

# Polymerase Chain Reaction (PCR)

Steven Salzberg

How do we make copies of DNA?



DNA seq → DNA -

for many copies.

Recall that DNA sticks to itself (“hybridizes”)



Primers

start seq of DNA base  
they stick to DNA.  
① primer

5' -CTATTCATTCAATCATACACCCAA

3' -GATAAGTAGTTAGTATGTGGGTTCTATCTATCTATCTATCTATCTATCTATCTATCTATCTAAGAACACCACCCAGAC-5'

5' -CTATTCATTCAATCATACACCCAA**GATAGATAGATAGATAGATAGATA**GATTCTTGTTGGTGGGTCTG-3'

CTAAGAACACCACCCAGAC-5'

② pri

reverse  
complimer.

Here we have 2 primers, one in green, one in blue

Melt (heat up gently)

DNA melts and falls apart

5' -CTATTCATTCAATCATACACCCAA }

3' -GATAAGTAAGTTAGTATGTGGGTTCTATCTATCTATCTATCTATCTATCTATCTATCTATCTAAGAACACCACCCAGAC-5'

5' -CTATTCATTCAATCATACACCCAA GATAGATAGATAGATAGATAGATA GATTCTTGTTGGTGGGTCTG-3'  
S  
3' CTAAGAACACCACCCAGAC-5'

Anneal (cool down gently)

*3' stick primer to DNA by cooling*

5'-CTATTCAATTCAATCATACACCCAA  
3'-GATAAGTAGTTAGTATGTGGTTCTATCTATCTATCTATCTATCTATCTATCTATCTAAGAACACCCAGAC-5'

5'-CTATTCATTCAATCATACACCCAA**GATAGATAGATAGATAGATAGATAGATAGATTCTTGTGGTGGGCTG-3'**  
**CTAAGAACACCACCCAGAC-5'**

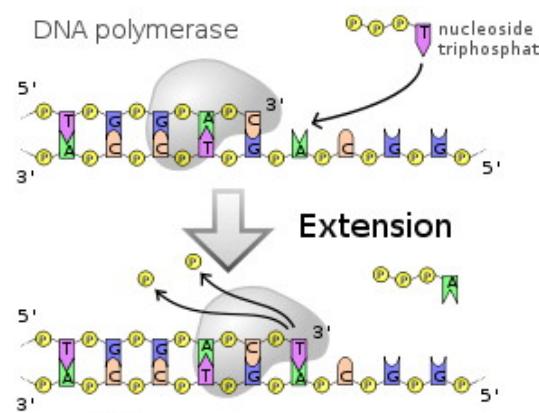
Add copier molecule: DNA polymerase (nature)

**5' -CTATTCAATTCAATCATACACCCAA**

3'-GATAAGTAAGTTAGTATGGGGTTC**TATCTATCTATCTATCTATCTATCTAAGAACACCCACCCAGAC**-5'

5' -CTATTCATTCAATCATAACACCAA**GATAGATAGATAGATAGATAGATAGATAGATTCTTGTTGGTGGGTCTG**-3'

**CTAAGAAACACCCAGAC-5'**



looks for single and double strand  
fills in where is missing

Result after round one:

*after cooling down.*

5' -CTATTCAATCATAACCCAA**GATAGATAGATAGATAGATAGATA**GATTCTTGTGGTGGGTCTG-3'  
3' -GATAAGTTAGTATGTGGGT**CTATCTATCTATCTATCTATCTATCTAT**CTAAGAACACCACCCAGAC-5'

5' -CTATTCAATCATAACCCAA**GATAGATAGATAGATAGATAGATA**GATTCTTGTGGTGGGTCTG-3'  
3' -GATAAGTTAGTATGTGGGT**CTATCTATCTATCTATCTATCTAT**CTAAGAACACCACCCAGAC-5'

Result after round two:

*each strand looks re-copying*

5'-CTATTCAATTACATACACCCAA**GATAGATAGATAGATAGATAGATA**GATTCTTGTGGTGGGTCTG-3'  
3'-GATAAGTAGTTAGTATGTGGGTCTATCTATCTATCTATCTATCTAT**CTAAGAACACCACCCAGAC**-5'

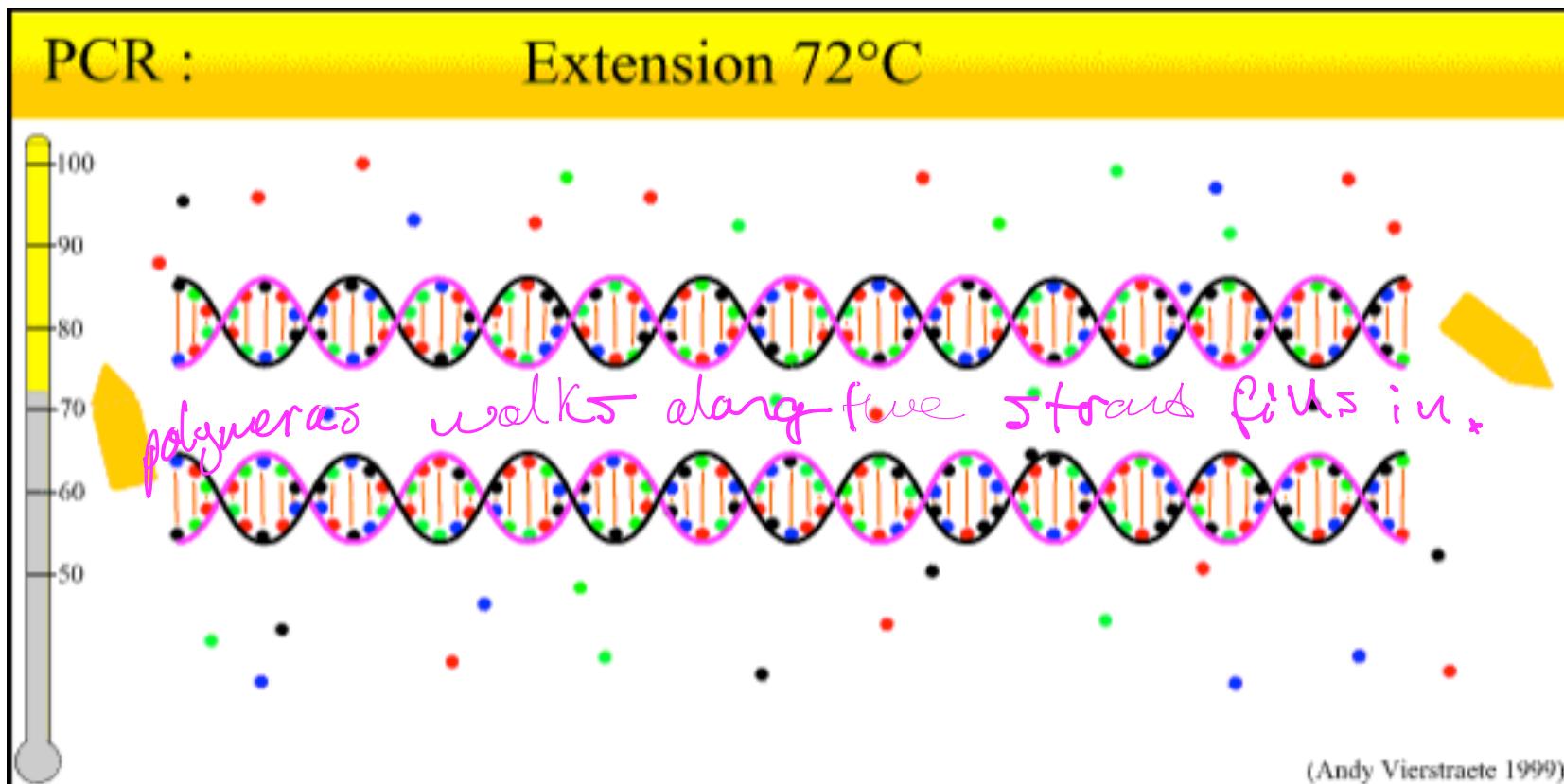
5'-CTATTCAATTACATACACCCAA**GATAGATAGATAGATAGATAGATA**GATTCTTGTGGTGGGTCTG-3'  
3'-GATAAGTAGTTAGTATGTGGGTCTATCTATCTATCTATCTAT**CTAAGAACACCACCCAGAC**-5'

5'-CTATTCAATTACATACACCCAA**GATAGATAGATAGATAGATAGATA**GATTCTTGTGGTGGGTCTG-3'  
3'-GATAAGTAGTTAGTATGTGGGTCTATCTATCTATCTAT**CTAAGAACACCACCCAGAC**-5'

5'-CTATTCAATTACATACACCCAA**GATAGATAGATAGATAGATAGATA**GATTCTTGTGGTGGGTCTG-3'  
3'-GATAAGTAGTTAGTATGTGGGTCTATCTATCTAT**CTAAGAACACCACCCAGAC**-5'

Repeat for 30 cycles or more...

Denature DNA



## Summary: the PCR recipe

### Ingredients

- DNA
  - primers
  - DNA polymerase
  - A's, C's, G's, T's
- + a lot of flour.*

## Summary: the PCR recipe

1. Melt at 94o C
2. Cool to 54o C
3. Warm to 72o C
4. Go to step 1



## The Nobel Prize in Chemistry 1993

Kary B. Mullis, Michael Smith

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# Nobel Lecture

Nobel Lecture, December 8, 1993

## The Polymerase Chain Reaction

In 1944 [Erwin Schrödinger](#), stimulated intellectually by [Max Delbrück](#), published a little book called *What is Life?* It was an inspiration to the first of the molecular biologists, and has been, along with Delbrück himself, credited for directing the research during the next decade that solved the mystery of how "like begat like."

Max was awarded this Prize in 1969, and rejoicing in it, he also lamented that the work for which he was honored before all the peoples of the world was not something which he felt he could share with more than a handful.

[Samuel Beckett's](#) contributions in literature, being honored at the same time, seemed to Max somehow universally accessible to anyone. But not his. In his