Altering the Code of DNA leads to Different Traits

Below you will find the DNA code that is transcribed and translated into hemoglobin (the protein found in red blood cells that helps to carry oxygen around the body). One code is for normal hemoglobin (A) and the other is for sickle hemoglobin (S).

Assume the 3'AAA 5' triplets are introns (non-coding segments) within the DNA. This is a very simplistic view of the actual hemoglobin protein. The polypeptide coded for here is only 5 amino acids long. The real hemoglobin molecule would be made of 4 polypeptides of greater length folded uniquely and combined together to make the functional protein.

Normal Hemoglobin (A):

3' AAA AAA TAC TGA AAA AAA GGA CTC AAA AAA CTC ATT 5'
5' TTT TTT ATG ACT TTT TTT CCT GAG TTT TTT GAG TAA 3'

Sickle Hemoglobin (S):

3' AAA AAA TAC TGA AAA AAA GGA CAC AAA AAA CTC ATT 5'
5' TTT TTT ATG ACT TTT TTT CCT GTG TTT TTT GAG TAA 3'

Act 1 – DNA replication and mutation

Scene 1 – Normal Hemoglobin DNA in the nucleus (show 5' and 3' ends)
– Helicase starts to unwind DNA and ssbp's keep apart the two strands
– Primase adds RNA primer to leading and lagging strands
Scene 2 – DNA polymerase adds nucleotides to the leading strand continuously and the lagging strand in chunks (Okazaki fragments) (show 5' and 3' ends)
– DNA mutation occurs … show the specific point mutation
Scene 3 – DNA polymerase replaces RNA primer with DNA nucleotides and ligase glues Okazaki fragments
Scene 4 – Two DNA molecules (both double stranded and one with a mutation) separate to opposite sides of the cell … a new allele has just been created … one cell is a normal red blood cell, one cell is a sickle cell

Summary of Act 1 (explain in 50 words or less)

Act 2 – Transcription and RNA processing

Scene 1 - Normal Hemoglobin DNA in the nucleus is transcribed into RNA (5' to 3') by RNA polymerase (moving in a 3' to 5' direction)
Scene 2 - RNA processing: 5' cap and 3' poly A tail are added; Introns are cut out and Exons are glued together
Scene 3 - mRNA leaves the nucleus (show bases)
Scene 4 - How would the mRNA product be different for Sickle Hemoglobin?

Summary of Act 2 (explain in 50 words or less)

Act 3 – Translation

Scene 1 - Normal Hemoglobin mRNA (show bases) attaches to small unit of ribosome
- tRNA (anticodon … show bases) binds and brings in Met
Scene 2 - Large subunit of ribosome binds to complete the initiation complex
- Ribosome reads codons one at a time and tRNA brings in amino acids to the A site
Scene 3 - Termination codon is reached and the release factor frees the polypeptide from the ribosome
- Ribosome and components dissociate
Scene 4 - Polypeptide created is a trait
Scene 5 – How would the polypeptide and trait be different for Sickle Hemoglobin?

Summary of Act 3 (explain in 50 words or less)