CHAPTER 1 / CONTENTS MAP - 1.2-1.3 ONLY

NOTE: This sheet covers Chapter 1, Sections 1.2-1.3 only (pp. 10-17). Sections 1.1 and earlier are not included yet.
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CHAPTER 1 / 1.2 OVERVIEW

Define:
biotechnology | using living things/parts to make useful products, solve problems
1.2 intro | only an intro, detail comes later
Example:
ex. Ch.2 preview: cell structure, DNA, genomes
ex. Ch.3 preview: gene cloning, recombinant technology, genomics
Key points:
- Ch.2: cell structure and function, DNA structure, genomes
- Ch.3: gene cloning, recombinant technology, modern genomics trends
- 1.2 is only an intro, detail in later chapters
Picture: none here, intro only
Try it: What does Ch.2 cover? A) Only farming B) Cell structure, DNA, genomes C) Only crime labs D) Only ocean life
Answer: B

CHAPTER 1 / 1.2 - MICROBIAL (FULL: CH.5)

Define:
microbial biotech | using bacteria/yeast to make/clean things
yeast | single-cell fungus, oldest use
Enzymes | proteins that speed reactions, better enzymes from microbes
recombinant protein | protein made by an organism given a new gene
microbial genomics | studying microbe genomes, role in human health
synthetic genomes | lab-made genomes, new/debated
Example:
ex. yeast for beer/wine, oldest use
ex. better enzymes, foods, simpler manufacturing, cleaning industrial waste
ex. vaccines, recombinant proteins in batches for medicine
ex. genomics: microbes in health, diagnosis in people/food/samples, bioweapons, biofuels
Key points:
- Oldest: yeast beer/wine
- Uses: enzymes, foods, manufacturing, waste cleanup, vaccines, proteins
- Genomics helps understand health role
- New/debated: synthetic genomes, diagnosis, bioweapons, biofuels
Picture: yeast/bacteria in a flask making a product (text description, no photo)
Try it: Oldest use? A) Biofuels B) Yeast for beer/wine C) Liquid biopsy D) Cultured meat
Answer: B

CHAPTER 1 / 1.2 - AGRICULTURAL (FULL: CH.6)

CHAPTER 1 / 1.2 - ANIMAL PART 1 (FULL: CH.7)

Define: **bioreactor animal** | animal used to make a product **antibodies** | protective proteins spotting/destroying foreign material **therapeutic proteins** | proteins made for treatment, needed in large amounts **transgenic** | animal with a gene from another source **silk milk** | spider silk genes in goats, silk in milk **Friendly Aedes** | Oxitec engineered mosquito, larvae die Example: ex. goats/cattle/sheep/chickens as bioreactors ex. antibodies help immune-system disorders ex. human clotting genes in goats, protein in milk ex. spider silk goats, silk for fabrics, military gear ex. Kanuma sebelipase alfa in transgenic chicken eggs, rare fatal lysosomal acid lipase deficiency ex. Friendly Aedes males mate wild females, larvae die, targets dengue/Zika/-chikungunya/yellow fever, FDA no significant impact OX513A Florida Keys trial Key points: - Scale problem: hundreds of kg needed - Animals: goats, cattle, sheep, chickens - Transgenic = gene from another source Picture: none yet in Part 1, see Part 2 for Fig.1.9/1.10 (text description, no photo) Try it: What is transgenic? A) No genes B) Animal with gene from another source C) Dish only D) Wild animal Answer: B

CHAPTER 1 / 1.2 - YOU DECIDE GM FOODS

Define: **ag biotech** | biotech on plants **genetically engineered** | genes changed by biotech **pest-resistant** | crop resists pests, less spray **gene-edited** | DNA cut/adjusted precisely **CRISPR-Cas** | tool that cuts/adjusts DNA at precise spots **older GM** | new genes carried in by bacteria/viruses from plant pests, landing uncontrolled Example: ex. pest-resistant crops, more protein/vitamins, plant drugs ex. Fig.1.8 white button mushroom Agaricus bisporus, 2016 Penn State CRISPR browning gene off, first gene-edited crop cleared, longer shelf life, stays pale ex. USDA: share plans, if no foreign pest genes, allowed ahead Key points: - Need: 9.1 billion by 2050, 70% more food, 100% more in developing countries - More per acre, disease/insect resistance, lower farmer costs - Older GM worry: harmful disruption, crossing with non-GM crops Picture: Fig.1.8 whole/sliced white mushrooms staying pale (text description, no photo) Try it: What made 2016 mushroom different? A) Sprayed more B) Browning gene off with CRISPR C) Grew horns D) Made from beef Answer: B

Define: **GM foods** | food from organism with changed genes, mainly recombinant DNA **recombinant DNA technology** | DNA from different sources joined **Bioengineered Food Disclosure Law** | 2016 US law, national disclosure standards Example: ex. many experts see GM as safe, large future benefits ex. many would pick non-GM over GM-labeled ex. CT/ME bills, old rule only if health/nutrition changed, 2016 law rules due end July 2018, up to 3 years comply ex. 2016 Academies 900+ studies, 20+ years, no greater risk, judge final food not technique Key points: - Public mixed: 1/3 said recombinant DNA to improve flavor/color/nutrition/freshness wrong, opposition up to 50% - Worries: against nature, allergies - Weigh: fewer pesticides, fresher, nutritious/cheaper, risk, nearby non-GM crops Picture: Fig.1.7 SAY NO TO GMOs / Poison protest sign, controversy (text description, no photo) Try it: 2016 Academies conclusion? A) Always riskier B) No greater risk than other methods C) Ban all D) Labels already national Answer: B

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CHAPTER 1 / 1.2 - ANIMAL PART 2 (FULL: CH.7)

Define: **gene editing animals** | cutting/swapping animal genes precisely **molecular scissors** | CRISPR-like tools cutting DNA **horn gene** | gene making horns grow in Holsteins **de-horning** | removing young horns, usually by burning **cultured meat** | meat grown from cells in dishes, not a whole animal Example: ex. UC-Davis + Recombinetics cut Holstein horn gene, swapped Angus no-horn gene, Fig.1.9 ex. de-horning by burning, horned cattle hurt each other ex. FDA: new DNA construct = new animal drug, debate humane vs pre-market/milk testing ex. cultured meat Fig.1.10 beef cells in dishes, $18,000/lb vs $5/lb ground beef Key points: - Hornless: more humane, less injury - Debate: first gene-edited food animal? need milk testing? - Cultured meat: less environmental harm than large farms/plants Picture: Fig.1.9 hornless calf; Fig.1.10 cultured beef in dishes (text description, no photo) Try it: Hornless how? A) Sprayed B) Cut Holstein horn gene, swap Angus no-horn gene C) Fed horns D) Cloned beef Answer: B

CHAPTER 1 / 1.2 - FORENSIC (FULL: CH.8)

CHAPTER 1 / 1.2 - BIOREMEDIATION (FULL: CH.9)

Define: **bioremediation** | using biotech, often microbes, to break down pollutants **oil-degrading bacteria** | bacteria that break down oil **Pseudomonas** | oil-eating bacteria strains in Alaskan soil, named in Fig.1.12 Example: ex. Fig.1.12 Exxon Valdez 1989, Prince William Sound, Alaska, boost oil-eating bacteria already in soil ex. shoreline cleaned nearly 3x faster than chemical cleaners alone ex. Deepwater Horizon 2010, fast microbe breakdown of dispersed oil helped research for future spills Key points: - Scope Ch.9: microbes, plants, engineered organisms, different materials/settings - Pros/cons of each approach - Could breaking down waste also yield energy? Picture: Fig.1.12 workers in suits on oily beach applying nutrients (text description, no photo) Try it: What cleaned Exxon Valdez faster? A) More oil B) Boosting oil-eating bacteria in soil C) Burning beach D) Phosphates Answer: B

CHAPTER 1 / 1.2 - AQUATIC (FULL: CH.10)

Define: **aquaculture** | raising finfish/shellfish controlled for food **transgenic salmon** | salmon with extra growth-hormone gene **bioprospecting** | searching water life for new useful genes/proteins/processes Example: ex. trout/salmon/catfish major US species, 50% fish eaten worldwide from aquaculture, fastest in developing countries ex. disease-resistant oysters, salmon virus vaccines ex. Fig.1.13 AquaAdvantage salmon FDA 2015 first GM animal for eating, extra growth hormone, market size in about half time, controversial ex. ocean cold/pressure/depth/salt, plankton/snails anti-tumor molecules Key points: - Harsh oceans = new traits - Aquaculture scale 50% worldwide - AquaAdvantage controversial, faster growth, lower time/cost Picture: Fig.1.13 larger GM salmon top, smaller non-GM below (text description, no photo) Try it: AquaAdvantage 2015? A) First GM plant B) First GM animal for eating C) First burger D) First biopsy Answer: B

CHAPTER 1 / 1.2 - MEDICAL (FULL: CH.11)

Define: **medical biotech** | finding/diagnosing disease, new treatments **gene therapy** | putting working genes in, swapping faulty genes **CRISPR-Cas medical** | molecular scissors cutting/replacing specific DNA **stem cells** | immature cells becoming nerve/blood/muscle/almost any cell **immunotherapy** | steering immune system, often with gene/stem work, against cancers Example: ex. 325+ million helped by biotech drugs/vaccines ex. Fig.1.14 headlines almost weekly ex. Human Genome Project whole-genome tests: Alzheimer/Parkinson/sickle cell/Tay-Sachs/-cystic fibrosis/cancer/infertility ex. gene therapy fast, CRISPR trials underway, controversial ex. stem cells lab tissue for transplants, controversial Ch.11/13 Key points: - Ch.11 wider than recombinant proteins: testing, sequencing, drug development, gene therapy, immunotherapy - Stem cells grown in lab, nudged to tissue - CRISPR promising, controversial Picture: Fig.1.14 headline collage genome editing, oldest genome, skin cancer gene, cancer genes (text description, no photo) Try it: Stem cells? A) Grown nerve only B) Immature cells becoming many types C) Soil bacteria D) Plant seeds only Answer: B

CHAPTER 1 / 1.2 - REGULATIONS (FULL: CH.12)

Define: **DNA fingerprinting** | methods revealing unique DNA pattern **trace amounts** | tiny tissue/hair/blood/fluid at scene **liquid biopsy** | cancer detection from blood DNA, not tissue **genetic markers** | DNA signs for disease, e.g. bladder cancer Example: ex. include/exclude suspect from hair/blood/tissue/fluid ex. first 1987 England rapist conviction, routine now, frees wrongly accused ex. paternity, remains, wine grape origin, endangered species, E.coli in meat, AIDS/meningitis/TB/Lyme/West Nile ex. liquid biopsy Fig.1.11 bladder markers, 3 genes urine 90.9%, tumor DNA joins detector, signals, Guardant/Exosome/Illumina, 2019 ~$1,000 Key points: - Caution: cancer DNA often means tumor already forming, too small for symptoms/imaging - Must separate cancer changes from polyp/mole changes - Needs FDA approval Picture: Fig.1.11 arrows + signal diagram (text description, no photo) Try it: First criminal use? A) 2015 USA B) 1987 England C) 1970 France D) 2001 Alaska Answer: B

Define: **regulation** | government safety/effectiveness checks before use **NDA** | New Drug Application **sensor-embedded drug** | drug with swallowable sensor + patch sensor tracking use Example: ex. drug-like safety/effectiveness, FDA many standards, USDA/EPA often involved, most heavily regulated ex. 2015 sensor Abilify Otsuka/Proteus, tablet sensor + patch track pill-taking, rest, body angle, activity ex. Abilify for schizophrenia/bipolar/depression, early warnings could prevent episode Key points: - Ch.12: purity/performance, patents, clinical trials in people - FDA, USDA, EPA all involved - System could warn doctors early Picture: FDA/USDA/EPA checklist, no figure (text description, no photo) Try it: Agencies? A) FDA only B) FDA, USDA, EPA C) NASA only D) None Answer: B

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CHAPTER 1 / 1.2 - INDUSTRIAL (NO SEPARATE CH.)

Define: **industrial biotech** | biotech in manufacturing **biocatalyst** | enzyme made by microbe speeding a reaction **phosphates** | detergent chemicals polluting water **algal blooms** | algae overgrowth from phosphate pollution Example: ex. faster/cheaper/-cleaner manufacturing, enzymes as biocatalysts ex. 1970s detergent phosphates polluted water, enzyme stain removers instead ex. lower temperature cleaning, lower energy, far fewer algal blooms Key points: - Organisms: bacteria, yeasts, fungi, natural or engineered enzymes - Fields: genomics, proteomics, bioinformatics, microbial - Seen as next big area, rivalling medical/agricultural Picture: enzyme breaking stain in cold water, no figure (text description, no photo) Try it: Biocatalyst? A) Phosphate B) Enzyme speeding reaction C) Salmon D) Mosquito Answer: B

CHAPTER 1 / 1.2 - BIG PICTURE

Define: **big picture** | biotech as one connected field, not separate subjects **interdependence** | types depend on each other to solve problems Example: ex. bioremediation uses microbes to clean environments ex. medical biotech uses microbes to make recombinant proteins ex. every branch is regulated Key points: - Do not treat types as separate, unrelated fields, they overlap heavily - Exam point: how many science areas combine, how types depend on each other - For 21st-century problems, branches work together Picture: web linking microbes to medicine, farming, cleaning, regulation (text description, no photo) Try it: Big picture link? A) Medicine never uses microbes B) Bioremediation uses microbes, medicine uses microbes for proteins C) Farming unrelated D) Regulation applies to nothing Answer: B

CHAPTER 1 / 1.3 - NEW BIOTECHNOLOGY CENTURY

Define: **new century** | what problems could the new biotechnology century solve, medical example **life-threatening diseases** | diseases that can kill, e.g. cancers and genetic diseases in Ch.11 Example: ex. What Will the New Biotechnology Century Look Like? ex. curing life-threatening diseases, barriers not impossible ex. better understanding biology, then designing/adapting solutions, not just guessing Key points: - Path: understand biology first, then design/adapt biotech solutions - Not just guessing at future uses - Pages sent stop mid-sentence in 1.3, so this covers 1.3 only up to that point Picture: none in part sent (text description, no photo) Try it: How are big challenges overcome? A) Guessing only B) Better understanding biology, then designing/adapting solutions C) Ignoring regulation D) Stopping research Answer: B

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