How **Knot Theory** is important to **DNA Biology**

PRIMES Circle 2020

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About Me

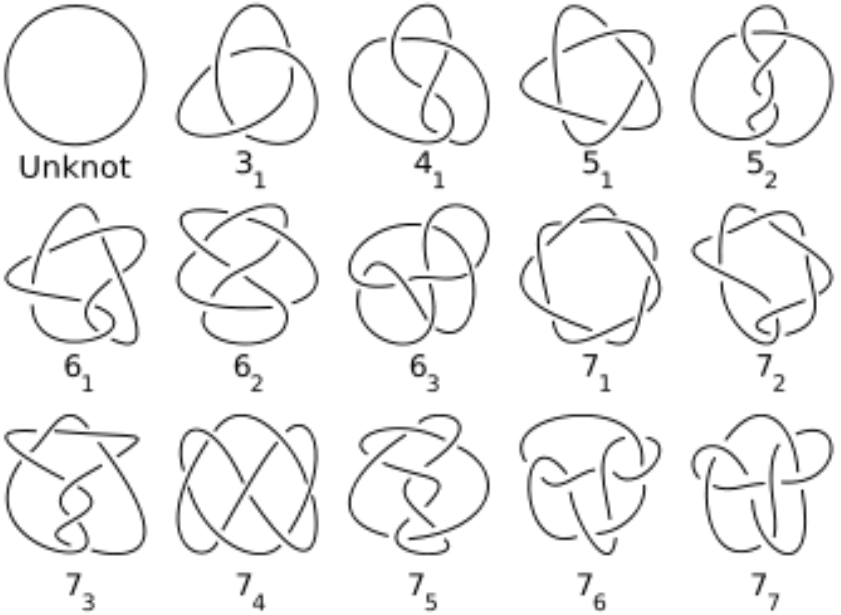
William Ayinon

I am a sophomore at Newton North High School

Interested in Computer Programming, Math, Biology and Chemistry

Knot Theory

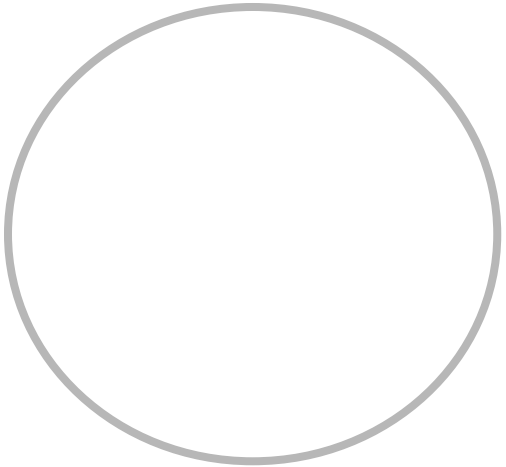
- The study of **mathematical knots**
- Theoretical string, ends glued together



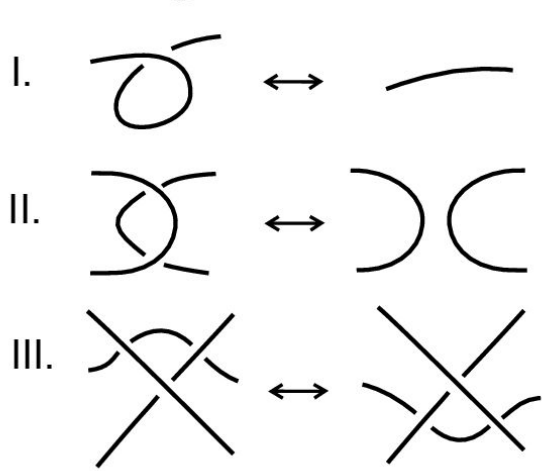
Knot Theory Terms

- **Unknot -** The simplest knot, it appears as a circle
- **Deformation -** A change to a knot that does not cut the string or pass it through itself somehow
- **Invariant -** A value that does not change when a knot is deformed

Reidemeister Moves

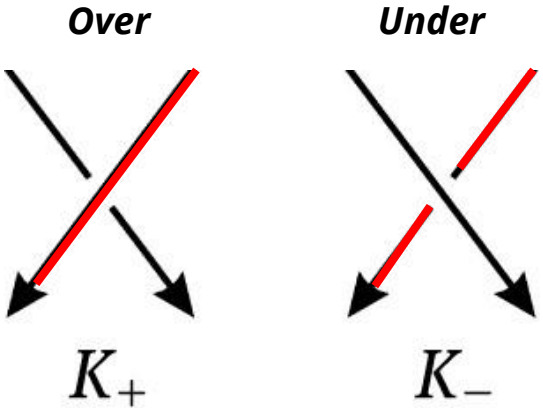


The **Unknot**

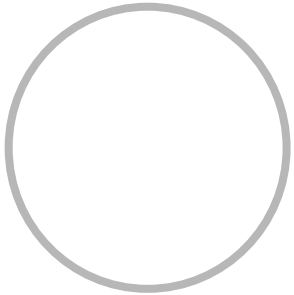


Reidemeister Moves

Crossings and Values



Writhe: 1
Unknotting Number: 0



Writhe: 0
Unknotting Number: 0

➔ **Writhe** - Total <u>over</u> crossings minus the total <u>under</u> crossings

➔ **Unknotting number** - Number of crossings that need to be reversed in order to form the unknot. *Invariant*

DNA Biology Terms

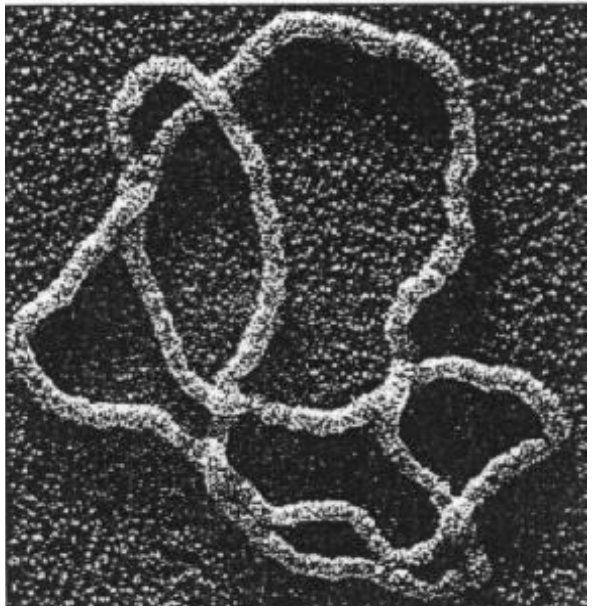
- **DNA -** Deoxyribonucleic acid, a molecule responsible for every biological function within an organism

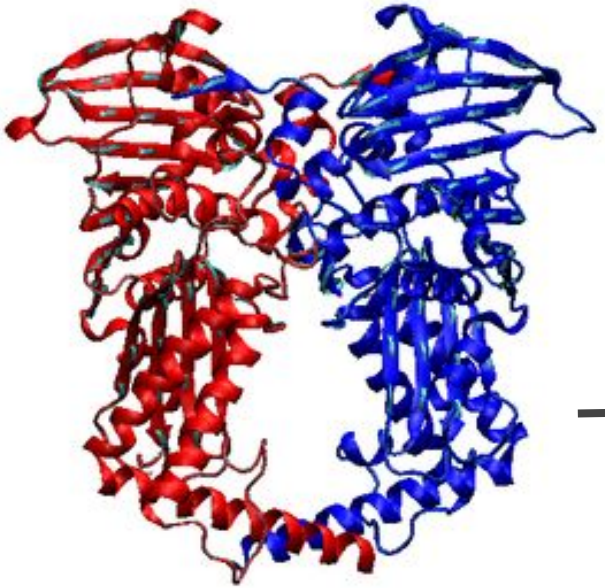
- **Supercoiling -** When DNA is coiled so tightly that it compresses itself like a telephone cord

- **Enzyme -** Proteins created by living organisms that bring about specific chemical reactions or chemical changes

DNA in a cell

Supercoiled DNA in a cell





Topoisomerase Enzyme

Knot Theory Applications

- Invariants / Knot Values
- DNA Knot Complexity
- How can we study the enzymes' work?

Cozzarelli and Brown

E. Coli Studies

- Gyrase enzyme
- Rate of work by Gyrase

Benefits

Helps understand how to better manipulate DNA

Developing field

Studying how enzymes replicate DNA

- Cancer drugs try to prevent cell division

Thank you for the support!

- ★ My parents
- ★ Peter Haine, mentor and coordinator
- ★ Kenneth Cox, mentor
- ★ PRIMES Circle as a whole

Thank You

Sources

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