Marking Key

Question	Answer	Explanation
1	A	Cell replacement therapy is used for heart/diabetes/Parkinson's disease and raises major ethical concerns over embryonic cells.
2	C	Gene replacement therapy replaces a non-functional gene with a functional one, meaning functional proteins are produced.
3	B	Major ethical concerns are raised when cell replacement therapy uses embryonic cells.
4	D	Isolate human gene, then isolate the bacterial gene, insert DNA into a bacterial plasmid and seal with ligase, bacteria replicate, generating gene products.
5	D	The PCR involves three phases – denaturation, annealing, synthesis/elongation.
6	B	Electrophoresis uses a semi-solid agarose gel and an electrical current to separate DNA strands based on size.
7	A	DNA is found in the nucleus, mitochondria and chloroplasts.
8	D	Transgenic organisms contain recombinant DNA.

Question 9.

9a) Denaturation; Hybridization/Annealing; Synthesis/Elongation. (1)

9b) To amplify a specific section of DNA. (1)

9c) Each time the PCR takes place the number of DNA fragments **double**. (1)

9d)

- A primer is a base sequence complementary to the start of a DNA sequence. (1)
- Without a primer, DNA polymerase would not be able to begin synthesis/elongation. (1)
- Primers are introduced in the annealing/hybridisation/second phase of the PCR. (1)

9e)

- Taq polymerase, also known as DNA polymerase, is obtained from *Thermus aquaticus*, a heat-resistant bacteria that is able to handle the high temperatures of the synthesis/elongation phase. (1)
- Taq polymerase functions to synthesise new nucleotides that are complementary to the template strand of the DNA. (1)

Question 10.

10a)

Any two marks:

- Paternity cases. (1)
- Forensics. (1)
- To detect genetic disease. (1)

10b) Agarose gel. (1)

10c)

- DNA is negatively charged/DNA has negatively charged phosphate groups in the DNA backbone. (1)
- DNA is attracted to the positive electrode, separating DNA segments based on size as the DNA moves. (1)

10d)

- Restriction enzymes are used to cut DNA at a specific location. (1)
- Restriction enzymes produce straight cuts of DNA with blunt ends or staggered cuts with sticky ends. (1)

10e)

Any five marks:

- Restriction enzymes cut a specific DNA sequence/gene of interest at a specific region, producing sticky ends. (1)
- This DNA region is inserted into a vector, a DNA section that can replicate/duplicate by itself. (1)
- A vector is commonly a bacterial plasmid/a circular, double-stranded, cytoplasmic DNA segment. (1)
- The sticky ends of DNA are complementary to the bases in the plasmid. (1)
- The sticky ends of DNA and the complementary plasmid sequence are joined via ligase. (1)
- The bacteria then replicate. (1)
- Replication of bacteria forms large amounts of the gene/protein produced by the gene. (1)

Question 11.

11a)

Any ten marks:

- Synthetic thyroxine is the hormone used to treat hypothyroidism/when people have low thyroxine blood levels. (1)
- Synthetic thyroxine will help increase metabolic rate/alleviate symptoms of condition. (1)
- Many diseases and hormonal deficiencies are treated via the use of synthetic vaccines and hormones. (1)
- This means the vaccines and hormones are made in a lab via the alteration of bacteria. (1)
- Identify the gene that codes for thyroxine. (1)
- Isolate the thyroxine gene with restriction enzymes. (1)
- Insert this gene into a bacterial plasmid/self-replicating DNA sequence in bacteria. (1)
- Use ligase to seal the gene into the plasmid. (1)
- The plasmid in the bacteria will replicate. (1)
- When the bacteria replicate, the thyroxine gene is copied. (1)
- Upon replication, the hormone/thyroxine/gene product is generated. (1)
- The gene product can then be isolated and turned into a bioavailable form. (1)

11b)

Any one mark:

- DNA profiles are generated using gel electrophoresis. (1)
- Can help identify known suspects as criminals if the DNA profiles are the same. (1)
- Can help identify paternity. (1)

11c)

Any three marks:

- DNA profiles are generated using gel electrophoresis. (1)
- Similar bands indicate that the DNA is shared/an exact match. (1)
- Compare and contrast DNA profiles from two or more individuals for similar bands. (1)

11d)

Any six marks, with two marks per phase:

- Denaturation/first stage heats DNA to 96°C. (1)
- DNA separates into two complementary strands. (1)
- Primers are added in the annealing/hybridisation/second stage. (1)
- Primers are complementary base sequences that initiate replication. (1)
- Cooling to 70°C causes primers to bind to a single strand of DNA. (1)
- Synthesis/third phase/elongation phase is when DNA polymerase added (Taq polymerase can withstand high temperatures – taken from bacterium called *Thermus aquaticus*). (1)
- DNA heated to 78°C. (1)
- DNA polymerase binds free nucleotides together to make a new section of DNA. (1)
- The process is repeated until millions of copies of the target gene are produced. (1)
- DNA can then be sequenced to detect the mutation. (1)