Introduction

Polymerase Chain Reaction (PCR) is one of the most powerful and widely used techniques in molecular biology. Developed in 1983 by Dr. Kary Mullis, PCR allows scientists to amplify and replicate speci c segments of DNA with remarkable precision and speed. is method has had a profound impact on elds ranging from genetics and diagnostics to forensics and medicine [1], enabling breakthroughs such as the identi cation of genetic diseases, DNA ngerprinting, and even the analysis of ancient biological samples. By rapidly creating millions of copies of a particular DNA sequence, PCR has revolutionized our ability to study and manipulate genetic material.

e Basics of PCR

PCR is a laboratory technique used to create multiple copies of a speci c DNA region. e process mimics natural DNA replication [2] but is carried out in a controlled environment outside of living cells. e basic components required for PCR include:

DNA template: e sample containing the DNA sequence to be ampli ed.

Primers: Short single-stranded DNA sequences that are complementary to the regions anking the target DNA sequence. Primers are necessary to initiate the ampli cation process.

DNA polymerase: An enzyme that synthesizes new strands of DNA by adding nucleotides to the growing DNA chain. e enzyme used in PCR is typically Taq polymerase [3], derived from the thermophilic bacterium

environmental DNA (eDNA) for biodiversity studies, and monitor the health of ecosystems by detecting microbial DNA from soil or water samples.

Advantages and Limitations of PCR

PCR o ers numerous advantages, but it is not without its limitations.

Advantages

Sensitivity: PCR can amplify DNA from minute quantities of material, making it highly sensitive.

Speed PCR can generate large amounts of DNA in a short time, usually within a few hours.

Speci city: e use of primers allows for the ampli cation of speci c DNA sequences, minimizing the chance of non-speci c ampli cation [9].

Versatility: PCR can be applied to a wide range of DNA sources, including ancient, degraded, or contaminated samples.

Limitations

Contamination risk: Because PCR ampli es DNA from very small amounts of starting material, contamination from external sources can lead to false results. Strict protocols are required to avoid contamination.

Error rate: While Taq poly.1 (u0 AA.2.1 (t i)1e)192a(g m),ue g mks-6 (ic)-7 (t p)-lows9 (io)12 (n f)72 Tw T*cta