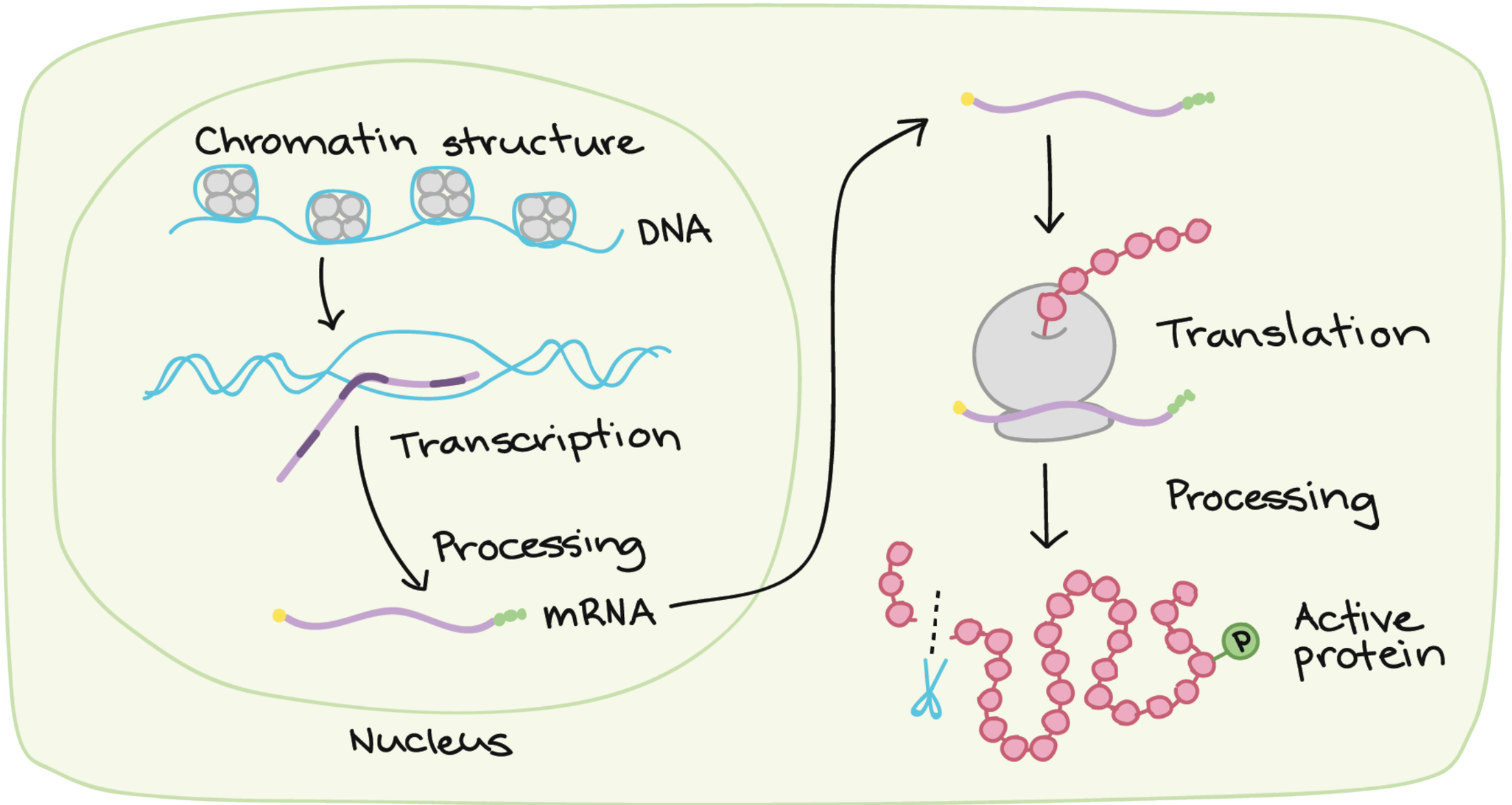
CSE 566 Spring 2023

Gene Expression Analysis

Instructor: Mingfu Shao

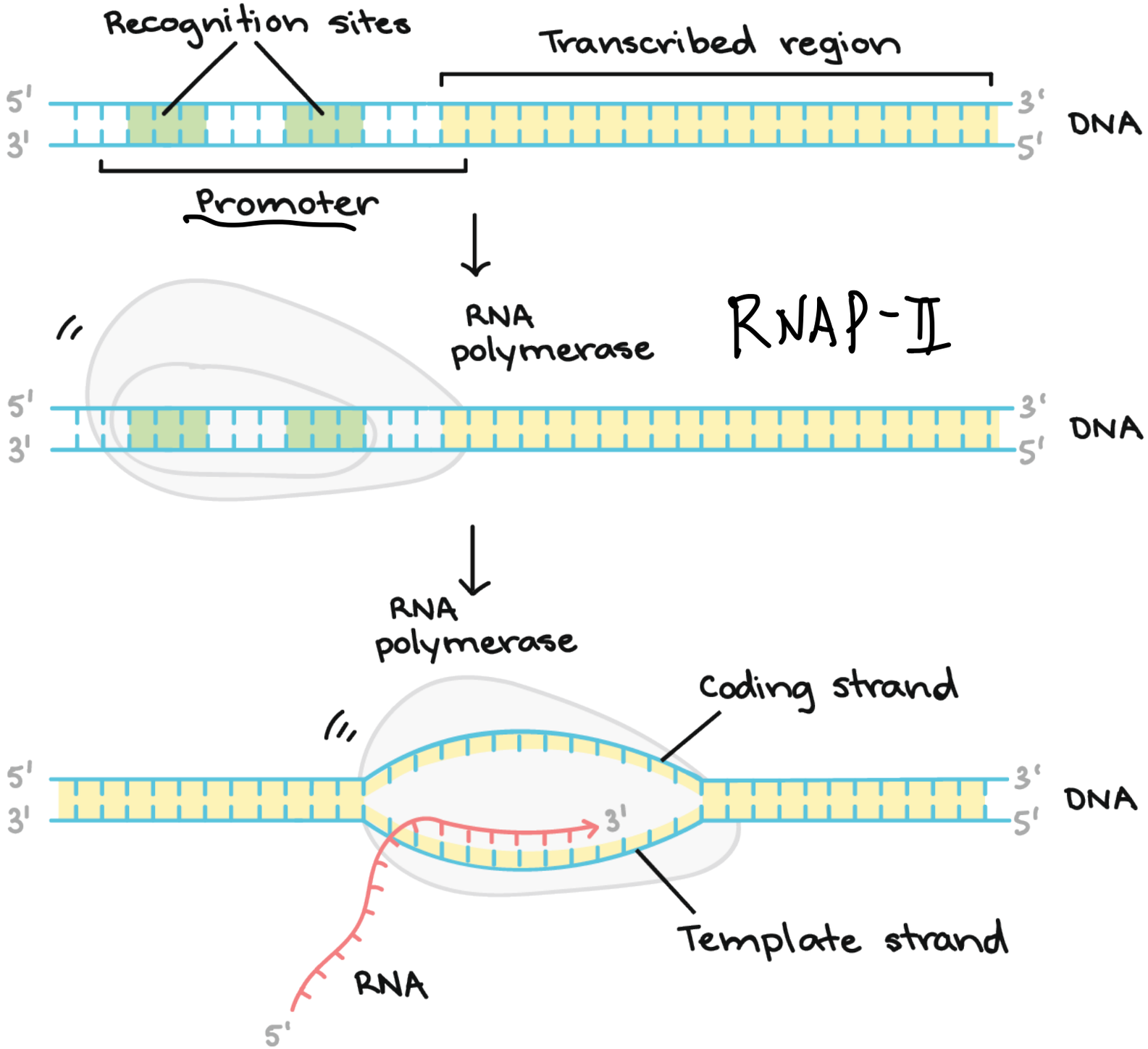
Gene Expression



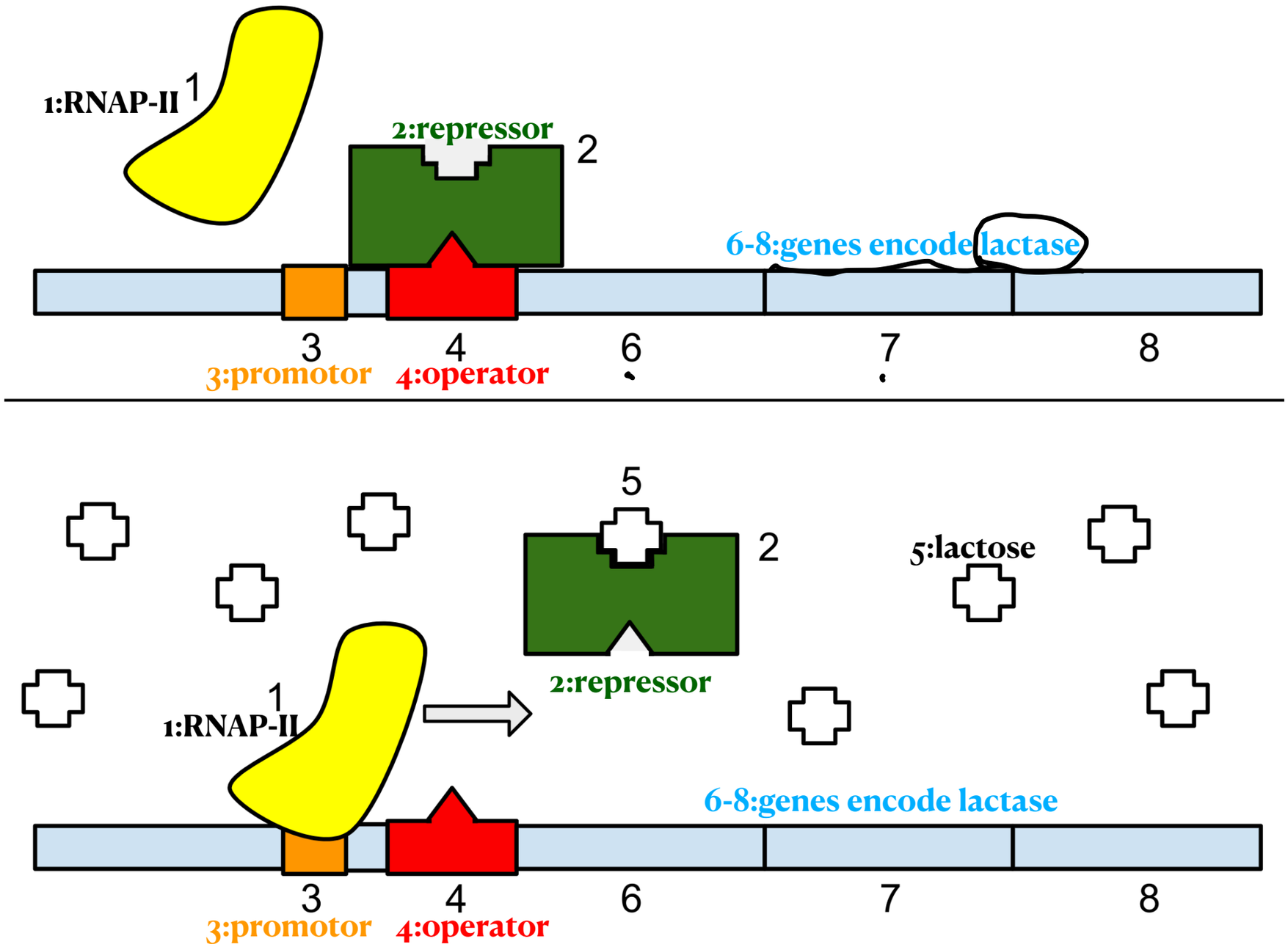
Regulation of Gene Expression

- **Gene regulation** is the process of controlling which genes in a cell's DNA are expressed.
- Gene expression is dynamic.
    - Cells are able to respond to environmental changes.
    - Expression varies with different stages of a cycle.
- Gene expression is tissue/cell-type-specific.
    - Each cell type has a different set of active genes.

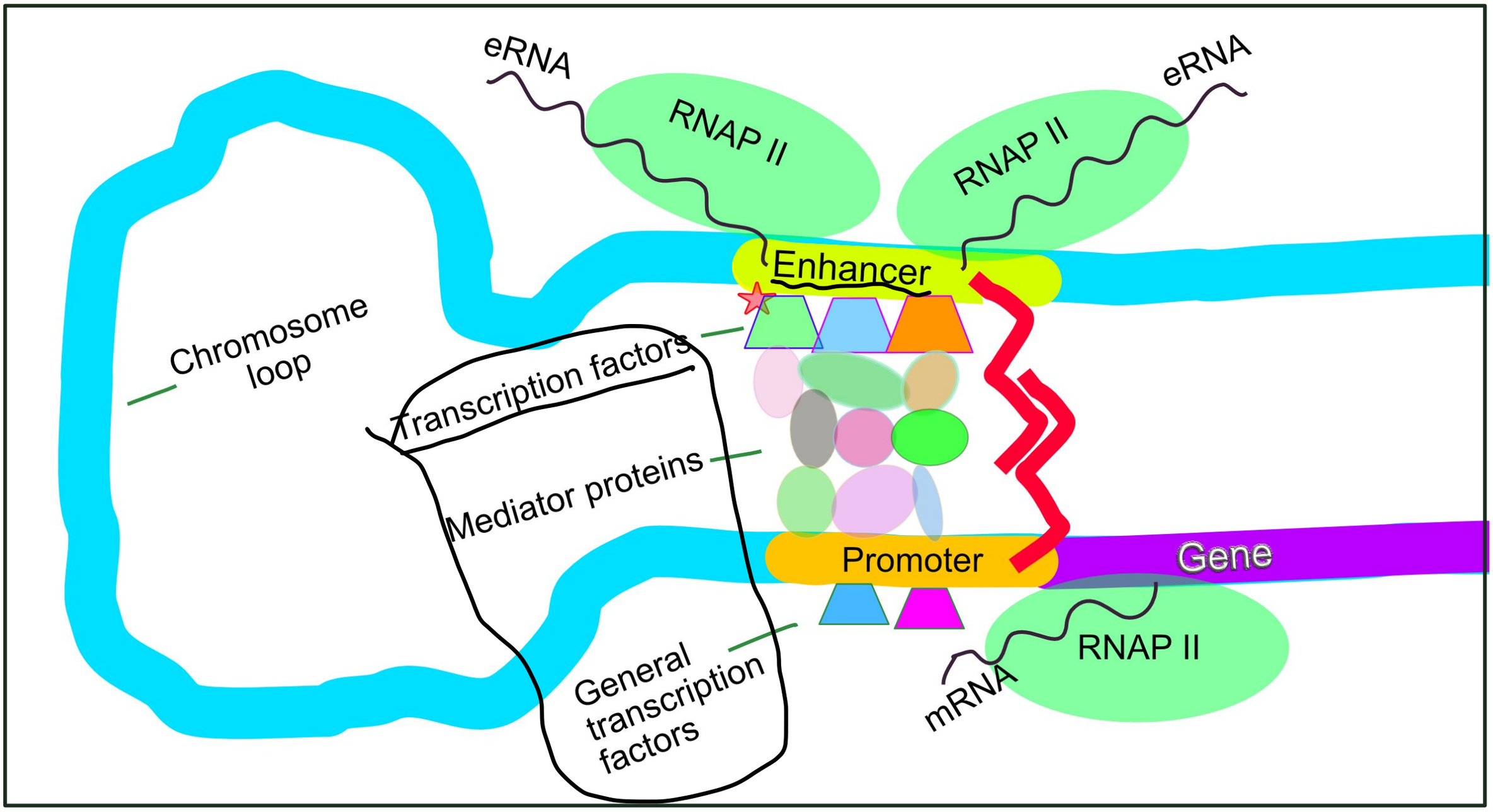
Transcription



Example of Gene Regulation

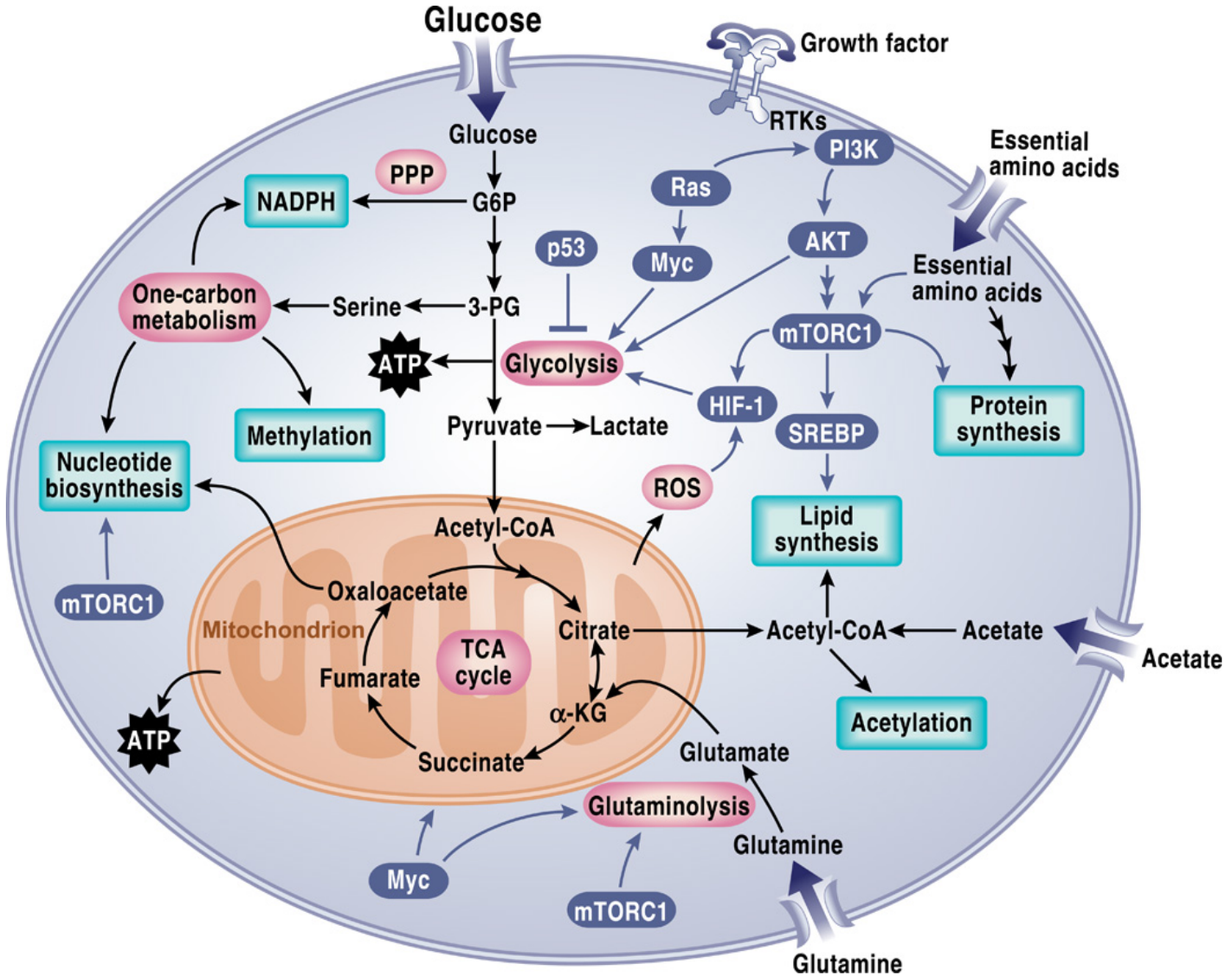


Gene Regulation of Eukaryotes



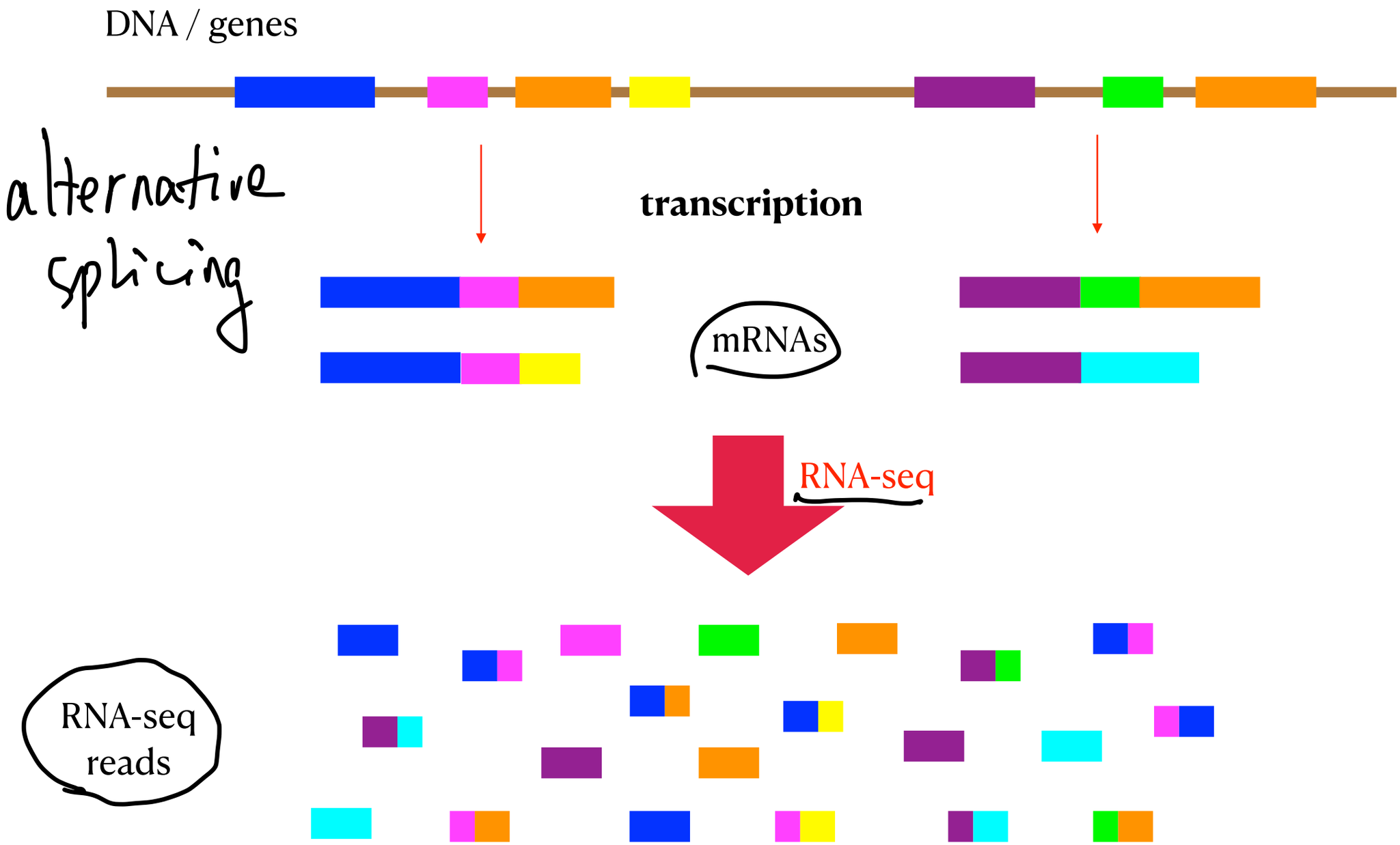
Deciphering Gene Regulation

- We are FAR away from understanding the cell-machinery.
- Elucidating gene regulations will greatly help disease diagnose and treatment.



signaling pathways that regulate cancer metabolism

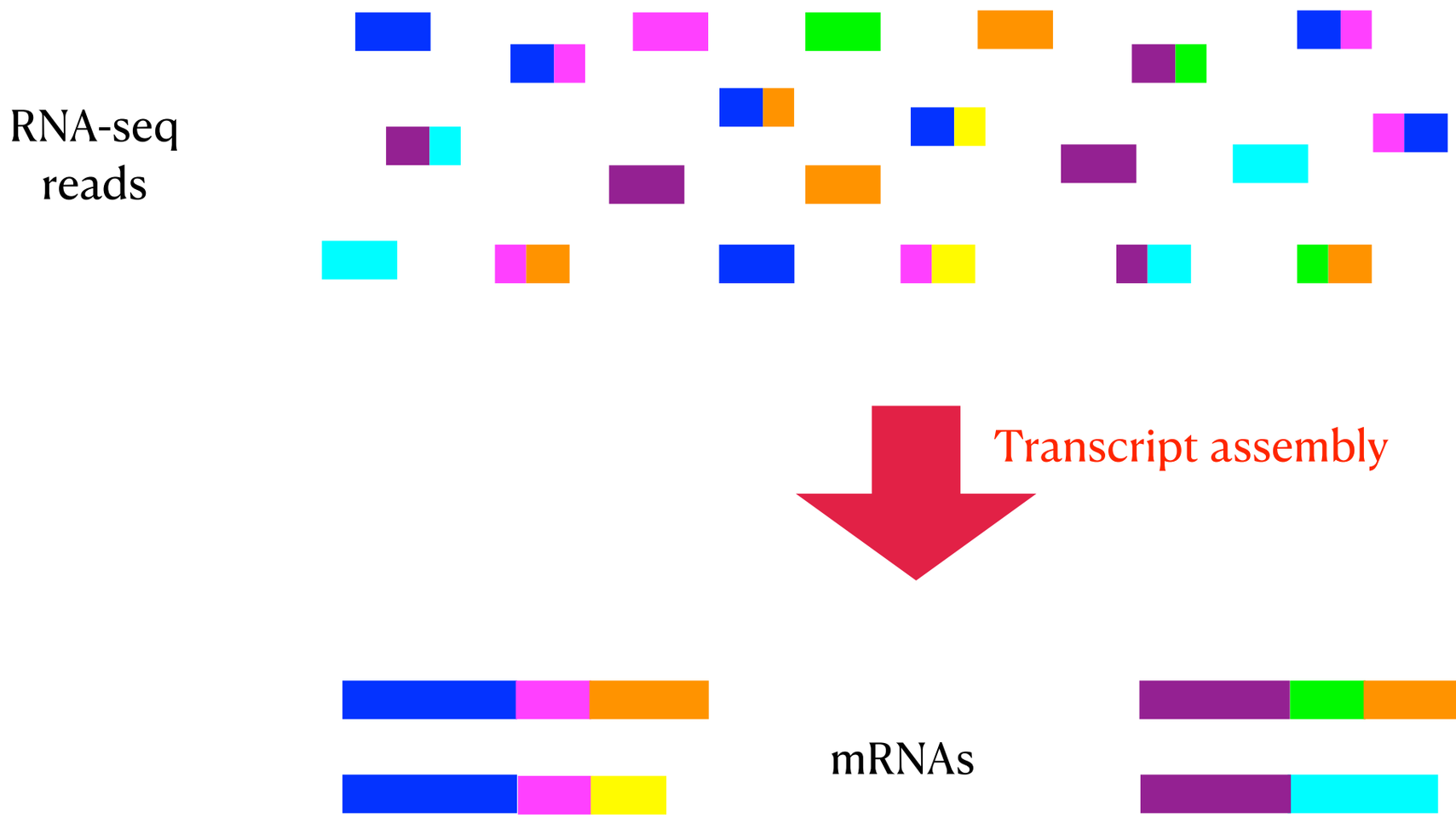
RNA Sequencing (RNA-seq)



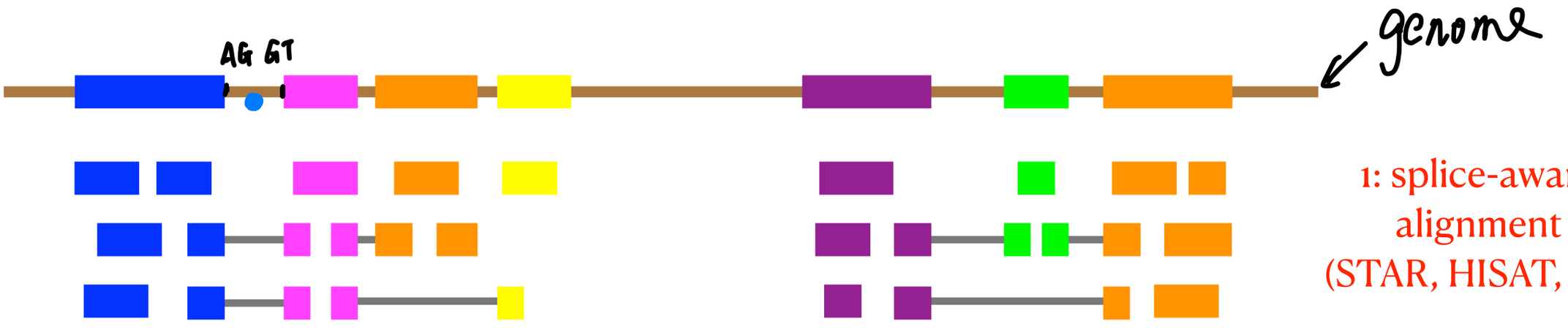
Applications of RNA-seq

- RNA-seq measures gene activities.
- To decipher cell machinery
    - study gene regulation
    - infer gene functions
    - study various RNAs, such as lncRNAs, microRNAs, eRNAs
    - many more...
- To identify biomarkers for disease diagnosis.

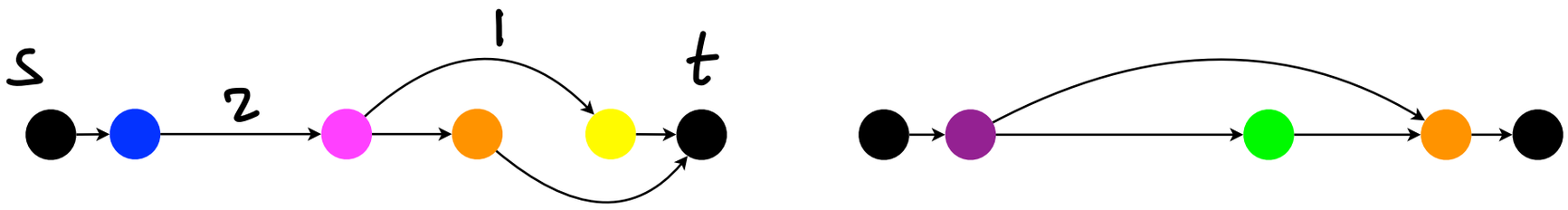
Assembly



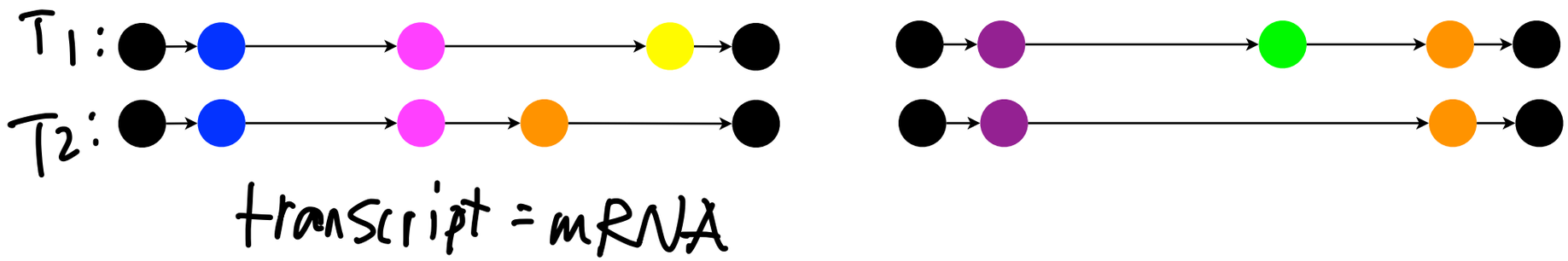
Reference-based Assembly



1: splice-aware alignment (STAR, HISAT, etc)



2: construct splice graph

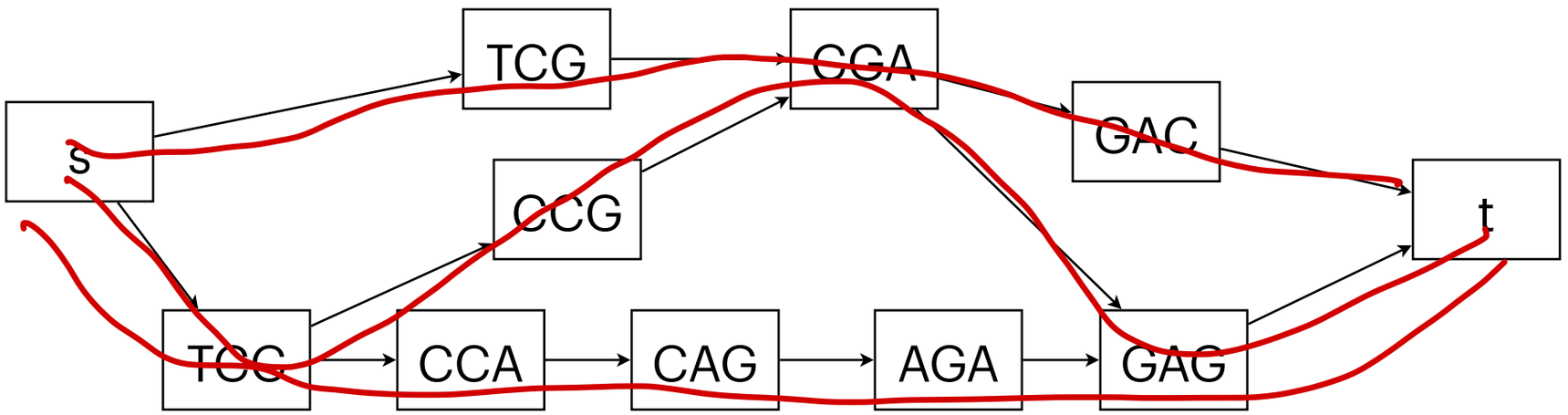


3: decompose splice graph

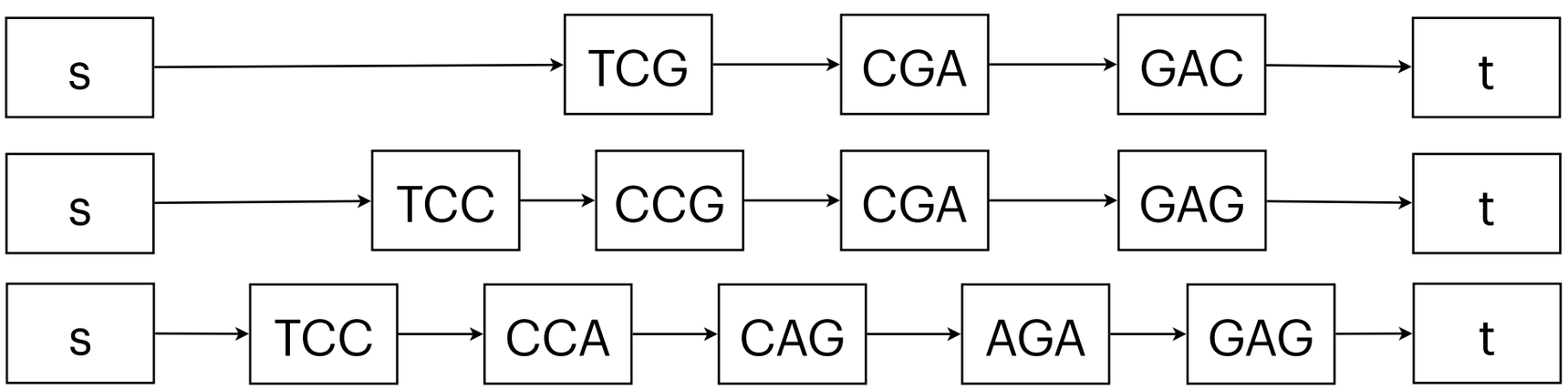
Assemblers: Cufflinks, TransComb, StringTie, StringTie2, Scallop, Scallop2

de novo Assembly

phasing



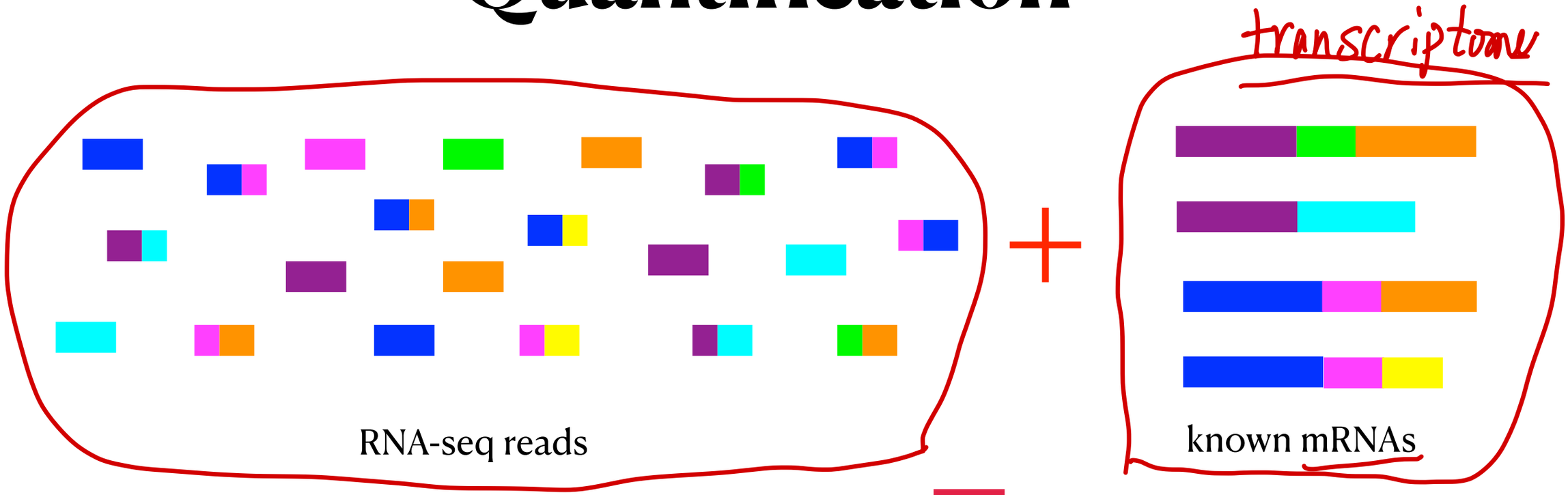
1: construct dBG or overlap graph



2: decompose the graph

Assemblers: Trinity, rna-SPADES, BinPacker, TransLiG

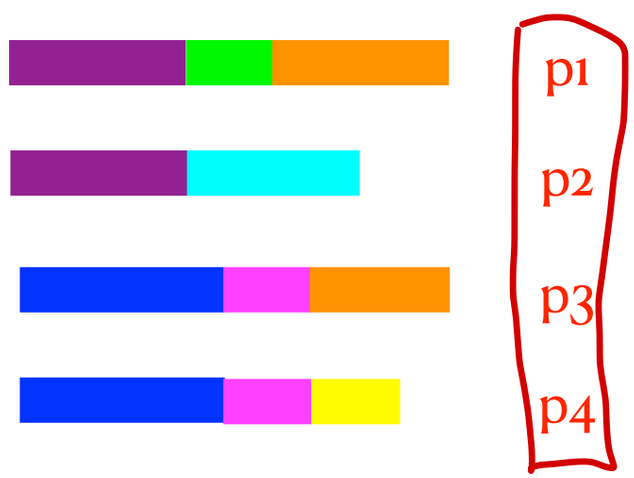
Quantification



Quantification

$\max_{p_1,p_2,p_3,p_4} \Pr(R \mid p_1, p_2, p_3, p_4)$

Tools: RSEM,
Sailfish, Salmon,
kallisto



Paper Presentation

- Send me your slides 3 days in advance.
- 20 min presentation + 5 min discussion
- You may need to pick the most interesting/relevant parts
- Include a slide to discuss the strength and weakness of the paper and discuss how you think it could be improved.
- Peer-evaluations 50% + instructor-evaluation 50%
  - Submit your evaluation/score in class
  - Submit your feedback by the end of the day

Paper Presentation

- Grading:
  - clarity, coherence, and organization of your presentation
  - whether the key points of the paper are clearly delivered
  - think critically about the paper
  - stay close to the time limit
  - quality of your answers to questions
  - clarity, coherence, and organization of your slides

Course Project

- Choose a problem: curiosity driven
  - Is that algorithm sensitive to certain parameter?
  - What is the range of parameters an algorithm is practical?
  - Can that algorithm be applied to other type of data / other research area / your research topic?
  - Can an efficient algorithm be still designed for a slightly different formulation?
  - Can this algorithm be improved?

Course Project

- You need to come up with some idea(s), but not necessarily working idea(s).
- When your ideas do not work, you need to think about why, but you are not required to fix it.