Curtis *et al.*
Il nuovo Invito alla biologia.blu

BIOLOGY HIGHLIGHTS – *KEYS*

Watch the videos and download the transcripts of this section at:
online.scuola.zanichelli.it/curtisnuovoinvitoblu/clil

> GENETIC ENGINEERING

2. WARM UP
a) Many vegetables have been genetically modified to provide them with qualities that are not naturally present in those foods, like soybeans or corn. A number of animals, like salmons and cows, have also been genetically engineered to increase yield and decrease susceptibility of diseases.
b) Cloning is the production of an organism genetically identical to another. Probably the most famous sheep in the world, Dolly has been the first mammal to be cloned from an adult somatic cell in 1996.
c) The first organism to be genetically modified (by American biologists Herb Boyer and Stanley Cohen) was the bacterium *E. coli* in 1973.

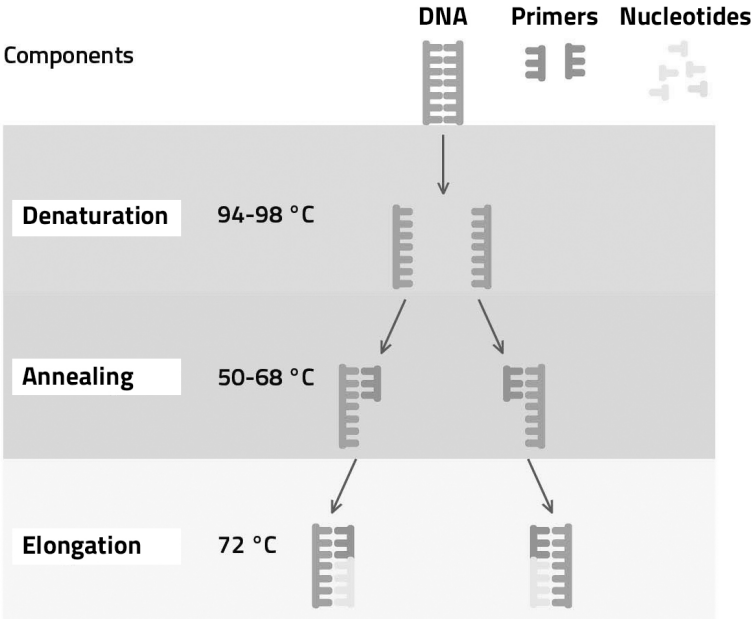
3. READING
Track D1
a) chromosomes; b) protein; genes; c) diploid cell, sex cell

4. VOCABULARY
a) cutting; b) restriction; c) plasmids; d) recombinant; e) egg; zygote; totipotent; f) chromosomes

5. READING
Track D2

Name	**Function**
a. Restriction enzymes	They cut DNA into fragments.
b. Sticky ends	Areas of DNA where bases are ready to be paired, so that they will "stick" to the matching DNA.
c. Recognition site	The specific site or spot where the enzyme cuts.
d. Blunt ends	Areas of DNA that cannot be paired to the foreign DNA.
e. Ligation	The joining of two different DNAs.

6. VISUAL LEARNING



7. VOCABULARY

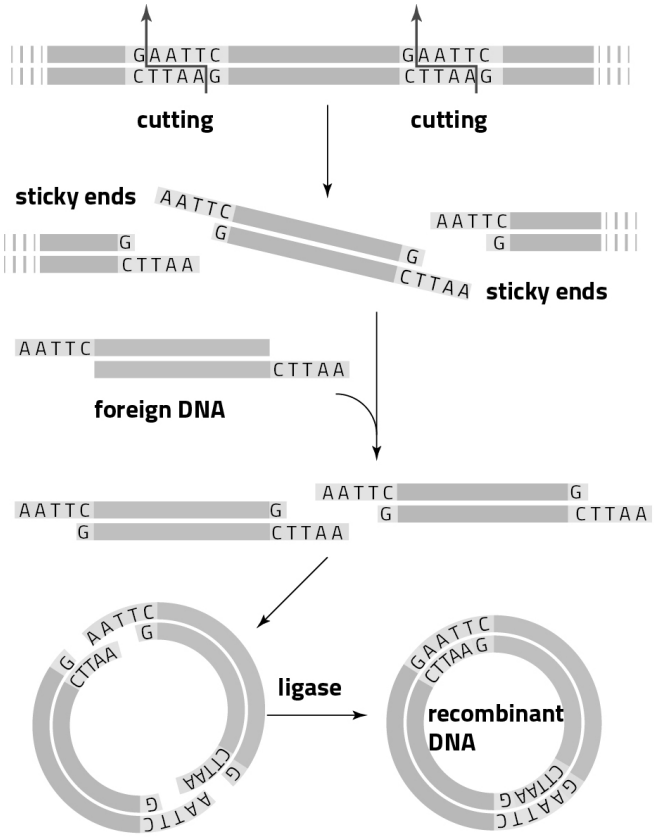
1-C; 2-E; 3-D; 4-F; 5-B; 6-A

8. READING

Track D3

a) In genetic engineering portions of DNA molecules from different sources are modified, recombined, and then inserted into other cells.
b) The DNA that is formed either naturally or in the laboratory by joining segments of DNA from different sources.
c) It means cutting DNA molecules at specific nucleotides sequences (recognised by specific restriction enzymes). These sequences are known as *recognition sequences*.
d) They are: obtaining short DNA segments (thanks to restriction enzymes); obtaining multiple copies, or DNA cloning, or PCR; determining nucleotide sequences; locating specific DNA segments. The order in which these stages of the process are accomplished depends on the goals of a particular project.
e) Cloning is the production of a large number of uniform, identical segments of DNA. Such multiple copies are known as *clones* and this process as *cloning*.

9. VISUAL LEARNING



10. DISCUSSION

a) Creating plants better resistant to weeds, pest and other diseases; bigger yields to create more efficient use of land, less uses of herbicides and other pesticides; creating foods with better texture, flavor and nutritional value; creating foods with a longer shelf life for easier shipping.
b) There are unknown consequences to altering the nature of an organism through foreign gene expression, and so GMOs might create unpredicted allergies, toxins, antibiotic resistant diseases, and nutritional problems.
c) *Free answer*.

11. VIDEO

Video D1
Transcript
CRISPR is a technology developed in 2012 which can modify the genome of an organism. The name CRISPR is an acronym meaning, clustered regularly interspaced short palindromic repeats. CRISPR sequences exist in the DNA of many species of bacteria. They are always associated with so-called Cas genes which encode proteins and enzymes.
Parts of DNA located between repeated sequences, known as spacer DNA, are identical to viral DNA sequences. CRISPR is, in fact, a type of immune memory of infections suffered by a bacterium. Let's see how it works.
A bacteriophage approaches a bacterium and injects its DNA, shown in yellow. Several proteins that have been encoded by Cas genes intervene immediately, producing two cuts. The first cut creates a fragment of viral DNA. The second cut occurs on the bacterial genome at a specific point in the CRISPR region - between the so-called leader sequence and the first repeated sequence.
The fragment of viral DNA is then inserted in the bacterial genome.

Other enzymes copy the repeated sequence and bind it near the viral DNA; in this way, a new spacer DNA is created.
This new DNA segment gives the bacteria the capacity to defend itself against viruses that have a stretch of DNA identical to the spacer DNA.
Additional spacer DNA, shown on the right, is created in the same way: by capturing DNA fragments from other viruses and inserting them between two repeated sequences.
We will now see how bacteria defends itself in the event of a second infection.
A bacteriophage attaches to a bacteria and injects its DNA into the cell.
The RNA polymerases of the bacteria transcribe the entire CRISPR segment to form a strand of RNA. Other small RNA molecules bind to this strand by using a part that is complementary to the repeated sequences.
Enzymes now intervene and cut the RNA strand into shorter segments called crRNA. Each crRNA therefore contains a sequence that is complementary to a spacer DNA, and consequently, to the viral DNA.
The crRNA acts together along with the enzyme Cas 9. When the crRNA-Cas 9 complex encounters the viral genome, it recognizes the complementary sequence in the viral DNA and cuts it into smaller pieces. These fragments are then digested and destroyed by the bacterial cell.
This bacterial defense system can be used in the laboratory to quickly modify DNA. When researchers want to modify a given sequence of DNA, they artificially synthesize a complementary RNA to which Cas proteins are added. The RNA/Cas complex is able to cut the genome at a desired point. This complex can also work in eukaryotic cells, as in the example we see here.
The artificial RNA guides the Cas enzyme to the part of the genome that is to be modified. The double helix is cut and a new fragment is inserted. In this way it is possible to repair a faulty gene that is lacking a stretch of DNA. It is also possible to insert a gene, as well as activate or deactivate it.
CRISPR has been successfully used to modify single genes in many types of organisms, including fruit flies, mice, plants and even human cells. It has potential applications in many areas, including the treatment of genetic diseases.

Keys
a) F (*All cells contain a copy of our genome*); b) T; c) T; d) T; e) F (*CRISPR is based on the system that bacteria use to protect themselves from viruses*). f) F (*The first component of this method is an enzyme called Cas9*). g) T; h) F (*Researchers have realized that any DNA sequences in any living cells can be cut this way*). i) T. j) T. k) F (*These interventions can be done in stem cells*). l) F (*This method allows researchers to target many genes at once*). m) T.

12. REVISION
Free answer

FINAL TEST
1.D; 2. B; 3. A; 4. D; 5. E; 6. C; 7. A; 8. C; 9. A; 10. C.
11. A restriction enzyme is an enzyme which cleaves the DNA at specific nucleotide sequences called *recognition sequences*.
12. A vector is a self-replicant DNA molecule into which a DNA segment can be spliced and introduced into a cell; generally a *plasmid* or a *virus*.
13. A plasmid is a small *DNA* molecule within a cell that is physically *separated* from a chromosomal DNA and can replicate independently.
14. CRISPR stands for *Clustered* Regularly Interspersed Short *Palindromic* Repeats.