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NCERT Solutions

*Step-by-step solutions for the 2026-27 NCERT
textbook*

Chapter 12: Recent Innovations in Biotechnology

This chapter connects recent biotechnology innovations with environmental biotechnology, biofuels, plant biotechnology, regenerative medicine, nanobiotechnology and synthetic biology.

Also see for this chapter: [Revision Notes](#) | [Exemplar Solutions](#)

Exercises

What are the advantages of biodiesel?

★ Quick Solution

Concept: Recent Innovations in Biotechnology.

Chapter: Class 12 Biotechnology Chapter 12.

Route: Biodiesel is renewable, biodegradable, usable in regular diesel engines and gives cleaner combustion than fossil diesel.

SOLUTION

Concept used. Biodiesel is a biofuel made from oils or fats by trans-esterification. Its value comes from cleaner burning and renewable biological origin.

Step 1. Biodiesel can be made from vegetable oils, animal fats, waste cooking oil and oil-rich crops.

Step 2. It contains more oxygen and hydrogen and less carbon than fossil diesel.

Step 3. This improves combustion and reduces particulate emissions from unburnt carbon.

Step 4. It can be used in pure form or as blends with diesel.

Step 5. The NCERT chapter notes that it can be directly used in regular diesel

engines without major modifications.

Step 6. Because it comes from biological sources, it can reduce dependence on non-renewable fossil fuels.

Final Answer: Biodiesel is renewable, cleaner burning, reduces particulate emissions and can be used in regular diesel engines without major engine changes.

EXPERT'S SOLUTION : *Aarav Sharma, M.Sc
Biotechnology, AIIMS Delhi*

Strategic angle. Treat this as an innovation-summary chapter. First name the technology, then state the benefit, risk or application asked in the question.

Step 1. Biodiesel is a biofuel made from oils or fats by trans-esterification. Its value comes from cleaner burning and renewable biological origin.

Step 2. Identify whether the question is asking for a benefit, a difference, a definition, an application or an option choice.

Step 3. Keep the answer tied to the exact

NCERT section: environment,
regenerative medicine,
nanobiotechnology or synthetic
biology.

Step 4. The key point is: Biodiesel is renewable, cleaner burning, reduces particulate emissions and can be used in regular diesel engines without major engine changes.

Step 5. This gives an answer that is concise enough for exams and complete enough for revision.

Final Answer: Biodiesel is renewable, cleaner burning, reduces particulate emissions and can be used in regular diesel engines without major engine changes.

Q 12.2 Enlist the differences between

biodegradation and bioremediation.

★ Quick Solution

Concept: Recent Innovations in Biotechnology.

Chapter: Class 12 Biotechnology Chapter

12. Route: Biodegradation is breakdown of substances by organisms. Bioremediation is the planned use of organisms to clean polluted sites.

SOLUTION

Concept used. Biodegradation is a natural or managed decomposition process, while bioremediation is an environmental clean-up strategy using living systems.

Step 1. Biodegradation means biological breakdown of complex substances into simpler products.

Step 2. It can occur naturally in soil, water, compost or waste systems.

Step 3. Bioremediation uses organisms, plants or microbes to remove, transform or detoxify pollutants.

Step 4. Bioremediation is therefore goal-directed and site-specific.

Step 5. Biodegradation may involve ordinary organic matter or biodegradable

products.

Step 6. Bioremediation usually targets pollutants such as oil, heavy metals, pesticides or industrial wastes.

Final Answer: Biodegradation is biological breakdown. Bioremediation is the controlled use of biological systems to reduce or remove pollution.

EXPERT'S SOLUTION : Priya Iyer, M.Sc Molecular Biology, JNU

Strategic angle. Treat this as an innovation-summary chapter. First name the technology, then state the benefit, risk or application asked in the question.

Step 1. Biodegradation is a natural or managed decomposition process, while bioremediation is an environmental clean-up strategy using living systems.

Step 2. Identify whether the question is asking for a benefit, a difference, a definition, an application or an option choice.

Step 3. Keep the answer tied to the exact

NCERT section: environment,
regenerative medicine,
nanobiotechnology or synthetic
biology.

Step 4. The key point is: Biodegradation is biological breakdown. Bioremediation is the controlled use of biological systems to reduce or remove pollution.

Step 5. This gives an answer that is concise enough for exams and complete enough for revision.

Final Answer: Biodegradation is biological breakdown. Bioremediation is the controlled use of biological systems to reduce or remove pollution.

Explain how biofuel is better than fossil fuels.

★ Quick Solution

Concept: Recent Innovations in Biotechnology.

Chapter: Class 12 Biotechnology Chapter 12.

Route: Biofuels are renewable and can lower greenhouse gas burden, while fossil fuels are non-renewable and pollution-heavy.

SOLUTION

Concept used. Biofuel is produced from biological products or wastes, so it can be renewed more easily than fossil fuel.

Step 1. Fossil fuels are non-renewable and their reserves are limited.

Step 2. Biofuels can be produced from crops, algae, organic waste, dung, manure and industrial organic waste.

Step 3. Bioethanol blending can reduce consumption of fossil petrol.

Step 4. Biodiesel combustion reduces particulate emissions because it contains more oxygen and less carbon.

Step 5. Biogas generation also serves waste removal, environmental management

and energy production.

Step 6. Biofuels can therefore support renewable energy and waste management together.

Final Answer: Biofuels are better because they are renewable, can use biological waste, reduce fossil-fuel dependence and can lower some emissions.

EXPERT'S SOLUTION : *Rohit Patel, Ph.D*
Environmental Biotechnology, IIT Delhi

Strategic angle. Treat this as an innovation-summary chapter. First name the technology, then state the benefit, risk or application asked in the question.

Step 1. Biofuel is produced from biological products or wastes, so it can be renewed more easily than fossil fuel.

Step 2. Identify whether the question is asking for a benefit, a difference, a definition, an application or an option choice.

Step 3. Keep the answer tied to the exact NCERT section: environment,

regenerative medicine,
nanobiotechnology or synthetic
biology.

Step 4. The key point is: Biofuels are better because they are renewable, can use biological waste, reduce fossil-fuel dependence and can lower some emissions.

Step 5. This gives an answer that is concise enough for exams and complete enough for revision.

Final Answer: Biofuels are better because they are renewable, can use biological waste, reduce fossil-fuel dependence and can lower some emissions.

Q 12.4 Enumerate the challenges in growing 3D cultures.

★ **Quick Solution**

Concept: Recent Innovations in Biotechnology.

Chapter: Class 12 Biotechnology Chapter 12.

Route: 3D cultures are hard to grow because cells need correct matrix, signals, nutrients, oxygen diffusion and reproducible organisation.

SOLUTION

Concept used. A 3D culture must recreate tissue-like physical and biochemical conditions rather than a flat monolayer surface.

Step 1. Cells must be placed in a suitable matrix such as hydrogel or Matrigel.

Step 2. The culture must provide the right exogenous factors to guide self-organisation.

Step 3. Nutrients and oxygen must diffuse into the 3D structure.

Step 4. Waste products must leave the culture without damaging cells.

Step 5. The size, shape and cell-type composition can vary between cultures.

Step 6. Maintaining reproducibility and

long-term viability is therefore a major challenge.

Final Answer: The main challenges are suitable matrix selection, growth-factor control, nutrient and oxygen diffusion, waste removal, reproducibility and long-term viability.

EXPERT'S SOLUTION : *Meera Gupta, M.Sc Stem Cell Biology, University of Delhi*

Strategic angle. Treat this as an innovation-summary chapter. First name the technology, then state the benefit, risk or application asked in the question.

Step 1. A 3D culture must recreate tissue-like physical and biochemical conditions rather than a flat monolayer surface.

Step 2. Identify whether the question is asking for a benefit, a difference, a definition, an application or an option choice.

Step 3. Keep the answer tied to the exact NCERT section: environment, regenerative medicine, nanobiotechnology or synthetic

biology.

Step 4. The key point is: The main challenges are suitable matrix selection, growth-factor control, nutrient and oxygen diffusion, waste removal, reproducibility and long-term viability.

Step 5. This gives an answer that is concise enough for exams and complete enough for revision.

Final Answer: The main challenges are suitable matrix selection, growth-factor control, nutrient and oxygen diffusion, waste removal, reproducibility and long-term viability.

Q 12.5 What are the applications of stem cells in generating organoids and spheroids.

★ **Quick Solution**

Concept: Recent Innovations in Biotechnology.

Chapter: Class 12 Biotechnology Chapter

12. Route: Stem cells can self-organise into organoids and spheroids for disease modelling, drug testing, tissue development studies and future regenerative medicine.

SOLUTION

Concept used. Stem cells can form complex three-dimensional structures when supplied with suitable matrix and signalling conditions.

Step 1. Pluripotent stem cells and adult stem cells can be guided to form organ-like structures.

Step 2. Organoids are small self-organised 3D tissue cultures that mimic selected features of organs.

Step 3. Spheroids are 3D cell aggregates useful for studying tissue-like behaviour.

Step 4. These models help study tissue development and disease mechanisms.

Step 5. They are useful in testing drugs and toxicity in a more realistic 3D system.

Step 6. They also support research in organ substitution and regenerative medicine.

Final Answer: Stem cells are used to generate organoids and spheroids for tissue modelling, disease research, drug screening and regenerative-medicine studies.

EXPERT'S SOLUTION : *Kabir Sen, M.Sc
Biotechnology, BHU*

Strategic angle. Treat this as an innovation-summary chapter. First name the technology, then state the benefit, risk or application asked in the question.

Step 1. Stem cells can form complex three-dimensional structures when supplied with suitable matrix and signalling conditions.

Step 2. Identify whether the question is asking for a benefit, a difference, a definition, an application or an option choice.

- Step 3.** Keep the answer tied to the exact NCERT section: environment, regenerative medicine, nanobiotechnology or synthetic biology.
- Step 4.** The key point is: Stem cells are used to generate organoids and spheroids for tissue modelling, disease research, drug screening and regenerative-medicine studies.
- Step 5.** This gives an answer that is concise enough for exams and complete enough for revision.

Final Answer: Stem cells are used to generate organoids and spheroids for tissue modelling, disease research, drug screening and regenerative-medicine studies.

★ Quick Solution

Concept: Recent Innovations in Biotechnology.

Chapter: Class 12 Biotechnology Chapter

12. Route: Nanomaterials are materials with dimensions in the nanoscale range, usually below one micron and often around 1 to 100 nm.

SOLUTION

Concept used. Nanoscience studies materials at nanometre scale, where small size can change physical, chemical and biological properties.

Step 1. A nanometre is extremely small compared with ordinary microscopic dimensions.

Step 2. The NCERT chapter describes nanoscale materials as less than one micron, in the 10^{-9} to 10^{-12} range.

Step 3. Nanomaterials may include nanoparticles, nanotubes, fullerenes and quantum dots.

Step 4. At this scale, surface area becomes very high relative to volume.

Step 5. Their optical, electrical, mechanical and biological behaviour can differ from bulk material.

Step 6. Nanobiotechnology applies such materials in diagnosis, delivery, sensing and therapy.

Final Answer: Nanomaterials are materials at nanoscale dimensions whose small size gives special properties useful in biotechnology, medicine and sensing.

EXPERT'S SOLUTION : *Nisha Rao, Ph.D*
Nanobiotechnology, IISc Bangalore

Strategic angle. Treat this as an innovation-summary chapter. First name the technology, then state the benefit, risk or application asked in the question.

Step 1. Nanoscience studies materials at nanometre scale, where small size can change physical, chemical and biological properties.

Step 2. Identify whether the question is asking for a benefit, a difference, a definition, an application or an option

choice.

- Step 3.** Keep the answer tied to the exact NCERT section: environment, regenerative medicine, nanobiotechnology or synthetic biology.
- Step 4.** The key point is: Nanomaterials are materials at nanoscale dimensions whose small size gives special properties useful in biotechnology, medicine and sensing.
- Step 5.** This gives an answer that is concise enough for exams and complete enough for revision.

Final Answer: Nanomaterials are materials at nanoscale dimensions whose small size gives special properties useful in biotechnology, medicine and sensing.

Q 12.7 Are there specific health risks from nano products?

★ Quick Solution

Concept: Recent Innovations in Biotechnology.

Chapter: Class 12 Biotechnology Chapter 12.

Route: Yes. Some nano products may carry risks because tiny particles can enter cells, interact with tissues and show unexpected toxicity.

SOLUTION

Concept used. Nanoproduct risk depends on particle size, surface chemistry, dose, exposure route and persistence in the body or environment.

Step 1. Nanoparticles are very small, so they may cross biological barriers more easily than larger particles.

Step 2. Their high surface area can make them chemically reactive.

Step 3. Some may enter cells or tissues and cause irritation, inflammation or toxicity.

Step 4. Risk can differ between inhalation, ingestion, skin contact and injection routes.

Step 5. Long-term environmental and

human-health effects must therefore be assessed.

Step 6. Safe design, testing, regulation and responsible use are important for nano products.

Final Answer: Yes. Nano products may pose health risks through cell entry, tissue interaction, inflammation or toxicity, so they need careful safety testing.

EXPERT'S SOLUTION : *Devika Menon, M.Sc Life Sciences, University of Hyderabad*

Strategic angle. Treat this as an innovation-summary chapter. First name the technology, then state the benefit, risk or application asked in the question.

Step 1. Nanoproduct risk depends on particle size, surface chemistry, dose, exposure route and persistence in the body or environment.

Step 2. Identify whether the question is asking for a benefit, a difference, a definition, an application or an option choice.

- Step 3.** Keep the answer tied to the exact NCERT section: environment, regenerative medicine, nanobiotechnology or synthetic biology.
- Step 4.** The key point is: Yes. Nano products may pose health risks through cell entry, tissue interaction, inflammation or toxicity, so they need careful safety testing.
- Step 5.** This gives an answer that is concise enough for exams and complete enough for revision.

Final Answer: Yes. Nano products may pose health risks through cell entry, tissue interaction, inflammation or toxicity, so they need careful safety testing.

Q 12.8 Organoids can be created from:

- (a) Both Totipotent and Pluripotent Cells
- (b) Both Pluripotent and Multipotent Cells
- (c) Both Adult Stem Cells and Pluripotent Cells
- (d) Both Adult Stem Cells and Multipotent Cells

★ **Quick Solution**

Concept: Recent Innovations in Biotechnology.

Chapter: Class 12 Biotechnology Chapter 12.

Route: NCERT states that organoids have been created from adult stem cells and pluripotent stem cells, so option (c) is correct.

SOLUTION

Concept used. Organoids are self-assembled 3D tissue cultures derived from stem cells.

Step 1. The chapter says organoids can be made from pluripotent stem cells.

Step 2. It also says organoids can be made from adult stem cells.

Step 3. Both cell sources can form organised 3D tissue-like structures under suitable conditions.

Step 4. Totipotent cells and multipotent cells

are not the pair stated in the NCERT exercise context.

Step 5. Therefore the exact NCERT-supported pair is adult stem cells and pluripotent cells.

Final Answer: The correct option is (c) Both Adult Stem Cells and Pluripotent Cells.

EXPERT'S SOLUTION : *Arjun Nair, Ph.D*
Regenerative Biology, NCBS Bangalore

Strategic angle. Treat this as an innovation-summary chapter. First name the technology, then state the benefit, risk or application asked in the question.

Step 1. Organoids are self-assembled 3D tissue cultures derived from stem cells.

Step 2. Identify whether the question is asking for a benefit, a difference, a definition, an application or an option choice.

Step 3. Keep the answer tied to the exact NCERT section: environment, regenerative medicine,

nanobiotechnology or synthetic biology.

Step 4. The key point is: The correct option is (c) Both Adult Stem Cells and Pluripotent Cells.

Step 5. This gives an answer that is concise enough for exams and complete enough for revision.

Final Answer: The correct option is (c) Both Adult Stem Cells and Pluripotent Cells.

Q 12.9 Incineration is:

- (a) Extracting metals from their ores using microbes
- (b) Treating waste, which involves the combustion of organic substances
- (c) Degrading harmful chemicals and materials using microbes
- (d) Remediation of harmful metals from the environment using microbes.

★ **Quick Solution**

Concept: Recent Innovations in Biotechnology.

Chapter: Class 12 Biotechnology Chapter 12.

Route: Incineration is waste treatment by burning organic substances, so option (b) is correct.

SOLUTION

Concept used. Incineration means controlled combustion of waste material, not microbial treatment.

Step 1. The word incineration refers to burning.

Step 2. In waste management, it is used for treating waste through combustion.

Step 3. Option (a) describes bioleaching.

Step 4. Option (c) describes biodegradation or bioremediation.

Step 5. Option (d) describes metal bioremediation.

Step 6. Thus only option (b) gives the correct definition.

Final Answer: The correct option is (b) Treating waste, which involves the combustion of organic substances.

EXPERT'S SOLUTION : *Tanya Kapoor, M.Sc
Bioprocess Technology, Jamia Millia Islamia*

Strategic angle. Treat this as an innovation-summary chapter. First name the technology, then state the benefit, risk or application asked in the question.

Step 1. Incineration means controlled combustion of waste material, not microbial treatment.

Step 2. Identify whether the question is asking for a benefit, a difference, a definition, an application or an option choice.

Step 3. Keep the answer tied to the exact

NCERT section: environment,
regenerative medicine,
nanobiotechnology or synthetic
biology.

Step 4. The key point is: The correct option is
(b) Treating waste, which involves the
combustion of organic substances.

Step 5. This gives an answer that is concise
enough for exams and complete
enough for revision.

Final Answer: The correct option is
(b) Treating waste, which involves the
combustion of organic substances.

Q 12.10

Ultra small, self-assembled, three dimensional tissue cultures derived from stem cells are called:

- (a) Spheroids
- (b) Organoids
- (c) Monolayer Cells Culture
- (d) Tissue Explants

★ **Quick Solution**

Concept: Recent Innovations in Biotechnology.

Chapter: Class 12 Biotechnology Chapter 12.

Route: Ultra-small self-assembled 3D tissue cultures derived from stem cells are organoids.

SOLUTION

Concept used. Organoids are miniature self-organised tissue models derived from stem cells.

Step 1. The stem-cell source and self-assembled 3D organisation are key clues.

Step 2. NCERT defines organoids as ultra-small self-assembled three-dimensional tissue cultures.

Step 3. Spheroids are 3D aggregates but the exact phrase in the question points to

organoids.

Step 4. Monolayer cell culture is two-dimensional.

Step 5. Tissue explants are pieces of tissue, not self-assembled stem-cell cultures.

Final Answer: The correct option is (b) Organoids.

EXPERT'S SOLUTION : *Sahil Verma, Ph.D*
Biotechnology, University of Pune

Strategic angle. Treat this as an innovation-summary chapter. First name the technology, then state the benefit, risk or application asked in the question.

Step 1. Organoids are miniature self-organised tissue models derived from stem cells.

Step 2. Identify whether the question is asking for a benefit, a difference, a definition, an application or an option choice.

Step 3. Keep the answer tied to the exact NCERT section: environment, regenerative medicine,

nanobiotechnology or synthetic biology.

Step 4. The key point is: The correct option is (b) Organoids.

Step 5. This gives an answer that is concise enough for exams and complete enough for revision.

Final Answer: The correct option is (b) Organoids.

Q 12.11 What is the colour of the nano gold particles?

(a) Yellow

(b) Orange

(c) Red

(d) Variable

★ **Quick Solution**

Concept: Recent Innovations in Biotechnology.

Chapter: Class 12 Biotechnology Chapter 12.

Route: Nano gold particles show size-dependent colour, so the best option is variable.

SOLUTION

Concept used. Gold nanoparticles can show different colours because their optical behaviour changes at nanoscale size.

Step 1. Bulk gold appears yellowish metallic.

Step 2. Gold nanoparticles can appear red, purple, blue or other colours depending on size and aggregation.

Step 3. This colour variation is linked with nanoscale optical properties.

Step 4. Since the question asks generally about nano gold particles, one fixed colour is not enough.

Step 5. Therefore the correct answer is variable.

Final Answer: The correct option is (d) Variable.

EXPERT'S SOLUTION : Riya Thomas, M.Sc
Molecular Medicine, Madras University

Strategic angle. Treat this as an innovation-summary chapter. First name the technology, then state the benefit, risk or application asked in the question.

Step 1. Gold nanoparticles can show different

colours because their optical behaviour changes at nanoscale size.

Step 2. Identify whether the question is asking for a benefit, a difference, a definition, an application or an option choice.

Step 3. Keep the answer tied to the exact NCERT section: environment, regenerative medicine, nanobiotechnology or synthetic biology.

Step 4. The key point is: The correct option is (d) Variable.

Step 5. This gives an answer that is concise enough for exams and complete enough for revision.

Final Answer: The correct option is (d) Variable.

Q 12.12 Quantum dots can be used in:

- (a) Crystallography
- (b) Optoelectronics
- (c) Mechanics
- (d) Quantum physics

★ **Quick Solution**

Concept: Recent Innovations in Biotechnology.

Chapter: Class 12 Biotechnology Chapter

12. Route: Quantum dots are widely used in optoelectronics, so option (b) is correct.

SOLUTION

Concept used. Quantum dots are nanoscale semiconductor particles with size-dependent optical and electronic properties.

Step 1. Quantum dots can absorb and emit light in size-dependent ways.

Step 2. They are useful in displays, imaging, sensors and light-emitting devices.

Step 3. These uses combine optical and electronic behaviour.

Step 4. That field is called optoelectronics.

Step 5. The other options do not match the standard application asked in the exercise.

Final Answer: The correct option is (b)
Optoelectronics.

EXPERT'S SOLUTION : *Neel Joshi, Ph.D Synthetic Biology, IISER Pune*

Strategic angle. Treat this as an innovation-summary chapter. First name the technology, then state the benefit, risk or application asked in the question.

Step 1. Quantum dots are nanoscale semiconductor particles with size-dependent optical and electronic properties.

Step 2. Identify whether the question is asking for a benefit, a difference, a definition, an application or an option choice.

Step 3. Keep the answer tied to the exact NCERT section: environment, regenerative medicine, nanobiotechnology or synthetic biology.

Step 4. The key point is: The correct option is (b) Optoelectronics.

Step 5. This gives an answer that is concise

enough for exams and complete
enough for revision.

Final Answer: The correct option is (b)
Optoelectronics.

Q 12.13 Fabrics are extensively made out
of nano materials like _____.

- (a) Carbon nano tubes
- (b) Fullerenes
- (c) Mega tubes
- (d) Polymers

★ **Quick Solution**

Concept: Recent Innovations in Biotechnology.

Chapter: Class 12 Biotechnology Chapter 12.

Route: Fabrics can use carbon nanotubes as
nanomaterials, so option (a) is correct.

SOLUTION

Concept used. Carbon nanotubes are
nanoscale carbon structures that can add
strength, conductivity and functional
properties to materials.

Step 1. The blank asks for a nanomaterial

used in fabric applications.

- Step 2.** Carbon nanotubes are recognised nanomaterials.
- Step 3.** They can be incorporated into fibres or coatings to improve fabric properties.
- Step 4.** Fullerenes are also nanostructures, but the textile clue points more directly to carbon nanotubes.
- Step 5.** Mega tubes is not the relevant term, and polymers are broad materials rather than the specific nanomaterial expected.

Final Answer: The correct option is (a) Carbon nano tubes.

EXPERT'S SOLUTION : *Ishita Das, M.Sc*
Biotechnology, Calcutta University

Strategic angle. Treat this as an innovation-summary chapter. First name the technology, then state the benefit, risk or application asked in the question.

- Step 1.** Carbon nanotubes are nanoscale carbon structures that can add strength, conductivity and functional

properties to materials.

Step 2. Identify whether the question is asking for a benefit, a difference, a definition, an application or an option choice.

Step 3. Keep the answer tied to the exact NCERT section: environment, regenerative medicine, nanobiotechnology or synthetic biology.

Step 4. The key point is: The correct option is (a) Carbon nano tubes.

Step 5. This gives an answer that is concise enough for exams and complete enough for revision.

Final Answer: The correct option is (a) Carbon nano tubes.

Q 12.14 Assertion: Bt cotton is a transgenic plant.

Reason: Bt toxin provides resistance to plants against insects.

(a) Both assertion and reason are true and the reason is the correct explanation of the assertion.

(b) Both assertion and reason are true but the reason is not the correct explanation of the assertion.

(c) Assertion is true but reason is false.

(d) Both assertion and reason are false.

★ **Quick Solution**

Concept: Recent Innovations in Biotechnology.

Chapter: Class 12 Biotechnology Chapter 12.

Route: Both statements are true, and Bt toxin explains why Bt cotton is engineered for insect resistance.

SOLUTION

Concept used. Bt cotton is produced by introducing a *Bacillus thuringiensis* toxin gene into cotton.

Step 1. A transgenic plant carries a foreign gene introduced through genetic

engineering.

Step 2. Bt cotton carries Bt gene information related to insecticidal toxin production.

Step 3. The Bt toxin gives resistance against target insect pests.

Step 4. Therefore the assertion is true.

Step 5. The reason is also true and explains the purpose of making the transgenic Bt cotton plant.

Final Answer: The correct option is (a). Both assertion and reason are true, and the reason correctly explains the assertion.

EXPERT'S SOLUTION : *Varun Mehta, Ph.D Plant Biotechnology, JNU*

Strategic angle. Treat this as an innovation-summary chapter. First name the technology, then state the benefit, risk or application asked in the question.

Step 1. Bt cotton is produced by introducing a *Bacillus thuringiensis* toxin gene into cotton.

- Step 2.** Identify whether the question is asking for a benefit, a difference, a definition, an application or an option choice.
- Step 3.** Keep the answer tied to the exact NCERT section: environment, regenerative medicine, nanobiotechnology or synthetic biology.
- Step 4.** The key point is: The correct option is (a). Both assertion and reason are true, and the reason correctly explains the assertion.
- Step 5.** This gives an answer that is concise enough for exams and complete enough for revision.

Final Answer: The correct option is (a). Both assertion and reason are true, and the reason correctly explains the assertion.

Q 12.15

Assertion: Biodiesel is made from raw materials such as vegetable oils, animal fats, etc.

Reason: Biodiesel reduces the particulate emissions from unburnt carbon.

(a) Both assertion and reason are true and the reason is the correct explanation of the assertion.

(b) Both assertion and reason are true but the reason is not the correct explanation of the assertion.

(c) Assertion is true but reason is false.

(d) Both assertion and reason are false.

★ **Quick Solution**

Concept: Recent Innovations in Biotechnology.

Chapter: Class 12 Biotechnology Chapter 12.

Route: Both statements are true, but lower particulate emissions do not explain why biodiesel is made from oils and fats.

SOLUTION

Concept used. The source of biodiesel and its emission advantage are two true but different facts.

Step 1. The assertion is true because NCERT

lists vegetable oils, animal fats and waste cooking oil as biodiesel raw materials.

Step 2. The reason is also true because biodiesel reduces particulate emissions from unburnt carbon.

Step 3. However, the emission advantage does not explain the raw-material origin.

Step 4. The raw material is chosen because oils and fats can undergo trans-esterification.

Step 5. So the reason is true but not the correct explanation of the assertion.

Final Answer: The correct option is (b). Both assertion and reason are true, but the reason is not the correct explanation.

EXPERT'S SOLUTION : Aditi Rao, M.Sc
Biotechnology, Delhi University

Strategic angle. Treat this as an innovation-summary chapter. First name the technology, then state the benefit, risk or application asked in the question.

- Step 1.** The source of biodiesel and its emission advantage are two true but different facts.
- Step 2.** Identify whether the question is asking for a benefit, a difference, a definition, an application or an option choice.
- Step 3.** Keep the answer tied to the exact NCERT section: environment, regenerative medicine, nanobiotechnology or synthetic biology.
- Step 4.** The key point is: The correct option is (b). Both assertion and reason are true, but the reason is not the correct explanation.
- Step 5.** This gives an answer that is concise enough for exams and complete enough for revision.

Final Answer: The correct option is (b). Both assertion and reason are true, but the reason is not the correct explanation.

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Key Takeaways

- Biofuels include biodiesel, bioalcohol, biogas and biomass.
- Biodegradation is biological breakdown, while bioremediation is planned clean-up using living systems.
- Organoids are self-organised 3D tissue cultures derived from stem cells.
- Nanobiotechnology supports nanomedicine, biosensors, diagnosis and delivery systems.
- Synthetic biology designs biological components for chosen functions, but needs ethical regulation.