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**Year 12 Human Biology**

**Unit 3: Science Inquiry – Evidence for Evolution and Biotechnology (10%)**

**Marking Key:**

**Review the following answers on the day prior to the validation to ensure students are all on the right track. NOTE: this is not being marked officially.**

Background info about mtDNA (2 marks)

|  |  |
| --- | --- |
|  | **Marks** |
| MtDNA has a higher rate of mutation than nuclear DNA  Or any other relevant reason for using mtDNA:   * mtDNA is a lot smaller than nuclear DNA. * There are many mitochondria in each cell so more mtDNA can be extracted. * It is easier to track as mtDNA is only inherited from the mother. * The same primers can be used between lots of different species when undergoing PCR. | 1 |
| The amount of mutations between individuals mtDNA is proportional to the closeness of their relationship through their maternal ancestors. | Any 1 |
| The less mutations between individuals mtDNA is indicative of a more recent common ancestor/closer relationship |

Aim: (1 mark)

|  |  |
| --- | --- |
|  | **Marks** |
| To compare the mitochondrial DNA (mtDNA) of humans with chimpanzees, gorillas, orangutans and gibbons in order to investigate the closest living biological relatives of humans. | 1 |

Must have all (straight from information given)

Hypothesis: (2 marks)

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|  | **Marks** |
| Humans will have more mtDNA base pairs/nucleotides in common with *chimpanzees* | 1 |
| as opposed to *gorillas, orangutans and gibbons* mtDNA. | 1 |

Or insert other species here.

**Variables:**

Independent: (1 mark)

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| --- | --- |
|  | **Marks** |
| Species - Humans, chimpanzees, gorillas, orangutans, gibbons | 1 |

Dependent: (1 mark)

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| --- | --- |
|  | **Marks** |
| Similarities in Mitochondrial DNA base pairs/nucleotides between humans and the other species | 1 |

Controlled: (3 marks)

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| --- | --- |
|  | **Marks** |
| Same sections of the mtDNA compared | Any 3 |
| Number of humans, chimpanzees, gorillas, orangutans and gibbons kept constant (sample size the same) |
| Same method of collecting the mtDNA ie. Blood sample |
| Same method of comparing the mtDNA samples ie. DNA sequencing |
| Must be specific, any other suitable controlled variable. |  |

Healthy participants and no conditions that may influences affect their DNA sequence

**Results**  (1 mark – completion)

**Figure 1: Mitochondrial Histidine transfer RNA (tRNA)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** |
| **1** Human | G | T | A | A | A | T | A | T | A | G | T | T | T | A | A |
| **2** Chimpanzee | G | T | A | A | A | T | A | T | A | G | T | T | T | A | A |
| **3** Gorilla | G | T | A | A | A | T | A | T | A | G | T | T | T | A | A |
| **4** Orangutan | G | T | A | A | A | T | A | T | A | G | T | T | T | A | A |
| **5** Gibbon | G | T | A | A | A | C | A | T | A | G | T | T | T | A | A |
|  | | | | | | | | | | | | | | | |
| **COMMON:** | G | T | A | A | A |  | A | T | A | G | T | T | T | A | A |

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|  | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** | **25** | **26** | **27** | **28** | **29** | **30** | **31** | **32** | **33** | **34** | **35** |
| **1** | C | C | A | A | A | A | C | A | T | C | A | G | A | T | T | G | T | G | A | A |
| **2** | C | C | A | A | A | A | C | A | T | C | A | G | A | T | T | G | T | G | A | A |
| **3** | C | C | A | A | A | A | C | A | T | C | A | G | A | T | T | G | T | G | A | A |
| **4** | C | C | A | A | A | A | C | A | T | T | A | G | A | T | T | G | T | G | A | A |
| **5** | T | C | A | A | A | A | C | A | T | T | A | G | A | T | T | G | T | G | A | A |
|  | | | | | | | | | | | | | | | | | | | | |
| **C** |  | C | A | A | A | A | C | A | T |  | A | G | A | T | T | G | T | G | A | A |

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|  | **36** | **37** | **38** | **39** | **40** | **41** | **42** | **43** | **44** | **45** | **46** | **47** | **48** | **49** | **50** | **51** | **52** | **53** | **54** | **55** |
| **1** | T | C | T | G | A | C | A | A | C | A | G | A | G | G | C | T | T | A | C | G |
| **2** | T | C | T | G | A | C | A | A | C | A | G | A | G | G | C | T | C | A | C | G |
| **3** | T | C | T | G | A | T | A | A | C | A | G | A | G | G | C | T | C | A | C | A |
| **4** | T | C | T | A | A | T | A | A | T | A | G | G | G | C | C | C | C | A | C | A |
| **5** | T | C | T | A | A | C | A | A | T | A | G | A | G | G | C | T | C | G | A | A |
|  | | | | | | | | | | | | | | | | | | | | |
| **C** | T | C | T |  | A |  | A | A |  | A | G |  | G |  | C |  |  |  |  |  |

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|  | **56** | **57** | **58** | **59** | **60** | **61** | **62** | **63** | **64** | **65** | **66** | **67** | **68** | **69** |
| **1** | A | C | C | C | C | T | T | A | T | T | T | A | C | C |
| **2** | A | C | C | C | C | T | T | A | T | T | T | A | C | C |
| **3** | A | C | C | C | C | T | T | A | T | T | T | A | C | C |
| **4** | A | C | C | C | C | T | T | A | T | T | T | A | C | C |
| **5** | A | C | C | T | C | T | T | G | C | T | T | A | C | C |
|  | | | | | | | | | | | | | | |
| **C** | A | C | C |  | C | T | T |  |  | T | T | A | C | C |

**Figure 1:** Alignment for mitochondrial histidine tRNA in five hominoid species sequences by Brown et al. (1982). Mitochondrial histidine is a small 69 nucleotide transfer RNA that transfers the amino acid histidine to a growing polypeptide at the ribosomal site of protein synthesis during translation.

(1 mark – completion)

**Figure 2: Summary**

|  |  |  |
| --- | --- | --- |
| Species | Number positions of Mitochondrial Histidine transfer RNA differences when compared to humans. | Total number of Mitochondrial Histidine transfer RNA differences when compared to humans. |
| 1 Human | - | - |
| 2 Chimpanzee | 52 | 1 |
| 3 Gorilla | 41, 52, 55 | 3 |
| 4 Orangutan | 25, 39, 41, 44, 47, 49, 51, 52, 55 | 9 |
| 5 Gibbon | 6, 16, 25, 39, 44, 52, 53, 54, 55, 59, 63, 64 | 12 |

**Figure 2:** Summary of nucleotide position differences in mitochondrial histidine tRNA for chimpanzees, gorillas, orangutans and gibbons, when compared to humans.

**Graph** (4 marks)

|  |  |
| --- | --- |
|  | **Marks** |
| Plotting – bar graph (totals plotted) | 1 |
| Labels – species (x axis) and number of Mitochondrial Histidine transfer RNA differences when compared to humans (y axis) | 1 |
| Units – species names (not including humans here, if included this is also fine but the bars at 0 for this) | 1 |
| Scale – appropriate scale for the y axis and even spaces etc on both axis including between bars. | 1 |

**Note:** no mark for title as this is given but should say “Total number of Mitochondrial Histidine transfer RNA differences when compared to humans”

**Phylogenetic tree** (2 marks)

|  |  |
| --- | --- |
|  | **Marks** |
| Species are correctly displayed on tree/correct order | 1 |
| A correct representation of a phylogenetic tree | 1 |

**Evaluation/interpretation of results** (2 marks)

|  |  |
| --- | --- |
|  | **Marks** |
| Humans are most closely related, share a more **recent** **common ancestor** to chimpanzees with **one** (1) difference in this section of mtDNA | 1 |
| Humans are most distantly related, share a more **distant** **common ancestor** to gibbons with **twelve** (12) differences in this section of mtDNA | 1 |