CHAPTER 1 / 1.2 - Cell and DNA - pp.10-11

What is a cell? Smallest living unit; all living things are made of one or more cells.
What does a cell do? Takes in nutrients, makes energy, grows, copies itself, and responds to its surroundings.
What is DNA? Long molecule in cells that stores instructions for building and running a living thing.
Where does DNA occur? In cells: in the nucleus of complex cells, free in simple cells.
What is a genome? Complete set of DNA instructions for one living thing.
What is its purpose? Base for biotechnology: read, copy, and change DNA to make new products.
What is needed? Cells, DNA, and tools to study genes.

CHAPTER 1 / 1.2 - Cell, DNA, Genome - pp.10-11. Overview base. Later chapters: DNA tools in full.

CHAPTER 1 / 1.2 - Microbial - pp.11-12

What is microbial biotechnology? Use of microbes, tiny living things, as tools to make products.

CHAPTER 1 / 1.2 - Microbial - pp.11-12 (cont)

What is its function? Ferment, break down, or build substances that people need.
What is an example? Yeast for beer and wine.
What happens when yeast ferments? Yeast turns sugars into alcohol and carbon dioxide, giving beer and wine their alcohol and fizz.
Where does it occur? In vats and tanks where yeast grows in sugary liquid.
What is needed? Microbes, food for microbes, and controlled warmth and cleanliness.
Properties: Tiny, fast-growing, easy to grow in large amounts, and able to make many chemicals.

CHAPTER 1 / 1.2 - Microbial Biotechnology (Full detail: Chapter 5) - pp.11-12.

CHAPTER 1 / 1.2 - Agricultural - pp.11-13

What is agricultural biotechnology? Use of living things and gene tools to improve crops and farm animals.
What is its function? Grow more food, resist pests and disease, and keep food fresh longer.

CHAPTER 1 / 1.2 - Agricultural - pp.11-13 (cont)

What is an example? White button mushroom, Agaricus bisporus.
What happens when it browns? A browning enzyme makes cut mushrooms turn brown and look old.
What did 2016 Penn State work do? Used CRISPR to turn off the browning enzyme gene.
What is the result? Mushrooms stay white longer, with less waste.
Why does it matter? First gene-edited crop cleared for eating, with no foreign DNA added.
PICTURE - Fig. 1.8, pp. 11-13: Fresh white button mushrooms. Shows CRISPR turning off the browning gene. Connects to longer-lasting mushrooms.

CHAPTER 1 / 1.2 - Agricultural Biotechnology (Full detail: Chapter 6) - pp.11-13. Fig. 1.8.

CHAPTER 1 / 1.2 - Transgenic 1 - pp.12-13

What is a transgenic animal? Animal with a gene added, removed, or changed in its DNA.
What is its function? Make animals healthier, more useful, or able to make medicines and other products.

CHAPTER 1 / 1.2 - Transgenic 1 - pp.12-13 (cont)

What is needed? A target gene, a way to put it into an embryo, and animals to carry it on.
What happens when a gene is added? The animal may make a new protein, lose a trait, or gain a new trait.
Example in brief: Animals made to resist disease or to produce useful proteins; details follow in part 2.

CHAPTER 1 / 1.2 - Transgenic Animals, part 1 (Full detail: Chapter 7) - pp.12-13.

CHAPTER 1 / 1.2 - Biotechnology - pp.10-11

What is biotechnology? Use of living cells and their parts to make products and solve problems.
What fields does it use? Biology, chemistry, physics, engineering, computing, and medicine, used together.
What is its purpose? Make useful products, treat disease, grow food, clean up waste, and learn how life works.
What is needed? Living cells, DNA, and tools to read, copy, and change genes.

CHAPTER 1 / 1.2 - Biotechnology Overview - pp.10-11. Later chapters give the full story.

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CHAPTER 1 / 1.2 - Bioremediation - pp.14-15

What is bioremediation? Use of living things, often microbes, to clean up polluted soil, water, and shorelines.
What is its function? Break down oil, chemicals, and waste into safer substances.
What is an example? Exxon Valdez oil spill in 1989.
What happened there? Oil spilled onto Alaskan shorelines, harming wildlife and beaches.
What microbes helped? Pseudomonas oil-eating bacteria.
What did they do? Ate oil on the shoreline, breaking it down.
What was the result? Shoreline cleaned nearly 3x faster than without them.
What is needed? Oil-eating microbes, nutrients, oxygen, and time.
PICTURE - Fig. 1.12, pp. 14-15: Oil-stained shoreline, 1989. Shows Pseudomonas breaking down oil. Connects to cleaning nearly 3x faster.

CHAPTER 1 / 1.2 - Bioremediation (Full detail: Chapter 9) - pp.14-15. Fig. 1.12.

CHAPTER 1 / 1.2 - Aquatic - pp.15-16

What is aquatic biotechnology? Use of water living things and gene tools to improve fish, shellfish, and other water life.
What is its function? Grow fish faster, resist disease, and make seafood more plentiful.
What is an example? AquaAdvantage salmon.
When was it cleared? FDA in 2015.
Why does it matter? First GM animal cleared for eating.
What happens when it grows? Grows in about half the time of ordinary salmon.
What is needed? Salmon eggs, a growth gene, and safe, contained farms.
PICTURE - Fig. 1.13, pp. 15-16: Fast-growing salmon. Shows FDA 2015 first GM animal for eating. Connects to growing in about half the time.

CHAPTER 1 / 1.2 - Aquatic Biotechnology (Full detail: Chapter 10) - pp.15-16. Fig. 1.13.

CHAPTER 1 / 1.2 - Forensic - pp.14-15

What is forensic biotechnology? Use of DNA and other biology tools to identify people and solve crimes.

CHAPTER 1 / 1.2 - Forensic - pp.14-15 (cont)

What is its function? Match DNA from a scene, body, or sample to a person.
What is an example? DNA detection markers, also called liquid biopsy.
What happens in a liquid biopsy? Tiny DNA markers in blood or fluid point to disease or identity, without a large tissue sample.
Where does it occur? In labs, and in clinics for tests such as bladder cancer checks.
Example: bladder cancer: DNA markers in urine can signal cancer, helping doctors spot it early.
When was it first used? First use in England in 1987, to help solve a crime with DNA.
What is needed? DNA sample, lab tests, and a reference sample to compare.
PICTURE - Fig. 1.11, pp. 14-15: DNA markers in blood or fluid. Shows liquid biopsy, bladder cancer example. Connects to early, less invasive detection.

CHAPTER 1 / 1.2 - Forensic Biotechnology (Full detail: Chapter 8) - pp.14-15. Fig. 1.11.

CHAPTER 1 / 1.2 - Transgenic 2 - pp.13-14

What is hornless cattle work? Cattle made without horns, so farmers do not need to remove horns.
Who did it? UC-Davis with Recombinetics.
What happened to the genes? Holstein horn gene cut out, Angus no-horn gene put in.
What is its function? Safer animals and workers, less pain and handling.
What is cultured meat? Beef grown in dishes from animal cells, not from a whole animal.
What does it cost at that time? About $18,000 per pound.
What does lean ground beef cost for comparison? About $5.00 per pound.
Comparison: Cultured meat, about $18,000/lb, lab-grown, very costly then, vs. lean ground beef, about $5.00/lb, farm-raised, common price.
What is needed? Cells, growth food, clean dishes, and time to grow.
PICTURE - Fig. 1.9, pp. 13-14: Hornless cattle. Shows safer cattle with no horns. Connects to the gene swap in this box.

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CHAPTER 1 / 1.2 - Transgenic 2 - pp.13-14 (cont)

PICTURE - Fig. 1.10, pp. 13-14: Cultured beef in dishes. Shows meat grown from cells, not a whole animal. Connects to cost and scale in this box.

CHAPTER 1 / 1.2 - Transgenic Animals, part 2 (Full detail: Chapter 7) - pp.13-14. Fig. 1.9, Fig. 1.10.

CHAPTER 1 / 1.2 - GM Foods - pp.12-13

What are GM foods? Foods from plants or animals with DNA changed by gene tools.
Why are they debated? Some worry about health, safety, and labelling; others point to more food and less waste.
What is an example of debate? Protest sign against GM foods, showing public worry, not lab proof.
What did the 2016 National Academies review find? No greater risk than foods made by other breeding methods.
What was it based on? 900+ studies.
What is its purpose? Check safety with evidence, not fear alone.
What is needed? Clear labels, tests, and rules, so people can choose.

CHAPTER 1 / 1.2 - GM Foods - pp.12-13 (cont)

PICTURE - Fig. 1.7, p. 12: Protest sign, SAY NO TO GMOs / Poison. Shows public worry, not lab proof. Connects to the GM debate in this box.

CHAPTER 1 / 1.2 - You Decide: GM Foods - pp.12-13. Fig. 1.7 on p. 12. Full preview: Ch.7, rules in Ch.12.

CHAPTER 1 / 1.2 - Medical - pp.15-16

What is medical biotechnology? Use of cells, genes, and microbes to prevent, find, and treat disease.
What is its function? Make medicines, vaccines, tests, and new treatments.
What is an example? Stem cells.
What are stem cells? Immature cells that can become many types of body cells.
What happens when they grow? They can form blood, nerve, muscle, and other cells, to repair damage.
What is another example? Microbes used to make proteins.
How does that work? Microbes are given a human gene, then they make the protein in large amounts.

CHAPTER 1 / 1.2 - Medical - pp.15-16 (cont)

What is needed? Cells, genes, labs, and safety tests.

CHAPTER 1 / 1.2 - Medical Biotechnology (Full detail: Chapter 11) - pp.15-16.

CHAPTER 1 / 1.2 - Regulations - pp.16-17

Who regulates biotechnology? Three US agencies, each covering a different part.
Comparison - Agency | What it covers: FDA | Food, drugs, and medical products, including GM food safety; USDA | Farm plants and animals, field tests, and farm use; EPA | Pesticides, microbes, and effects on the environment.
What does FDA cover in short? Safety of food and medicines made with biotech.
What does USDA cover in short? Crops and animals grown on farms.
What does EPA cover in short? Environmental safety, such as pest-control products.
What is its purpose? Check safety before products reach people, farms, and nature.
What is needed? Tests, data, labels, and approval before sale.

CHAPTER 1 / 1.2 - Regulations (Full detail: Chapter 12) - pp.16-17.

CHAPTER 1 / 1.2 - Industrial - pp.16-17

What is industrial biotechnology? Use of cells and enzymes in factories to make chemicals, fuels, and materials.
What is its function? Replace harsh chemical steps with cleaner, faster biology steps.
What is an example? Biocatalyst.
What is a biocatalyst? An enzyme that speeds up a reaction.
What happens when it works? A reaction that was slow becomes fast, without the enzyme being used up.
Where does it occur? In factory tanks and reactors, often with microbes or enzymes.
Properties: Specific, reusable in a process, and often works at mild warmth and pH.
What is needed? Enzyme or microbe, raw material, and controlled reactor conditions.

CHAPTER 1 / 1.2 - Industrial Biotechnology, no separate chapter - pp.16-17.

CHAPTER 1 / 1.2 - Big Picture - pp.16-17

What is the big picture in 1.2? Same base, DNA and cells, used in many fields, each with its own job.

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CHAPTER 1 / 1.2 - Big Picture - pp.16-17 (cont)

Comparison - Field | Job | Example: Microbial | Ferment and build | Yeast for beer/wine; Agricultural | Improve crops | Non-browning mushroom; Animal | Change animal traits | Hornless cattle; Forensic | Identify with DNA | Liquid biopsy, bladder cancer; Bioremediation | Clean pollution | Oil-eating Pseudomonas; Aquatic | Grow fish faster | AquaAdvantage salmon; Medical | Treat disease | Stem cells; Industrial | Speed factory reactions | Biocatalyst enzyme.

Remember: Microbes as tools; genes can be turned off, cut, or moved; evidence, not fear, checks GM food safety.

Remember: Regulators split the job: FDA food and drugs, USDA farms, EPA environment.

Remember: Cost and time matter: cultured meat was about $18,000/lb vs. about $5.00/lb ground beef; salmon in about half the time.

CHAPTER 1 / 1.2 - Big Picture Summary - pp.16-17. Remember lines below.

CHAPTER 1 / 1.3 - New Century - p.17

What will the new biotechnology century look like? Faster, more personal, and more widespread use of DNA tools in medicine, food, and industry.

What is a medical example? New treatments built from a person's own cells and genes, and microbes making medicines.

What is its function? Treat diseases that were hard to treat, with care matched to the person.

Where does it occur? In clinics, labs, and farms, as tools spread beyond research labs.

What is needed? Safe tests, rules, and trained workers, the workforce of the new century.

What is the limit of this sheet? Covered only up to where pp. 10-17 stop, mid-sentence in 1.3. Later 1.3 content is not included yet.

Remember: This sheet is Ch.1, Sections 1.2-1.3 only. Sections 1.1 and earlier are not included yet.

PICTURE - Fig. 1.14, pp. 16-17: Headlines about genes and genomes. Shows DNA news in public life. Connects to the new century in this box.

CHAPTER 1 / 1.3 - New Biotec-hnology Century - p.17. Coverage stops at pp. 10-17, mid-sentence in 1.3.

CHAPTER 1 - Pictures - pp.12-17

Fig. 1.7 - GM protest sign - p. 12	Shows: a protest sign, SAY NO TO GMOs, with Poison. About: public fear over GM food safety and labels. Why it matters: trust and choice shape rules, even after the 2016 review found no greater risk. Connects: You Decide GM Foods, pp.12-13.
Fig. 1.8 - Mushroom - pp. 11-13	Shows: fresh white button mushrooms. About: 2016 Penn State CRISPR turning off the browning enzyme gene. Why it matters: stays white longer, less waste, first gene-edited crop cleared for eating, no foreign DNA added. Connects: Agricultural, pp.11-13.

CHAPTER 1 - Pictures - pp.12-17 (cont)

Fig. 1.9 - Hornless cattle - pp. 13-14	Shows: cattle with no horns. About: UC-Davis with Recombinetics, Holstein horn gene out, Angus no-horn gene in. Why it matters: safer animals and workers, less pain, no horn removal. Connects: Animal part 2, pp.13-14.
Fig. 1.10 - Cultured beef - pp. 13-14	Shows: beef grown in dishes from animal cells. About: lab-grown meat, not from a whole animal. Why it matters: cost then, about $18,000/lb vs. about $5.00/lb ground beef, so scale and cost were the hurdle. Connects: Animal part 2, pp.13-14.

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CHAPTER 1 - Pictures - pp.12-17 (cont)

Fig. 1.11 - Liquid biopsy - pp. 14-15	Shows: tiny DNA markers in blood or fluid. About: liquid biopsy, a test without a large tissue sample, bladder cancer example. Why it matters: early, less invasive detection, and DNA matching for identity and crime, first use England 1987. Connects: Forensic, pp.14-15.
Fig. 1.12 - Exxon Valdez - pp. 14-15	Shows: an oil-stained shoreline after the 1989 Exxon Valdez spill. About: Pseudomonas oil-eating bacteria breaking down oil. Why it matters: shoreline cleaned nearly 3x faster, microbes can clean pollution in place. Connects: Bioremediation, pp.14-15.

CHAPTER 1 - Pictures - pp.12-17 (cont)

Fig. 1.13 - Salmon - pp. 15-16	Shows: a fast-growing salmon. About: AquaAdvantage salmon, FDA 2015, first GM animal cleared for eating. Why it matters: grows in about half the time, more fish faster, with contained farms and rules. Connects: Aquatic, pp.15-16.
Fig. 1.14 - Genes/-genomes collage - pp. 16-17	Shows: a collage of headlines about genes and genomes. About: DNA news in public life. Why it matters: the new century is public and workforce-wide, not only in labs. Connects: Overview and 1.3 New Century, pp.16-17.

CHAPTER 1 / 1.2-1.3 - Pictures Fig. 1.7-1.14 - pp.12-17. Text descriptions only.

CHAPTER 1 - Questions - pp.10-17

LABEL: CHAPTER 1 / 1.2-1.3 - Questions, Try-it, You Decide, Big Picture

TRY IT - Overview: What is biotechnology? Answer: Use of living cells and their parts to make products and solve problems.

TRY IT - Cells/DNA: What is a genome? Answer: Complete set of DNA instructions for one living thing.

TRY IT - Microbial (Ch.5): What does yeast do for beer and wine? Answer: Turns sugars into alcohol and carbon dioxide.

TRY IT - Agricultural (Ch.6): What did 2016 Penn State CRISPR work turn off in mushrooms? Answer: The browning enzyme gene in Agaricus bisporus.

TRY IT - Animal, part 1 (Ch.7): What is a transgenic animal? Answer: Animal with a gene added, removed, or changed.

YOU DECIDE - GM Foods: What are GM foods? Answer: Foods from plants or animals with DNA changed by gene tools.

YOU DECIDE - GM Foods: Why are GM foods debated? Answer: Health, safety, labelling, and choice worries vs. more food and less waste.

CHAPTER 1 - Questions - pp.10-17 (cont)

YOU DECIDE - GM Foods: What did the 2016 National Academies review find, and on what evidence? Answer: No greater risk than other breeding methods, based on 900+ studies.

TRY IT - Animal, part 2 (Ch.7): Why hornless cattle? Answer: Safer animals and workers, less pain, no horn removal; Holstein horn gene out, Angus no-horn gene in.

TRY IT - Animal, part 2: Cultured meat cost then vs. lean ground beef? Answer: About $18,000/lb vs. about $5.00/lb.

TRY IT - Forensic (Ch.8): What is a liquid biopsy, and when first used? Answer: DNA markers in blood or fluid, bladder cancer example; first use in England in 1987.

TRY IT - Bioremediation (Ch.9): What cleaned Exxon Valdez shoreline, and how much faster? Answer: Pseudomonas oil-eating bacteria, nearly 3x faster, 1989.

TRY IT - Aquatic (Ch.10): What is AquaAdvantage salmon, when cleared, how fast? Answer: FDA 2015, first GM animal for eating, grows in about half the time.

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CHAPTER 1 - Questions - pp.10-17 (cont)

TRY IT - Medical (Ch.11): What are stem cells? Answer: Immature cells that can become many types of body cells.

TRY IT - Regulations (Ch.12): FDA, USDA, EPA in short? Answer: FDA food and drugs, USDA farms, EPA environment.

TRY IT - Industrial: What is a biocatalyst? Answer: An enzyme that speeds up a reaction.

BIG PICTURE - Question: What base do all 1.2 fields share? Answer: Cells, DNA, and genomes.

BIG PICTURE - Question: Which field cleans pollution, which grows fish faster, which identifies with DNA? Answer: Bioremediation, Aquatic, Forensic.

BIG PICTURE - Question: What will the new century (1.3) look like, in short? Answer: Faster, more personal DNA tools in medicine, food, and industry, with trained workers.

SCOPE - Question: What is NOT on this sheet yet? Answer: Sections 1.1 and earlier, and the rest of 1.3 past where pp. 10-17 stop, mid-sentence; send those pages to add them.

CHAPTER 1 / 1.2-1.3 - Questions, with short answers - pp.10-17.

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