UPSC Prelims- 2019

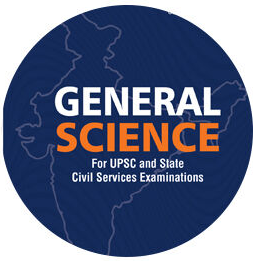
Science and Technology

Questions Asked

Detailed Solutions

Right Approach

PrepMate Science and Technology Book Performance



PrepMate GeneralScience Book Performance

1. With reference to communication technologies, what is/are the difference / differences between LTE (Long-Term Evolution) and VoLTE (Voice over Long-Term Evolution)?

1. LTE is commonly marketed as 3G and VoLTE is commonly marketed as advanced 3G.

2. LTE is data-only technology and VoLTE is voice-only technology.

Select the correct answer using the code given below.

(a) 1 only

(b) 2 only

(c) Both 1 and 2

(d) Neither 1 nor 2

Sol.1 (d) Neither 1 nor 2

Source: PrepMate Science & Technology, Chapter 13 Communication Technology, Page 190

Both the Statements are incorrect.

2. **Long-Term Evolution (LTE):** The LTE is a 4G wireless broadband technology. It has been named 'Long-Term Evolution', because it represents the next step (4G) in a progression from GSM, a 2G standard, to Universal Mobile Telecommunications Service (UMTS), the 3G technologies based upon GSM. The LTE provides significantly increased peak data rates, with the potential for 100 Mbps downstream and 30 Mbps upstream, reduced inactivity, accessible bandwidth capacity, and backwards compatibility with existing GSM and UMTS technology.

2. In the context of digital technologies for entertainment, consider the following statements:

1. In Augmented Reality (AR), a simulated environment is created and the physical world is completely shut out.

2. In Virtual Reality (VR), images generated from a computer are projected onto real-life objects or surroundings.

3. AR allows individuals to be present in the world and improves the experience using the camera of smart-phone or PC.

4. VR closes the world, and transposes an individual, providing complete immersion experience.

Which of the statements given above is / are correct?

(a) 1 and 2 only

(b) 3 and 4

(c) 1, 2 and 3

(d) 4 only

Sol. 2 (b) 3 and 4

Topic: Science & Technology

Statement 1 is incorrect and Statement 3 is correct: Augmented reality (AR) adds digital elements to a live view often by using the camera on a smartphone. Examples of augmented reality experiences include Snapchat lenses and games such as Pokemon Go.

Statement 2 is incorrect and Statement 4 is correct: Virtual reality (VR) refer to complete immersion experience that shuts out the physical world. Using VR devices users can be transported to imagined environments such as among the dinosaurs or within a haunted house.

3. With reference to the recent developments in science, which one of the following statements is **not** correct?

(a) Functional chromosomes can be created by joining segments of DNA taken from cells of different species.

(b) Pieces of artificial functional DNA can be created in laboratories.

(c) A piece of DNA taken out from an animal cell can be made to replicate outside a living cell in a laboratory.

(d) Cells taken out from plants and animals can be made to undergo cell division in laboratory petri dishes.

Sol. 3 (a) Functional chromosomes can be created by joining segments of DNA taken from cells of different species.

Source: PrepMate Science & Technology

This question can be solved through elimination technique.

Let us start from option (d). It is easiest. The statement given in answer option can be eliminated on the basis of cloning technique. In the process of cloning, cells taken out from plants and animals undergo cell division in laboratory petri dishes.

Source: PrepMate Science & Technology, Chapter 1, Page 8

Process of Cloning

Human cloning is performed by somatic cell (any cell in the body other than sperm and egg, the two types of reproductive cells) nucleus transfer to an enucleated egg (an egg cell whose nucleus has been removed). The egg so obtained is thereafter, stimulated by electric shock and chemicals to initiate division. Within a week, this single cell becomes a ball of mass having around 150 unspecialised cells.

Options (b) and (c) can also be eliminated. Synthetic biology is used to create pieces of artificial functional DNA. It can also be used to replicate DNA outside a living cell.

Source: PrepMate Science & Technology, Chapter 1, Page 7

What Is Synthetic Biology?

It is an emerging science through which new life forms can potentially be made in labs and existing life forms, such as bacteria and other microbes, are altered to produce specific proteins or chemically useful products.

Possible Benefits of Synthetic Biology

Synthetic biology in microbial systems holds promise for the production of drugs, vaccines, fuel components and other chemicals. Microorganisms have also been constructed to act as sensors that can detect a toxin in vitro (outside a living organism) or in vivo (inside a living organism).

4. Consider the following statements:

A digital signature is

1. an electronic record that identifies the certifying authority issuing it

2. used to serve as a proof of identity of an individual to access information or server on Internet.

3. an electronic method of signing an electronic document and ensuring that the original content is unchanged

Which of the statements given above is / are correct?

(a) 1 only

(b) 2 and 3 only

(c) 3 only

(d) 1, 2 and 3

Sol. 4 (d) 1, 2 and 3

Source: PrepMate Science & Technology, Chapter 11, Page 159

Statements 1 and 3 are correct.

3 DIGITAL SIGNATURE

Digital signature is used to authenticate both the sender of the message and the contents of the message. The authentication is done in such a manner that it is provable to the third party. Let us understand the following terms to understand digital signature.

Steps in Digital Signature

1. Sender of the document applies hash function in the document.
2. Sender uses private key to create digital signature and encrypt the document.
3. The document is transmitted to the receiver.
4. The receiver of the document applies public key corresponding to the particular private key to confirm the identity of the sender.
5. The receiver applies the same hash algorithm in the document as applied by the sender. If the hash result is identical, then it authenticates the originality of the document.

   Thus, digital signature authenticates both the sender of the document and the content of the message.

Statement 2 is also correct. A digital certificate can also be presented electronically to prove one's identity, to access information or services on the Internet.

5. Recently, scientists observed the merger of giant 'blackholes' billions of light-years away from the Earth. What is the significance of this observation?

(a) 'Higgs boson particles' were detected.

(b) 'Gravitational waves' were detected.

(c) Possibility of inter-galactic space travel through 'wormhole' was confirmed.

(d) It enabled the scientists to understand 'singularity'.

Sol. 5 (b) 'Gravitational waves' were detected.

Source: PrepMate Science & Technology Book, Chapter 10, Page 148

What Are Gravitational Waves?

Gravitational waves are distortions or 'ripples' caused due to the force of gravity exerted by the object. Albert Einstein predicted the existence of gravitational waves in 1916.

How Are They Produced?

Einstein theoretically proved that massive accelerating objects (such as neutron stars or black holes orbiting each other) would produce ripples in space. Furthermore, these ripples would travel at the speed of light through the universe.

The strongest gravitational waves are produced by events such as colliding black holes (region of space with intense gravitational field that no matter or radiation can escape through) and other very high density objects.

What Is the Significance of This Breakthrough?

The study of these waves will offer scientists greater insights into the origin of the universe and how planets are created.

There are many objects in the universe such as black holes and dark matter, that do not emit light, but emit waves. Detecting gravitational waves will open avenues to study these objects.

Where Were These Waves Detected?

The waves were first detected by Laser Interferometer Gravitational-Wave Observatory (LIGO). LIGO is a system of two identical detectors, located in Louisiana and Washington, which were constructed to detect even minute vibrations due to gravitational waves.

Even though the gravitational waves were generated due to the merger of two black holes, this merger was so far away from Earth that the gravitational waves are extremely difficult to detect.

As a result, scientists have built huge instruments that are supremely sensitive. These instruments are part of the LIGO. There are more than 1,000 scientists from 86 institutions around the world, including India, working with LIGO project.

6. Which of the following are the reasons for the occurrence of multi-drug resistance in microbial pathogens in India?

1. Genetic predisposition of some people

2. Taking incorrect doses of antibiotics to cure diseases

3. Using antibiotics in livestock farming

4. Multiple chronic diseases in some people

Select the correct answer using the code given below.

(a) 1 and 2

(b) 2 and 3 only

(c) 1, 3 and 4

(d) 2, 3 and 4

Sol. 6 (b) 2 and 3 only

Source: PrepMate Science & Technology, Chapter 15, Page 206

5 ANTIBIOTIC RESISTANCE

Antibiotic resistance refers to the ability of bacteria or other microbes to resist the effects of an antibiotic. In other words, the bacteria (or other microbes) continue to survive and even multiply despite the intake of an antibiotic.

Antibiotic resistance occurs when bacteria change in some way that reduces or eliminates the effectiveness of drugs, chemicals or other means designed to cure or prevent infections.

Why Is It Important to Tackle Antibiotic Resistance?

Antibiotic resistance is one of the most pressing public health problems, especially for a country like India, where large population suffers from communicable diseases. Almost all the types of bacteria have become stronger and less responsive to antibiotic treatment. These antibiotic-resistant bacteria can quickly spread among people and can infect people with an infectious disease.

Someone with an infection that is resistant to a certain medicine can pass that resistant infection to another person. In this way, a hard-to-treat illness can spread from person to person. In some cases, the illness can lead to serious disability or even death.

What Is Antibiotic Resistance?

Excessive antibiotic use promotes the development of antibiotic-resistant bacteria. Every time a person takes antibiotics, sensitive bacteria are killed, but the resistant ones survive and may even multiply. Repeated and noncompletion of antibiotics course as prescribed by a medical practitioner are primary causes of the increase in drug-resistant bacteria. Thus, widespread use of antibiotics promotes the spread of antibiotic resistance.

Anything which is associated with excessive use of antibiotics is a cause behind antibiotic resistance.

Statement 2 is correct. Incorrect doses of antibiotics lead to excessive use of antibiotics.

Statement 3 is correct. This statement has been specifically mentioned in current affairs. Antibiotic resistance in humans has also been traced to resistant microbes originating in livestock. Thus, increased use of antibiotics in livestock also leads to antibiotic resistance.

Statements 1 and 4 are not directly related to antibiotic resistance.

7. For the measurement/estimation of which of the following are satellite images/remote sensing data used?

1. Chlorophyll content in the vegetation of a specific location

2. Greenhouse gas emissions from rice paddies of a specific location

3. Land surface temperatures of a specific location

Select the correct answer using the code given below.

(a) 1 only

(b) 2 and 3 only

(c) 3 only

(d) 1, 2 and 3

Sol. 7 (d) 1, 2 and 3

Source: PrepMate Science & Technology Book, Chapter 3, Page 49

This question requires understanding of capability of remote sensing satellites (RSS). All the given statements in this question are correct.

Statement 1 is correct. Chlorophyll content in the vegetation of a specific location can be estimated by observing composition of plants.

Statement 2 is correct. Greenhouse gas emissions are tracked by RSS.

Statement 3 is correct. RSS can track temperature through measurement of radiations.

1. **Remote sensing satellite:** It is a space-based Earth observatory system which collects information about the objects and phenomena on Earth and transmits the information to the ground station. The information is collected through images, infrared rays and X-rays.

   The remote sensing satellites are launched in MEO and LEO. The remote sensing satellites are launched with Polar Satellite Launch Vehicle (PSLV).

What Does Remote Sensing Include?

The technology of modern remote sensing began more than 150 years ago with the invention of the camera. Presently, remote sensing involves the detection and measurement of radiation of different wavelengths reflected or emitted from distant objects or materials, by which they may be identified and categorised by class/type, substance and spatial distribution.

The applications of remote sensing satellites include:

- **Agriculture:** Remote sensing data help in assessing the estimate of net crop area, volume of crop, the area affected by drought and availability of resources for irrigation, etc.
- **Forestry:** Remote sensing data help in assessing the size and density of forests.
- **Biodiversity:** Remote sensing data help in assessing the distribution of species.
- **Meteorology:** Accurate weather observation is done through remote sensing.
- **Identification of natural resources:** Remote sensing help in the identification of natural resources such as oil and natural gas reserves.
- **Disaster management:** Remote sensing help in estimating the impact of earthquake, level of flood water in different areas, impact of cloudburst, spread of forest fires and thus, help in post-disaster management.
- **Defence:** Remote sensing can trace the movement of enemy's armed forces, keep vigil over borders and identify the secret military installations of other nations.

8. 'RNA interference (RNAi)' technology has gained popularity in the last few years. Why?

1. It is used in developing gene silencing therapies.

2. It can be used in developing therapies for-the treatment of cancer.

3. It can be used to develop hormone replacement therapies.

4. It can be used to produce crop plants that are resistant to viral pathogens.

Select the correct answer using the code given below.

(a) 1, 2 and 4

(b) 2 and 3

(c) 1 and 3

(d) 1 and 4 only

Sol. 8 (a) 1, 2 and 4

Source: PrepMate General Science Book, Biology Section, Chapter 4, Page 233

This question can be solved by understanding functioning of RNA.

Statement 1 is correct. As RNA transcribes genetic information from the DNA found in a cell's nucleus and then carries this information to other cell organelles, RNAi is used in developing gene silencing therapies.

Statement 2 is correct. Cancer is abnormal growth of body cells which is related to DNA present in them. As DNA are expressed through RNA, RNAi can be used in developing therapies for-the treatment of cancer.

Statement 3 is incorrect. So far, genetic information has not been intrinsically related to our hormone system. Thus, RNAi It cannot be used to develop hormone replacement therapies.

Statement 4 is correct. RNA can impact expression of DNA which may make plant vulnerable to viral pathogens. Thus, RNAi can be used to produce crop plants that are resistant to viral pathogens.

DNA and RNA

DNA, or deoxyribonucleic acid, is like a genetic blueprint of guidelines that a living organism must follow to exist and remain functional. RNA, or ribonucleic acid, helps carry out this blueprint's guidelines. It is complementary to DNA, helping to carry out the tasks encoded in DNA.

DNA is more stable and holds more complex information for longer periods of time. On the other hand, RNA is more flexible capable of performing different tasks.

DNA is found in the nucleus of a cell (nuclear DNA) and in mitochondria (mitochondrial DNA). It has a fixed double helix structure. The RNA does not have fixed location in a cell and adopts different structures depending on the role it is to play—as messenger RNA (mRNA), transfer RNA (tRNA) or ribosomal RNA (rRNA).

Messenger RNA (mRNA) transcribes genetic information from the DNA found in a cell's nucleus and then carries this information to other cell organelles specifically ribosome (site of protein manufacture). The full range of messenger RNA, or mRNA, molecules expressed by an organism is transcriptome. An organism's transcriptome varies depending on many factors, including the stage of development and environmental conditions. In contrast with the genome, which is characterised by its stability, the transcriptome actively changes.

Transfer RNA (tRNA) is found in a cell's cytoplasm and is closely related to mRNA as its helper. tRNA literally transfers amino acids, the core components of proteins, to the mRNA in a ribosome.

Ribosomal RNA (rRNA) is found in a cell's cytoplasm. In the ribosome, it takes mRNA and tRNA and translates the information they provide. From this information, it 'learns' whether it should create protein.

DNA genes are expressed, or manifested, through the proteins which are produced with the help of RNA. Traits (phenotypes) come from which proteins are made and which are switched on or off. The information found in DNA determines which traits are to be created, activated or deactivated, while the various forms of RNA do the work.