, 508, 508f
fat (adipose tissue), 89t
fat deposits, 83f
feedback loops, 312, 315
fens, 298
Fermat's principle, 412, 451
fertilization, 68
fibre optics, 465, 465f, 466, 466f
fibrous roots, 65, 65f
field of view (eyes), 485
fire retardants, 166
fish-eye lenses, 491, 491f
flow of air, 449, 449f
flowers, 60, 60f, 68, 70f
fluorescence, 403f, 405–406, 405f, 406f
fluorescence microscope, 8f
fluoride, 142t
fluorine, 164, 181
focal length, 420, 490, 490f
focal point, 420, 421
 converging lenses, 490, 490f, 495t, 496, 496f
 convex mirror, 432, 432f
 diverging lenses, 490, 490f, 497t, 498
follicles, 84
“Food Miles” Initiative, 384
food preservation, 197, 197f
forcing agent, 368, 368f
forest fires, 54
formic acid, 221
fossil fuels, 200f, 335f
fossils, 357, 357f
fruit, 70f
fruit fly, number of chromosomes, 16t
fungicides, 66
Furdyk, Michael, 463
fusion reactions, 404

G

Galilei, Galileo, 502
gall bladder, 97f, 98, 98f
galls, 67, 67f
gamma rays, 409f
gas, 162t
gas exchange systems, 105
gastric juices, 95, 97
gene therapy, 27
general circulation model (GCM), 364, 364f, 366, 367
genes, 16, 17–27, 18f
genetic engineering, 4
genetic screening, 19–21
genetically modified organisms (GMOs), 22–23, 23t
geostationary, 361
Gerber Daisy, 60f
germs, 7
giardiasis, 294
gills, 105, 105f
glacial ice, 291
glacial lakes and sediment cores, 356
glaciation, 269f
global carbon budget, 334
global climate, 317
global warming, 290, 313f, 317, 324
global warming potential, 330, 376, 376f
glow sticks, 400, 407, 407f
glowing slime, making, 401
glucose
 in animal cells, 12f, 14
 in plant cells, 13f, 14, 60, 63, 75, 75f, 180
gold mining, 202
Golgi body, 12f, 13f, 38
granum, 63, 63f
graph, 486
graphic organizer, 218, 486
grass-pink orchids, 298f
grassland, 283f, 285
gravitational lenses, 500, 500f
Great Lakes Wetlands Conservation Action Plan, 298
great ocean conveyor belt, 316f

green medicines, 166–167
greenhouse effect, 152, 273, 273f, 277, 308
greenhouse gases, 276, 308, 323–331, 373f, 379, 380, 380f
Greenland Ice Core Project, 352
ground tissue, 58, 58f
growth hormone, 23t
guanine, 17f
guard cells, 60f, 61, 61f

H

Haber, Fritz, 182
Haber process, 182
Haber-Bosch process, 337
hair follicle, 83f
hairs, 83f
halocarbons, 328
halogens, activity series, 194
hantavirus, 294, 294f
hard X rays, 409f
Hayman, Michael, 463
Hazardous Household Product Symbols (HHPS), 204, 204t
health and climate, 294
heart, 100, 100f
heart attack, 102, 131
heart disease, 102
heat reservoir, 275
helium, 140
hemoglobin, 104
high blood pressure, 102
HIV/AIDS, 112
Hooke, Robert, 10, 46
hormones in plants, 68
Hudson Plains ecozone, 287f, 303t
human, number of chromosomes, 16t
human papilloma virus (HPV), 44
Huntington disease, 20, 21, 22
hurricanes, 296
hydrangea flowers, 221, 221f
hydrobromic acid, 218, 222t
hydrochloric acid, 97, 218, 220, 220f, 222, 222t
hydrofluoric acid, 218, 222, 222f, 222t
hydrogen, 162t, 164, 181, 192f, 454t
hydrogen fuel cells, 176, 182–183
Hydrogen Highway, 176
hydrogen peroxide, 161
Hydrogen Village, 176, 183
hydroiodic acid, 222t
hydroponics, 72f
hydrosphere, 274
hydroxide, 148, 148t
hydroxide ions, 226
hydroxyapatite, 170
hyperopia, 486, 508, 508f
hypertension, 102
hypochlorous acid, 229

- I**
- ice, sea, 266, 291–292, 290*f*, 291*f*, 317
- ice cores, 352–355, 353*f*, 355
- ice sheets, 269*f*
- Igliniit Project, 291
- image distance, 416*t*
- images, 402, 484
- concave mirrors, 419–429
 - converging lens, 496, 496*f*
 - diverging lenses, 497
 - lens magnification, 494, 494*f*
 - plane mirrors, 414
- immune system, 96*f*
- incandescence, 404, 404*f*
- incandescent bulbs, 331, 404, 404*f*
- incident ray, 412, 413*f*, 420, 421, 458*f*
- index of refraction, 452, 454, 454*t*, 490
- indicators in pH scale, 229–234
- indigo carmine, 233*f*, 233*t*
- induced pluripotent stem cells, 91, 91*f*
- Industrial Revolution, 240, 277, 329*t*
- infectious diseases, 110
- inference, 268, 448
- infrared, 409*f*
- infrared radiation, 314
- inheritance, 27
- insulin, 23*t*
- integumentary system, 96*f*
- Intergovernmental Panel on Climate Change (IPCC), 269, 376, 376*f*, 377
- International Union of Pure and Applied Chemistry (IUPAC), 142, 222
- interphase, 40, 40*f*
- intestine, 97*f*
- Inuit Circumpolar Council, 291
- Investigations
- acid neutralization, 250
 - acids and bases, exposure to, 247
 - astigmatism, 514–515
 - cancer report, 50
 - cell structures, 46–47
 - chemical change, evidence of, 207
 - climate change and vegetation, 304
 - converging lens, 512, 513
 - decomposition reactions, 208, 209
 - displacement reactions, 210–211
 - ecoregions of Canada, 302–303
 - El Niño and La Niña, effects of, 341–342
 - Fermat's principle, 478–479
 - "Food Miles" Initiative, 384
 - frog dissection, 117–118
 - greenhouse effect, modelling, 344
 - heart disease, risk factors for, 116
 - heat absorption of soil and water, 300–301, 343
 - ice core data, understanding, 382–383
 - index of refraction, 477
 - internal reflection, 463, 480
 - laws of reflection, 439–441
 - mass of reactant and product, 172
 - metal activity, 212
 - mitosis, 48–49
 - paper recycling pollutants, 169
 - pH of lakes near Sudbury, 248–249
 - real or virtual images, 442
 - refraction, air to water, 476
 - smoking rates, 119–120
 - synthesis reactions, 208, 209
 - telescope, making a simple, 516
 - toothpaste effectiveness, 170–171
 - total internal reflection, 480
 - transpiration in plants, 77
 - water transport in plants, 78
- iodine, 164, 181
- ionic compounds, 136, 139–150, 187
- ionization, 220
- ions, 140, 142*t*
- iris (of eyes), 506
- iron, 179
- iron(II) oxide, 147
- iron(III) oxide, 179
- isotopes, 354
- J**
- Jansen, Johannes and Zacharias, 505
- jellyfish, 408*f*
- jet streams, 274
- Jupiter, 502
- K**
- kangaroos, 326, 326*f*
- Kapoor, Anish, 419
- karotype, 19, 29*f*
- Kepler, Johannes, 502
- kidneys, 99, 99*f*, 102
- Koppen climate classification system, 282, 282*t*
- Koppen, Wladimir, 282
- krill, 408*f*
- Kyoto Protocol, 377
- L**
- La Niña*, 317, 318*f*, 319*f*, 341–342
- Lake Temagami ecoregion, 286
- lakes as heat reservoirs, 275
- large intestine, 99
- larynx, 103*f*
- laser eye surgery, 109, 109*f*, 508–509
- lateral bud, 59, 59*f*
- latitude, 272, 272*f*
- Lavoisier, Antoine, 160, 160*f*
- Lavoisier, Marie-Anne, 160*f*
- law of conservation of mass, 136, 160, 161
- laws of reflection, 412, 420, 421
- leaching, 202, 203
- leaves, 60–63, 60*f*, 61*f*, 63*f*, 70*f*
- Leeuwenhoek microscope, 8*f*
- lenses, 484, 487
- axis of symmetry, 489
 - biconcave, 489
 - camera, 487, 492, 492*f*, 507, 507*f*, 521
 - chromatic aberration, 492, 492*f*
 - converging lenses, 489, 489*f*, 490, 490*f*, 495*t*, 496*f*, 498*t*
 - curvature, 490, 490*f*, 491, 491*f*
 - distortion, 428, 428*f*
 - diverging lenses, 489, 489*f*, 490, 490*f*, 497*f*
 - in eyes, 492, 492*f*, 506–510
 - focal length, 420, 490, 490
 - gravitational, 500, 500*f*
 - images formed, 494–500, 494*f*
 - index of refraction, 452, 454, 454*t*, 490
 - liquid, 487, 487*f*
 - magnification equation for, 498
 - spherical aberrations, 491
 - thick, 491–492, 491*f*, 492*f*
 - thin, 492*f*, 498–499, 498*f*
- see also* focal point, reflection, refraction
- light, 449–454, 484
- colour of, 454
 - concave mirrors, 419–429, 420, 420*f*
 - convex mirrors, 431–437, 432*f*, 433*t*, 436*f*, 437*f*
 - dispersion, 453, 453*f*
 - distortion, 428
 - electromagnetic spectrum, 409, 409*f*
 - emissions, types of, 413–404
 - fluorescence, 415–406, 405*f*, 406*f*
 - luminescence, 407, 407*f*, 408*f*
 - mirages, 472–474, 473*f*, 474*f*
 - nature of, 409, 409*f*
 - optical phenomena, 468–473
 - plane mirror images, 414–415, 409*f*, 409*f*, 409*f*
 - rainbows, 468–470, 468*f*, 470*f*
 - rays, 411–416, 420–424, 451–452, 457–466
 - reflection, 412, 413, 414*f*, 415*f*, 416*f*
 - shimmering, 471, 471*f*
 - speed of, 452–455
 - ultraviolet, 405, 405*f*
- see also* refraction
- lily cell, 13*f*
- limestone, 188
- liming, 243, 243*f*
- liquid, 162*t*
- liquid lenses, 487, 487*f*
- litmus, 231, 231*f*
- liver, 97*f*, 98, 98*f*
- London School of Economics, 328
- Lorenz, Edward, 365
- luminescence, 407
- lungs, 102, 103*f*
- lyme disease, 294
- M**
- magnesium chloride, 144*f*, 145
- magnesium hydroxide, 150, 226
- magnesium nitride, 145*t*
- magnetic resonance imaging (MRI), 94*t*
- magnification, 402, 425
- magnification equation, 425, 434, 498, 499
- malaria, 294
- Malpighi, Marcello, 71
- maple sap, 75, 75*f*
- Marion, Kienan, 500
- marshes, 298
- mass, conversion of, 177
- Material Safety Data Sheets (MSDS), 203
- McCulloch, Dr. Ernest, 91
- medical imaging technology, 93, 93*f*
- medical sonography, 94*t*
- medical technology, 82
- medium, 411, 448
- mercury as vapour, 405
- mercury(II) oxide, 160
- mercury mirror telescope, 527
- meristematic cells, 58, 58*f*, 59, 59*f*
- mesophyll tissue, 60*f*, 61
- metalloids, 141*t*
- metals, 140, 141*t*
- acid leaching, 244
 - activity series, 176
 - corrosion, 179*f*
 - multivalent, 146
 - reactivity series, 192, 192*f*
 - single displacement reactions, 191, 193
 - toxic, clean-up, 245
- metaphase, 34, 34*f*
- meteorite impact, 190, 190*f*, 236
- methane, 154, 326, 329*t*, 330*t*
- methyl orange, 218, 233, 233*f*, 233*t*
- methyl red, 218, 233, 233*f*, 233*t*
- micrograph, 10, 10*f*, 11*f*
- microscopes, 7, 8–9*f*, 484, 505, 505*f*

- microscopy, 7
microvilli, 98, 102
microwaves, 409
Migratory Bird Sanctuaries, 298
Milankovic, Milutin, 271
mining, 190, 202
mirages, 471, 472, 473f, 474, 474f
mirror equation, 425, 426, 434, 435
mitochondrion, 12f, 13f, 14, 61
mitosis, 32, 33–38, 34–35f, 40f, 56
mixed-wood forest, 302f, 303t
“mock suns” (sun dogs), 446, 469
molecular compounds, 136, 152–157, 153
 binary, 154–157, 154t, 155t, 156t
molecules, 153
monitoring, 360
Moon, 502
mortar, 188
Mount Pinatubo, 325, 325f
Mount St. Helens, 276f
mountain pine beetle, 298, 298f
MRI scan, 94t
mucus, 97, 103
multivalent metals, 145, 147, 147f
muscle tissue, 88, 88t
muscular system, 96f, 106, 106f
mutagens, 27
mutations, 26, 27, 27f
mycorrhizal fungus, 66
myopia, 486, 507, 507f
- N**
nasal cavity, 103
National Wildlife Areas, 298
near-sightedness. See myopia
negative feedback loop, 313, 313f, 321
nerve endings, 83f
nervous system, 96f
nervous tissue, 88, 89t
nettle stings, 221
neutralization, 237
Newton, Sir Isaac, 504
nickel, mining, 190
nickel(II) sulfide, 190
night-vision device, 510, 510f
nitric acid, 223
nitride, 142t
nitrogen, 164, 181, 273
nitrogen cycle, 337–339, 338f
nitrogen dioxide, 155, 155f, 176, 183, 183f, 201
nitrogen fixation, 337, 337f
nitrogen monoxide, 176, 183, 201
nitrous oxide, 327, 329t, 330t
noble gases, 140
non-metals, 140, 141t, 142t, 194
normal, 412, 413f, 420
North American Waterfowl Management Plan, 298
northern flying squirrel, 298f
- nuclear membrane, 10f
nuclear pores, 10f
nucleolus, 10f
nucleus, 10, 10f, 11f, 12f, 13f, 16
nutrients, 61
- O**
object distance, 416t
objective lens, 502, 503
oceans
 acidity, 292, 293t
 carbon cycle, 335f
 climate change affecting, 293t, 297, 297f
 currents and wind, 274, 274f
 energy transfer, 316, 316t, 317
 heat retention and reflection, 274–275
 human activities disrupting, 333, 333t
 salinity, 316–317
 thermohaline circulation, 316–317
 water density, 316–317
octane, 157
Office of Energy Efficiency (OEE), 378
oil gland, 83f
Oke, Isdin, 68
open circulatory system, 101
open system (climate), 311
optical fibres, 465
organ transplants, 4
organelles, 10
 animal, 10f, 11, 12, 12f, 14, 85, 85f
 plant, 12, 13f, 14, 63, 63f
organs, 58, 60
 human, 93–106
 plant, 58–68
osmosis, 30, 31, 31f, 73, 73f
oxide, 142t
oxoacids, 223, 223t
oxygen, 14, 164, 180, 181, 273, 454t
ozone, 327, 327f, 328, 328f
- P**
paleoclimatologists, 350, 351, 357
palisade tissue, 60f, 61
pancreas, 97f, 98, 98f
PAP smears, 114, 114f
Papanicolaou, Dr. George, 114
paper manufacturing, 139, 139f
paramecium, 8f, 9f, 29f
Paranjothy, Ted, 44
parent cells, 29, 33, 34–35f, 37, 37f, 38, 38f
parhelia, 469
partial reflection and refraction, 458
Partington, P.J., 328
parts per million (ppm), 323, 323t
pathogens, 110
Peltier, Dr. Richard, 368, 395
pepsin, 97
pericycle, 56, 65, 65f
periodic table, 140, 141t
Perkins, Colin, 68
permafrost, 268
permanent embryos, 58
permanent ice, 284f
permeability, 31
peroxide, 148, 148t
pesticide run-off, 205
pH indicator, 231–234, 232f
pH of lakes, 240–241, 241t, 243
pH meter, 218, 231, 231f
pH probe, 218, 231
pH scale, 216, 229–234, 232f, 230, 230f
phagocytes, 110
pharynx, 97, 97f
phase-contrast microscope, 9f
phenolphthalein, 233f, 233t
phenylalanine, 19
phenylketonuria, 16, 19, 21
phloem, 56, 60f, 64, 64f, 65f, 71, 73f
phosphide, 142t
phosphorescence, 400, 400f, 407
phosphoric acid, 223, 223t
phosphorus trichloride, 156, 156t
photography chemicals, 196
photosynthesis, 70, 71, 180
 chloroplasts used for, 13f, 58f, 60f, 61, 63f
 glucose production, 60, 63, 75, 75f
 sucrose production, 75, 75f
photosynthetic cell, 58f
Physicians for a Smoke-Free Canada, 119
phytoplankton, 312–313
pitcher plant, 72
PKU test, 22
plague, 294
plane mirrors, 414–415, 409f, 409f, 409f
plant cells and cytokinesis, 37
plant galls, 67
plants
 buds, 59, 59f, 75
 chloroplasts, 13f, 58f, 60f, 61, 63f
 cytokinesis, 38, 38f
 flowers, 60, 60f, 66f, 68, 68f
 galls, 67, 67f
 glucose production, 60, 63, 75, 75f
 growing up, 59
 hormones, 68
 hydroponics, 72f
 leaves, 60–63, 60f, 61f, 63f, 74, 74f
 meristematic cells, 58, 58f, 59, 59f
 organelles, 12, 13f, 14, 63, 63f
 organs, 54, 57, 60f
 phloem, 56, 60f, 64, 64f, 65f, 71, 73f
 roots, 59, 59f, 60, 60f, 65, 65f, 70, 70f
 rust, 66, 66f
 specialized cells, 57–59
 stems, 60, 60f, 64, 64f
 sucrose production, 75, 75f
 tissues, 58–65
 transpiration, 61, 74, 74f, 77
 viruses, 66, 66f
 water, absorbing, 61, 63, 63f, 65, 72–74, 72f, 73f, 74f, 78
 xylem, 56, 58f, 60f, 64, 64f, 65f, 71, 73f
pluripotent stem cells, 90, 90f
polar bears, 291, 291f
polar ice cover, 291
polar zone, 279, 279f
pollen, 68
pollutants from synthesis reactions, 183, 183f
pollution, 200f, 216f
polyatomic ions, 148, 148t, 149, 149t
positive feedback loop, 312, 312f, 324
potassium bromide, 144f
potassium chromate, 195
ppm (parts per million), 323, 323t
precession of Earth, 271, 271f
precipitate, 178, 180, 180f
precipitation
 acid, 236, 236f, 239–243, 242f, 243f
 in biomes, 283, 284–285f
 changing levels of, 288, 295–296, 295f, 296f
 climatographs, 280, 280f, 284–285f
 wind affecting, 274, 274f, 295–296, 295f, 296f
prenatal care, 19, 109
presbyopia, 486, 509
prevailing winds, 274, 274f
preventive health care, 109
principal axis, 420, 421
 concave mirror, 420
 converging lenses, 490, 490f, 495t
 diverging lenses, 490, 490f, 497f, 497t
prisms, 453f, 464, 464f
products, 160
 decomposition reactions, 184–188
 double displacement reactions, 195–196
 state, 162f, 162t
 synthesis reaction, 181–183
properties of acids and bases, 234t
prophase, 34, 34f, 56
proteins, 12, 12f, 13f, 17, 17f, 18, 19
public health, 58
Public Health Agency of Canada, 113

public health strategy, **109**
pulmonary artery, 100
pulse rate, 101
pupils (of eyes), 506

Q

quartz, index of refraction, *454t*
Quick Scatterometer, 362

R

radar, 417, *417f*
 concave surfaces, 429, *429f*
 convex surfaces, 437, *437f*
radiation, 314*t*, 315*f*
radio waves, 409
rainbows, 446, **468**, *468f*, 469, *469f*
ray diagrams
 apparent depth, 470*f*
 concave mirrors, 420*t*, 422*t*, 423*t*, 424*t*, 428*t*
 converging lenses, 495*t*
 convex mirrors, 432, 433*t*
 diverging lenses, 497*t*
 mirages, 473*f*, 474*f*
 reflected light, 458*f*, 459*f*, 461*f*, 462*f*, 464*f*, 465*f*
 refracted light, 450*f*, 451*f*, 452*f*, 453*f*, 458*f*, 459*f*, 461*f*, 462*f*
 rainbows, 470*f*, 472*f*
 telescopes, 503, 503*f*
ray model of light, 446
rays (of light), **411**–416, 412*f*, 413*f*, 416*t*, 420–424, 451–452, 457–466
reactants, 138, 160, 162*t*, 176, 181, 185
reading stones, 488*f*
real image, 402, 423
rebreather, 162, 162*f*
rectum, 97*f*, 99
recycling, 139, 331
red blood cells, 7*f*, 11*f*, 26*f*, 104*f*
reflected rays, **412**, 413*f*, 420, 458*f*
 see also reflection
reflecting telescopes, 504, 504*f*
reflection, **411**–437
 concave mirrors, 419–429
 convex mirrors, 431–437
 critical angle, 462
 and distortion, 428, 428*f*
 Fermat's principle, 412
 fibre optics, 465–466, 465*f*, 466*f*
 focal point, 420–424, 422*t*, 423*t*, 424*t*
 internal, total, 457, 463
 laws of, 400, 412, 420, 421
 partial, 458–461, 458*f*, 460*f*, 461*f*
 in plane mirrors, 414–415, 414*f*, 415*f*, 416*t*
 radar technology, 429, 429*f*

ray diagrams, 458*f*, 459*f*, 461*f*, 462*f*, 464*f*, 465*f*
rearview mirror, 459, 460
retroreflectors, 465, 465*f*
 and solar ovens, 428–429
 of solar radiation, 320–321, 320*f*, 320*t*
 and stealth technology, 417, 417*f*
 total internal, 457, 462–466
refracted rays, **452**, 452*f*, 458*f*
 see also refraction
refracting telescopes, 504
refraction, 446–447, **449**–466
 apparent depth, 470, 470*f*
 boundary, reaching the, 450, 450*f*, 457, 457*f*, 458
 changing direction of light ray, 464, 464*f*
 critical angle, **462**
 describing, 450, 450*f*, 451
 dispersion, 453, 453*f*
 effects of, 468
 Fermat's principle, 451
 indices of, 452, 454, 454*t*
 in lenses, 488–489, 490
 mirages, 472–474, 473*f*, 474*f*
 partial reflection and, 458–461, 458*f*, 460*f*, 461*f*
 prisms, 453, 453*f*, 464, 464*f*
 rainbows, 468–470, 468*f*, 470*f*
 ray diagrams, 450*f*, 451*f*, 452*f*, 453*f*, 458*f*, 459*f*, 461*f*, 462*f*
 rearview mirror, 459–460, 460*f*
 shimmering, 471, 471*f*
 sundogs, 446, 469
 water to air, 461–462, 461*f*, 462*f*

regeneration, 90
Rembrandt tulips, 66, 66*f*
reproductive system, 96*f*
respiratory system, 96*f*, 103, 103*f*
retina, **506**
retroreflectors, 465, 465*f*
ribosomes, 10*f*, 12*f*, 13*f*
Robinson, Penelope, 415
rod cells, 506
Roman Numerals, 147*t*
root hairs, 73
root pressure and xylem, 73
root system, **70**, 70*f*
roots, 59, 59*f*, 60, 60*f*, 65, 65*f*, 70, 70
rust, 179
rust, wheat, 66–67

S

safety in the lab, xiv–xvii
salamanders, 90
saliva, 97
salivary glands, 97*f*
salmon, 23*t*
Salton Sea, 400
SARS, 112, 112*f*

satellites, 361–363, 362*f*
scanning electron microscope, 9*f*
scrubbers, 242
scurvy, 108
sea ice, melting, 266, 291–292, 290*f*, 291*f*, 317
sea level, rising, 292, 292*f*
security mirrors, 436–437, 436*f*, 437*f*
sediment cores, 356, 356*f*
sedimentary rocks, 356, 356*f*
selective breeding, 66
shatter cones, 236
shimmering, **471**, 471*f*
shoot system, **70**, 70*f*
Siamese cats, 86, 86*f*
sickle cell anemia, 26, 26*f*
Sidhu, Jasmeet, 380
sight, 484, 506
silver chromate, 195
silver nitrate, 191, 195, 196
Singh, Nikhita, 205
single displacement reactions, 176, **191**, 197*t*
 metals, 191, 191*f*, 193
 non-metals, 194
single-celled organisms
 amoeba, 85, 85*f*
 paramecium, 8*f*, 9*f*, 29*f*
 reproduction in, 29
sink, **324**
skeletal muscle, 88*t*
skeletal system, 96*f*
skeleton equations, 161, 165
skin, 82
skin epithelia, 88*t*
Sky Mirror, 419, 419*f*, 420
small intestine, 97*f*, 98
smallpox, 109
Smith, Robert Angus, 240
smog, 155, 155*f*, 339
smoking, 105, 105*f*
smooth muscle, 88*t*
snow and albedo, 275
soap, 219, 225, 225*f*
sodium, reaction with water, 159, 159*f*
sodium azide, 187, 187*f*
sodium bicarbonate, 150, 166
sodium carbonate, 139
sodium chloride, 142*f*, 142*t*, 143, 144, 150, 162*t*, 454*t*
sodium fluoride, 170
sodium hydroxide, 162, 226, 226*f*
sodium hypochlorite, 229
sodium vapour bulb, 404, 404*f*
soft X rays, 409*f*
soil erosion, 152
solar activity and climate, 270
solar cycle, 270
solar ovens, 428–429
solar panels, 415
solar radiation, 314–315, 315*f*, 320*f*, 320*t*
solid, 162*t*
Sorenson, Soren, 230

specialized cells, 57–59
species and extinction, 297
specific heat capacity, 275
spectrum, 453
sphere, 402
spherical aberrations, **428**, 428*f*, 492, 502
sphincter, 96*f*, 98
spider maps, **138**, 486
spina bifida, 21
spindle fibres, 34*f*, 35*f*
spongy parenchyma cells, 60*f*
stable octet, 140, 143
starfish, 90
state and reactants, 162, 162*t*
steel, 179
stem, 58, 60, 60*f*, 64, 70*f*
stem cells, **90**, 91, 91*f*
Steward, Fredrick, 24*f*
stoma, 61, 61*f*
stomach, 97*f*, 98*f*, 237, 237*f*
stomata, 60*f*, 61
store, **333**
storms, 296
striations, 88
stroke, 102
Study Toolkit
 asking questions, 84
 base words, 138, 402
 comparing and contrasting, 56, 402
 creating a word map, 178, 350
 identifying cause and effect, 178, 350
 identifying main ideas and details, 138, 350
 interpreting climatographs, 268
 interpreting cross sections, 56
 interpreting diagrams, 402
 interpreting tables, 218
 making connections to prior knowledge, 486
 making connections to visuals, 310
 making inferences, 268, 448
 making study notes, 84
 monitoring comprehension, 178
 multiple meanings, 56, 448
 previewing text features, 6
 skim, scan, or study, 138
 summarizing, 448
 synthesizing, 310
 using graphic organizers, 218, 486
 visualizing, 6
 word families, 6, 486
 word origins, 84, 268
 word parts, 218, 310
sucrose, 75
Sudbury, 236, 236*f*, 239, 244
Sudbury Basin, 190, 190*f*
sulfide, 142*t*
sulfur dioxide, 239, 242

in food preservation, 197, 197f
 sulfur oxides, 242
 sulfuric acid, 223, 223t
 sulfurous acid, 223
 summary, 448
 Sun, 270, 404
 sunblock, 150, 150f
 sundogs, 446, 469
 sunscreen, 150, 150f
 sunspots, 270, 270f
 surgical lasers, 108
 swamps, 298, 298f
 sweat glands and pores, 83, 83f
 synthesis and ammonia, 182f
 synthesis reactions, 181–183, 181f, 182f, 183f, 197t
 synthesizing, 310
 synthetic elements, 141t
 systems, **70, 311**
 human body, 95–106, 96f
 plant organs, 70–75

T

table salt, 142f, 142t, 150
 tables, interpreting, 218
 tailings, 245, 245f
 taproots, 65, 65f
 tectonic, 268
 tectonic plates, 275–276
 telescopes, 484, 502–504, 502f, 503f, 504f, 516
 telophase, 35, 35f
 temperate deciduous forest, 283f, 285
 temperate rainforest, 283f, 285
 temperate zone, 279f
 temperature, 280, 280f, 283
 temperature inversions, 474, 474f
 terminal bud, 59, 59f
 ternary compound, **148**
 Terra (satellite), 362, 362f
 Terrestrial eozones, 287f
 thermal energy, 314t
 thermohaline circulation, **316–317**
 thick lenses, 491–492, 491f, 492f
 thin lenses, 492f, 498–499, 498f
 thylakoid, 63, 63f
 thymine, 17f
 Till, Dr. James, 91
 tin(IV) sulfide, 147t
 tissue, **58**
 adipose, 89t
 characteristics, 89
 connective, 88, 89t
 dermal, 56, 58, 58f, 61, 65f
 epithelial, 88, 88t, 104
 ground, 58, 58f
 mesophyll, 60f, 61
 muscle, 88, 88t
 nervous, 88, 89t
 palisade, 60f, 61
 plants, 58–65
 spongy parenchyma, 60f
 types of, 88

vascular, 58, 58f
 see also cells
 tobacco mosaic virus, 66, 66f
 tongue, 97f
 toothpaste, 150, 170–171
 total internal reflection, **462**
 totipotent stem cells, 90, 90f
 toxic material removal, 200
 trachea, 103f, 104
 trade winds, 274f
 transgenic organisms, **22–23, 23t**
 transgenic therapy, 66–67
 transmission electron microscope, 9f
 transpiration, **61, 74, 74f, 77**
 tree rings, 351, 351f, 352
 trinitrotoluene, 186, 186f
 tropical rainforest, 283f
 tropical storms, 296
 tropical zone, 279, 279f
 trough, 409
 tubules, 33, 34f
 tumours (cancerous), **42, 43f**
 tundra, 268, 283f, 284f

U

ultrasound, 84, 94t, 109, 109f
 ultraviolet, 409f
 ultraviolet light, 405, 405f
 ultraviolet (UV) radiation, 472, 473
 univalent metals, 184
 universal indicator of pH scale, 232, 232f
 upwelling, 317
 ureters, 99f
 urethra, 99f
 UV radiation, 472–473

V

vaccinations, **109–111**
 vacuoles, 12f, 13f, 57f
 valence electrons, **140, 140f**
 valves, 100
 van Leeuwenhoek, Anton, 46
 vascular bundle, 60f, 64
 vascular tissue, 58, 58f
 veins, 61, 100, 100f, 104f
 velocity of light, 446
 vena cava, 99f
 Venn diagrams, 56, 267, 402, 486
 ventricle, 100f
 Venus, 502
 Venus flytrap, 72
 vertex of concave mirror, 420
 vesicles, 12f, 13f, 38, 38f
 villi, 98, 98f, 102
 vinegar, 219, 220, 221f
 virtual images, 402, **415**
 viruses, 7, 66–67, 66f
 vision, 507, 510, 510f
 visualizing, 6
 vitamin C, 108
 volcanic activity, 276

W

Walkerton water tragedy, 294–295
 water
 adhesion, 74
 angle of incidence, 458, 458f, 462, 462f, 476, 480
 angle of refraction, 451, 451f, 452, 452f, 462, 462f, 476, 480
 atmosphere, 273, 325
 Bohr-Rutherford model, 153, 153f
 in cells, 14
 cohesion, 74
 decomposition of, 185
 density, 316–317
 dihydrogen monoxide, 152, 152f
 greenhouse gases, 324
 heat absorption of soil and, 300–301, 343
 index of refraction, 454t
 models, 153, 153f, 154
 pH, 241
 plants absorbing, 61, 63, 63f, 65, 72–74, 72f, 73f, 74f, 78
 pollution, 338
 reaction with sodium, 159, 159f
 refraction, air to water, 476
 refraction, water to air, 461–462, 461f, 462f
 state, 162t
 test kit, 229f
 vapour, 273, 324, 325, 365
 Walkerton tragedy, 294–295
 see also oceans
 water test kit, 229f
 Watson, James, 17
 wave fronts, 450, 450f
 wavelength, **409, 409f**
 weather
 changing patterns, 269, 295–296
 droughts, 296, 296f
 prevailing winds, 274, 274f
 storms, 296
 see also precipitation
 West Nile virus, 113, 113f
 westerly winds, 274f
 wetlands, shrinking, 298
 Wexler, Nancy, 20, 20f
 whales, 85f
 wheat rust, 66–67
 whip scorpion, 221
 white blood cells, 11f, 89, 110, 110f, 111
 white light, 403
 WHMIS symbols, xvii
 whooping cough, 111
 wind farms, 380f
 winds, 273, 273f, 274, 274f, 295–296, 295f, 296f
 word equations, 161, 165
 word families, 6

word maps, 178, 350
 World Conservation Society (WCS), 291

X

X rays, 94, 94t, 95, 95f, 409f
 xylem
 and cohesion (of water), 74
 and energy stores, 71
 in leaves, 60, 60f, 61, 71, 74, 74f
 Malpighi's experiment, 71
 maple sap, transporting, 75, 75f
 nutrients, transporting, 71, 72, 72f, 73, 73f
 pressure in, 73
 in roots, 65, 65f, 71, 73, 73f
 sap, 75, 75f
 in stems, 64, 64f
 transpiration, function in, 74, 74f
 vascular bundles, 61, 64, 64f
 water, transporting, 58f, 61, 64, 71–74, 72f, 73f, 74f

Y

yarrow, 65f
 “Year Without a Summer”, 276

Z

zebra fish and fluorescence, 403f
 zero-emission in paper manufacturing, 139
 zinc and gold mining, 202
 zinc oxide, 150, 150f