# Bioinformatics

## CS300

## Chap 2

## Computational Manipulation of DNA

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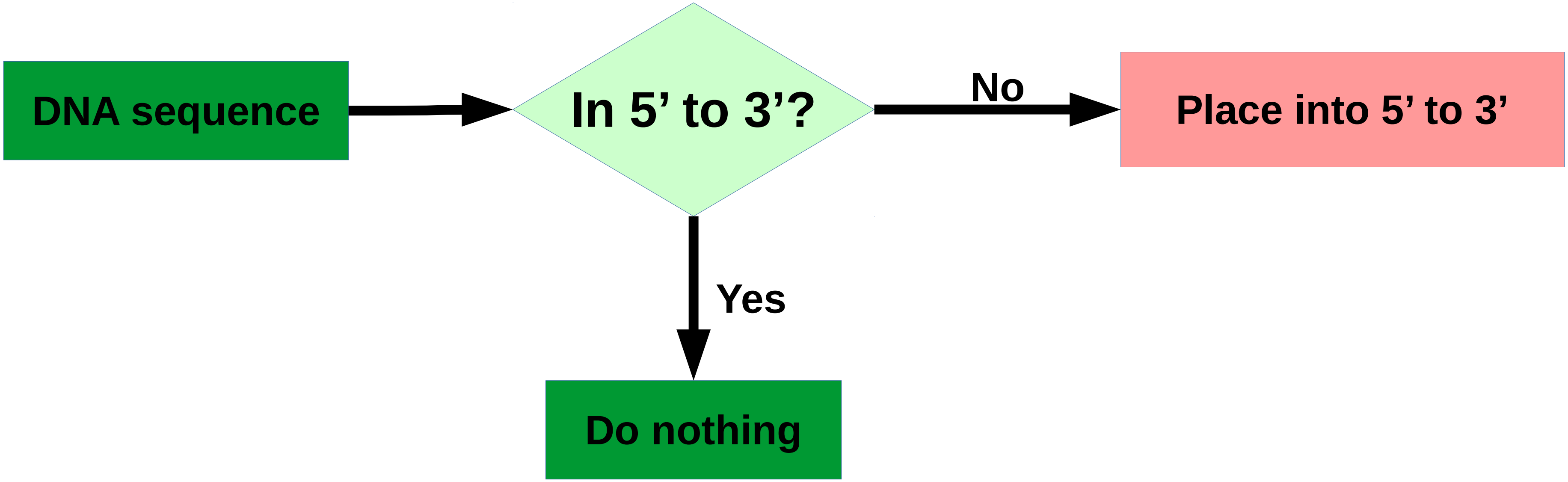
# The Unnamed Sequence

- Unlabeled strands of DNA are assumed to be in the 5’ to 3’, (left to right) direction.
- A new sequence is given to us for analysis.
- What are the steps to place this sequence into a format for use with bioinformatics tools?



DNA sequence

In 5’ to 3’?

No

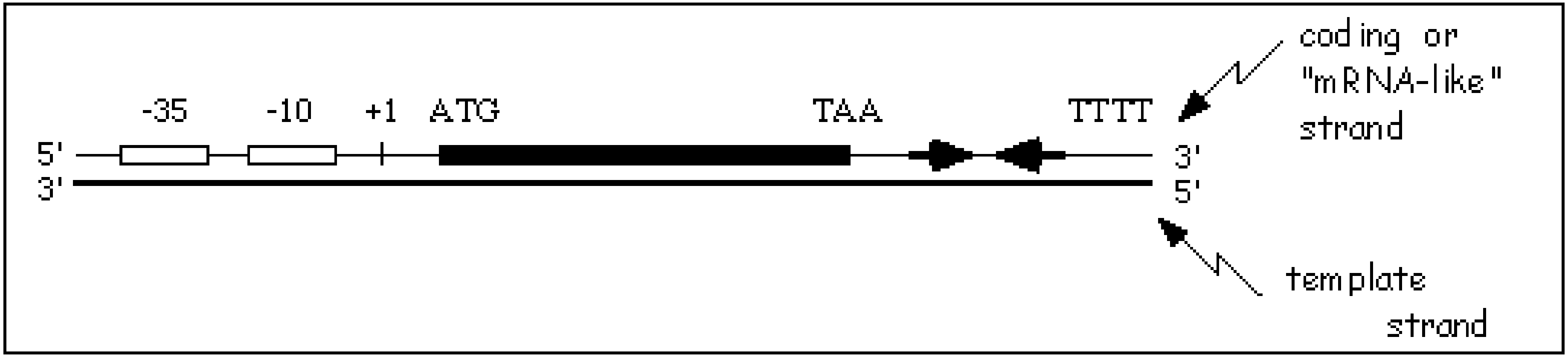
Place into 5’ to 3’

Yes

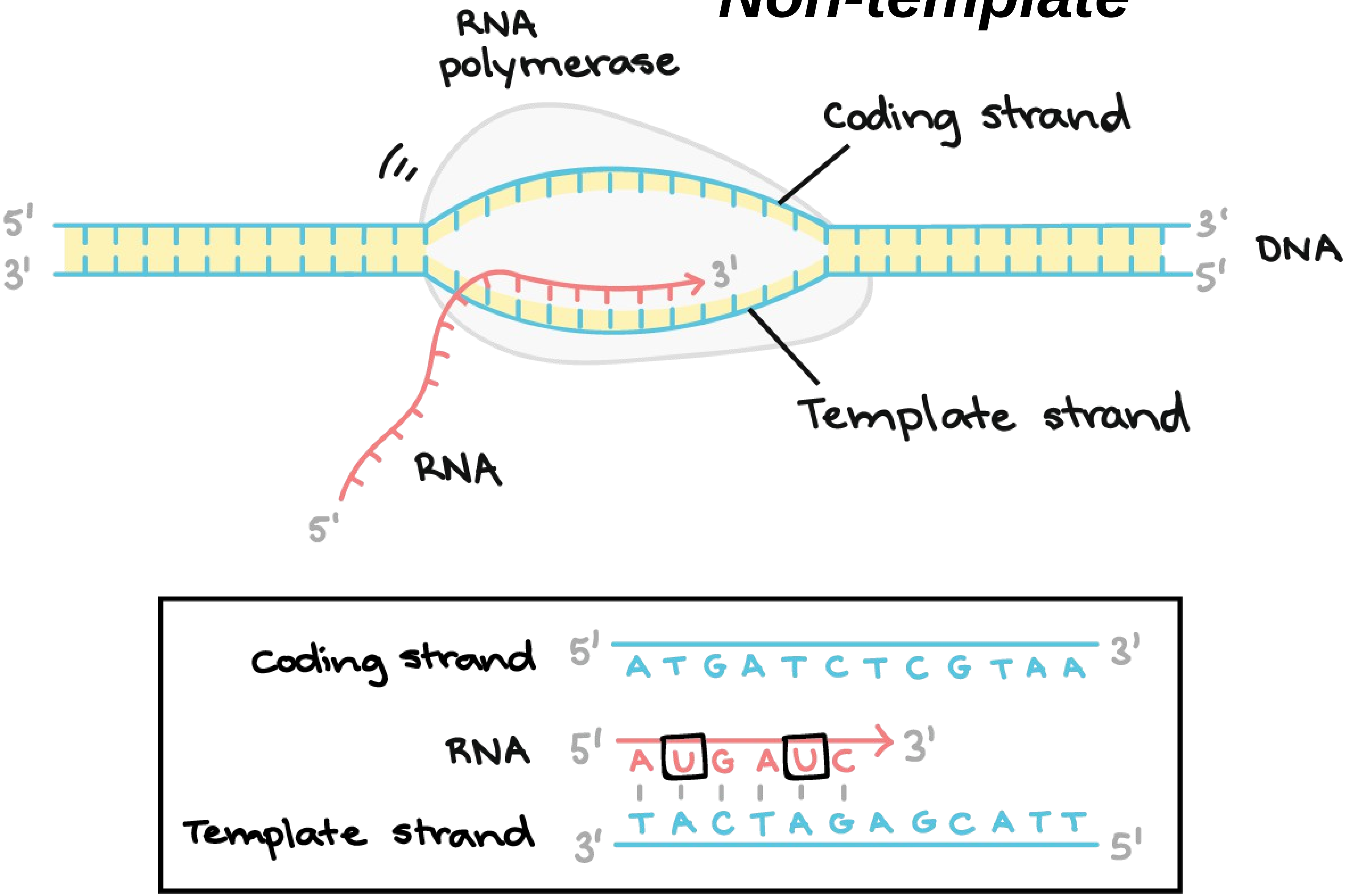
Do nothing

# Template vs nonTemplate

- Input:
  - DNA sequence: AGCAT
  - Strand: **template** (used to make mRNA) or **non-template** (the compliment of this strand that looks like mRNA)
  - Orientation: 3’ -> 5’ or 5’ -> 3’
- Output:
  - Template strand in 3’ -> 5’ orientation ready for transcription

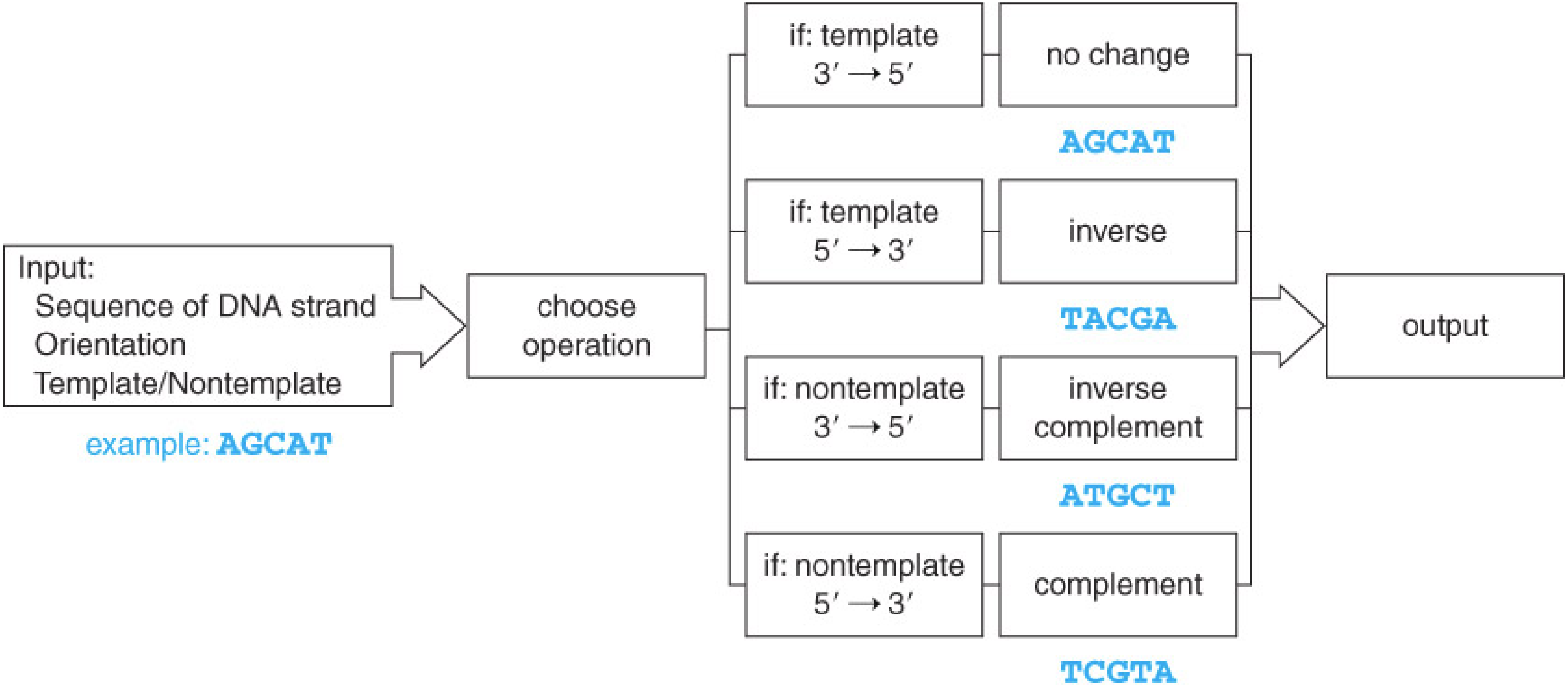


# ***Non-template***



# DNA Manipulation Algorithm

- A series of steps when handling DNA



**Output DNA in 3’ to 5’**

# The DNA Manipulation Algorithm

1. Input a DNA sequence, including details of being a template or non-template strand as well as its orientation
2. Convert to all uppercase
3. Choose the appropriate operation:
   1. If it is the **template** strand and oriented **3' -> 5'**, simply output the same sequence
   2. If it is the **template** strand and oriented **5' -> 3'**, **inverse** the sequence (traverse the string from right to left and add each character to output the string)
   3. If it is the **non-template** strand and oriented **3' -> 5'**, generate the **inverse complement** sequence ((i.) traverse the string from right to left and (ii) for each character, add the complement to the output string)
   4. If it is the **non-template** strand and oriented **5' -> 3'**, generate the **complement** ((i.) traverse the string from left to right and (ii) for each character add the complement to the output string)
4. Output the completed sequence, including 5' and 3' end labels

# Transcription Algorithm

- Input: **template** strand in the **3’ → 5’** orientation
- Output: mRNA strand in the 5’ → 3’ orientation
  - Traverse the string from left to right
    - add complementary base to the output string
    - (note T is now U)

# Alternative Transcription Algorithm

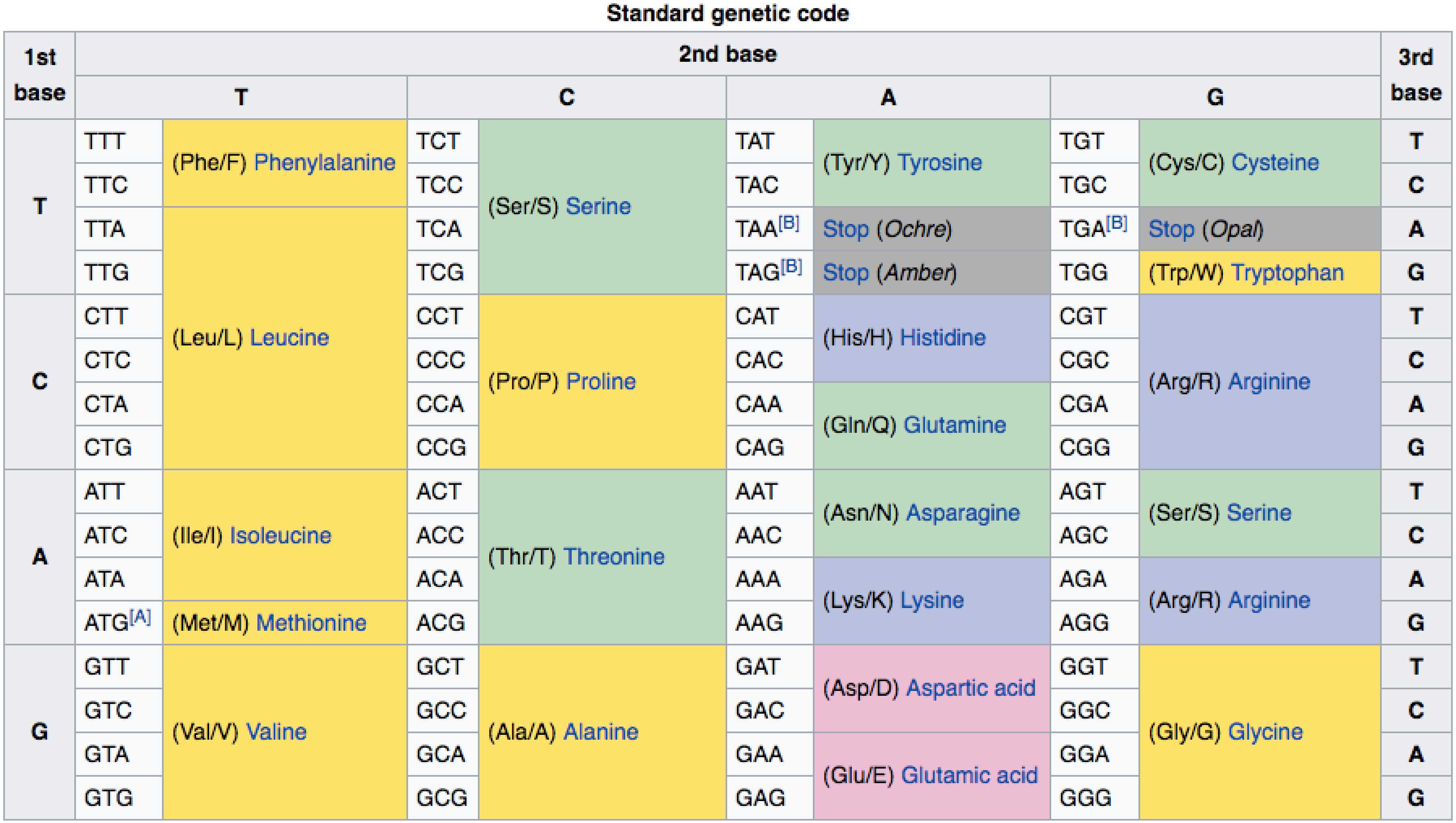
- Input: **non-template** strand in the **5’** → **3’** orientation
- Output: mRNA strand in the **5’** → **3’** orientation
  - Traverse the string from left to right
    - Replace all the T’s with U’s

# Translation Algorithm

- Input: mRNA strand in the **5’** → **3’** orientation
- Output: amino acid sequence
  - Traverse the string looking at one codon at a time
  - Add one amino acid corresponding to the protein sequence.

# Codon Table to Translate the Protein Product

- DNA triplets read in groups of three called codons and represent an amino acid



Standard genetic code

| 1st base | 2nd base | | | | | | | | 3rd base |
|---|---|---|---|---|---|---|---|---|---|
| | T | | C | | A | | G | | |
| T | TTT | (Phe/F) Phenylalanine | TCT | (Ser/S) Serine | TAT | (Tyr/Y) Tyrosine | TGT | (Cys/C) Cysteine | T |
| | TTC | | TCC | | TAC | | TGC | | C |
| | TTA | (Leu/L) Leucine | TCA | | TAA[B] | Stop (*Ochre*) | TGA[B] | Stop (*Opal*) | A |
| | TTG | | TCG | | TAG[B] | Stop (*Amber*) | TGG | (Trp/W) Tryptophan | G |
| C | CTT | | CCT | (Pro/P) Proline | CAT | (His/H) Histidine | CGT | (Arg/R) Arginine | T |
| | CTC | | CCC | | CAC | | CGC | | C |
| | CTA | | CCA | | CAA | (Gln/Q) Glutamine | CGA | | A |
| | CTG | | CCG | | CAG | | CGG | | G |
| A | ATT | (Ile/I) Isoleucine | ACT | (Thr/T) Threonine | AAT | (Asn/N) Asparagine | AGT | (Ser/S) Serine | T |
| | ATC | | ACC | | AAC | | AGC | | C |
| | ATA | | ACA | | AAA | (Lys/K) Lysine | AGA | (Arg/R) Arginine | A |
| | ATG[A] | (Met/M) Methionine | ACG | | AAG | | AGG | | G |
| G | GTT | (Val/V) Valine | GCT | (Ala/A) Alanine | GAT | (Asp/D) Aspartic acid | GGT | (Gly/G) Glycine | T |
| | GTC | | GCC | | GAC | | GGC | | C |
| | GTA | | GCA | | GAA | (Glu/E) Glutamic acid | GGA | | A |
| | GTG | | GCG | | GAG | | GGG | | G |

# Python Programming

- Biopython
- DNA Manipulation Algorithm
- Translation functions
  - DNA → RNA
  - RNA → DNA
  - RNA → Protein

Follow along in class and save your notes in a text file!!