BioLogic – a graphical tool for teaching/assessing biology concepts

Rationale

Long answer questions (LAQ) in exams are used to test students understanding by having them explain complex concepts. Such hand-written questions are very difficult to mark automatically – so for large classes it becomes a huge burden on staff to ensure consistency of marking between students, and provide feedback

Proposal – to develop a software tool, BioLogic, in which biological concepts/explanations/reasoning are put together as graphical logic networks. These would be used to teach students how to think logically, but also to provide a powerful tool for assessment that is scalable and amenable to AI help

Creating a graph – (see following pages)

The tool would have two components to build a network – "facts" and "relationships"

- the knowledge would come as building blocks of information. e.g. "kinases add phosphate groups". These could created by students/lecturers/tutors from lecture content during semester, but also provided in exams as raw-material to construct their answer to a question
- FACTs would be connected with logical operators/relationships. A standard set would be provided in the interface (i.e because, and, but, whereas ....) but a student could also add their own.
- A "translator" would automatically convert the graph into English sentences – so that students can see that the graph is saying what they intended.
- The translation process could also be customized. e.g. a simple network in which one fact implies a second (i.e. Fact1–hence-Fact2) could be rendered into English as:
    - Fact 1 so Fact2. OR
    - Fact2 because of Fact1
- students could hiearchically group things into sub-networks, which could be ordered, to further customise translation

Marking a graph

By having a student's answer in a machine readable form – it becomes simple to map multiple students' answers onto templates and then assessors would just mark those templates – so there'd be much less work. The hierarchical naturealso allows one to map complex answers and simple answers onto each other – but still allow for extra points for more complete explanations. e.g. Fact1 so Fact2 might get less marks than Fact1 so Fact 2, and Fact2 is because of Fact3.

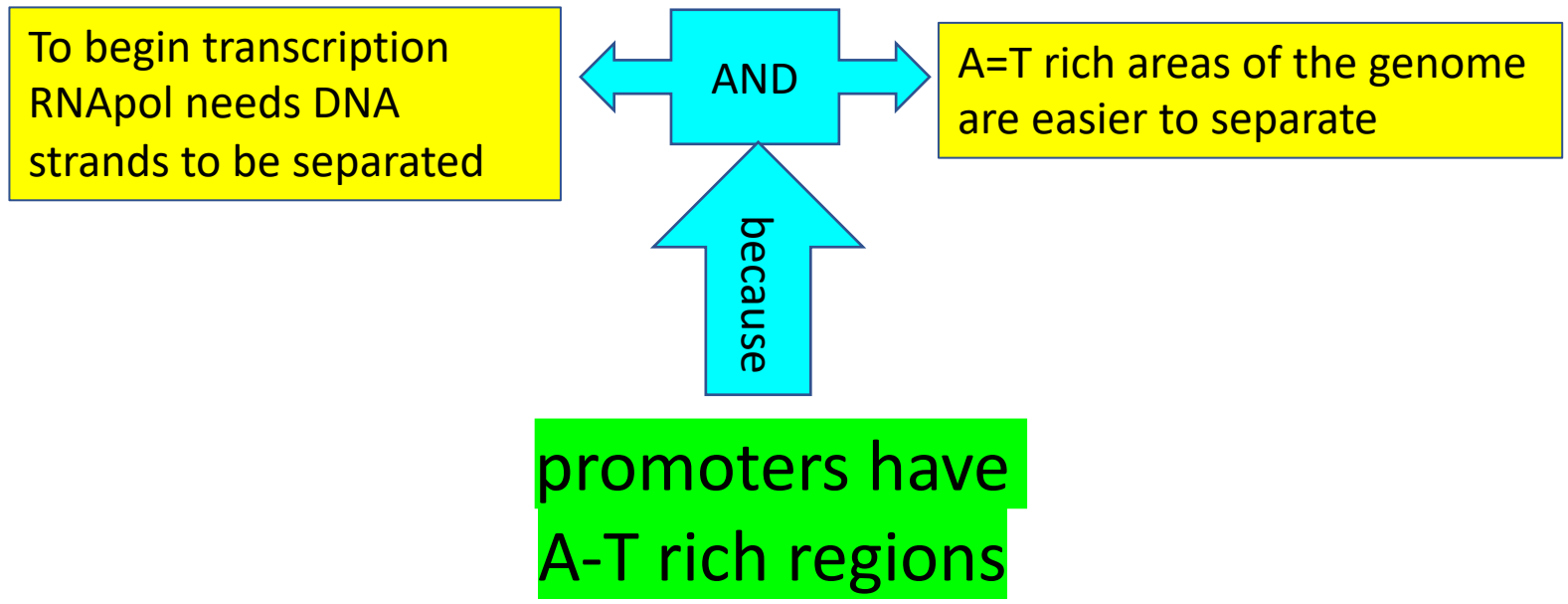
Building knowledge

students could use the tool during semester to organise the content they're being delivered – both to help them build up a library of their knowledge, and to prepare for exam situations (i.e. match practice). This knowledge/logic base could build up over multiple years.

SIMPLE STUDENT ANSWER

Question. Why do promoters have A-T rich regions?

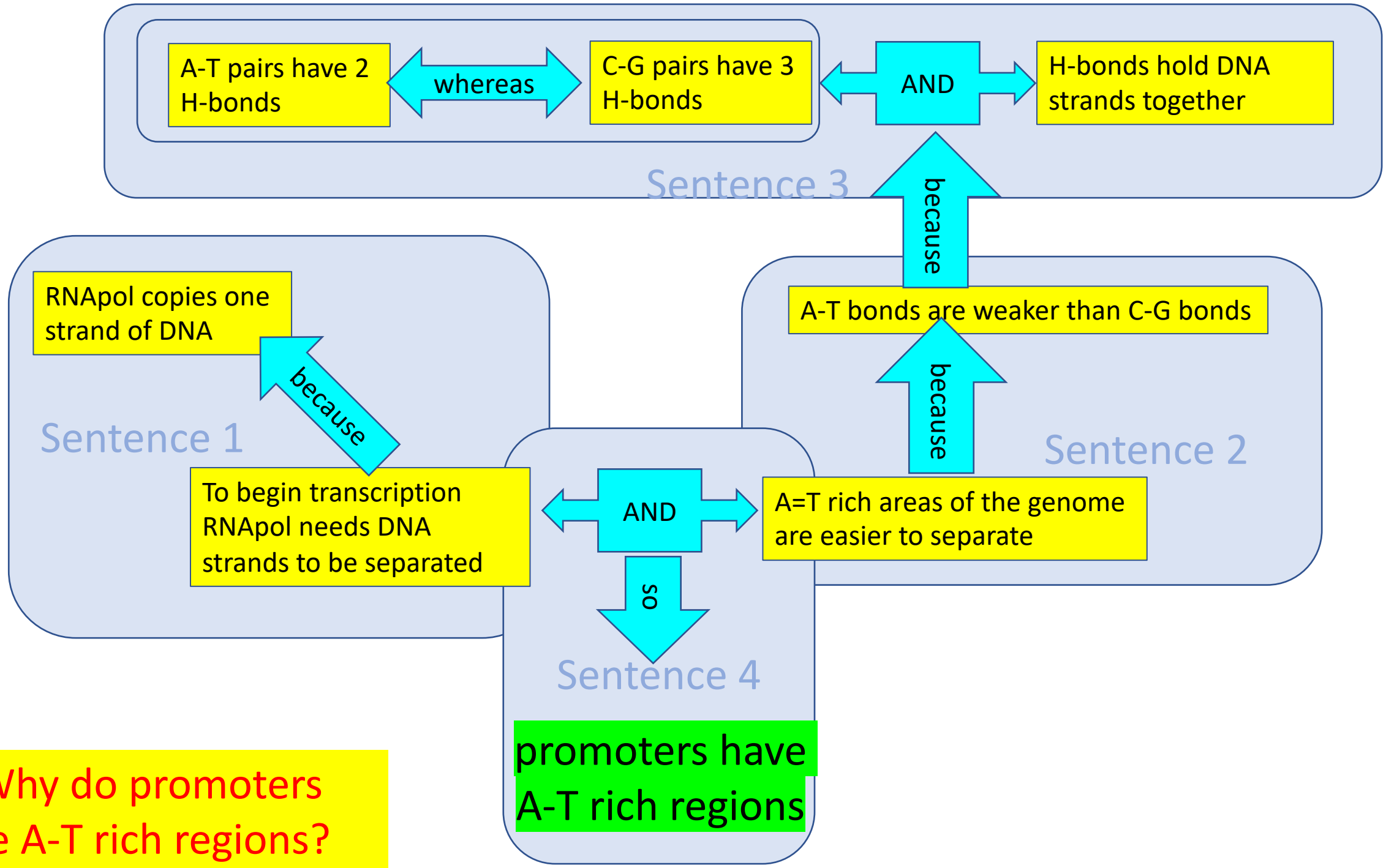
ANSWER - GRAPH



ANSWER – ENGLISH TRANSLATION

1. Promoters have A-T rich regions because to begin transcription RNApol needs DNA strands to be separated and A=T rich areas are easier to separate.

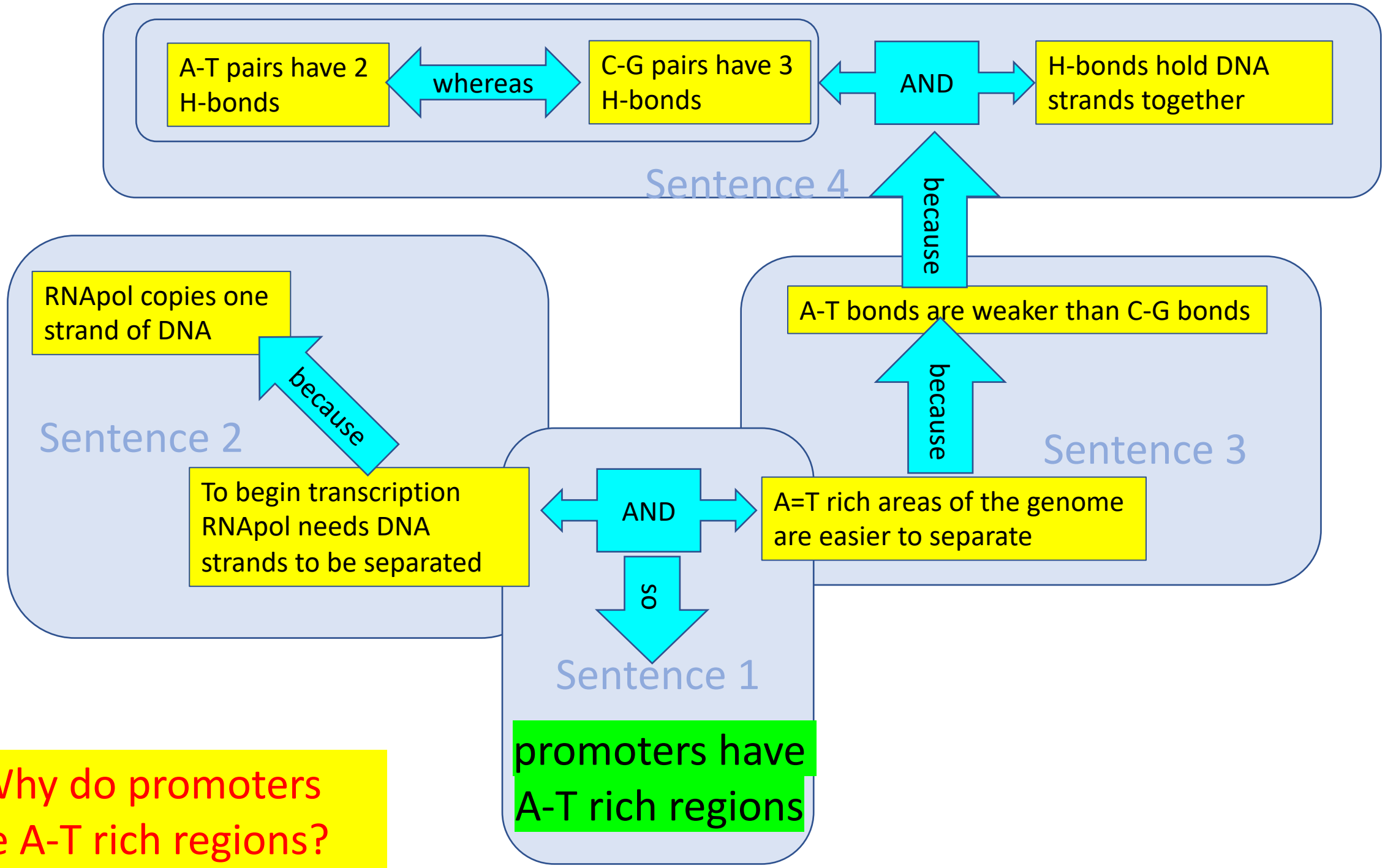
COMPLEX STUDENT ANSWER



Q. Why do promoters have A-T rich regions?

1. To begin transcription RNApol needs DNA strands to be separated because RNApol copies one strand of DNA.
2. A=T rich areas are easier to separate because A-T bonds are weaker than C-G bonds.
3. This is because, A-T pairs have 2 hydrogen bonds, whereas C-G pairs have 3 h-bonds, AND H bonds hold DNA strands together.
4. So that's why, promoters have A-T rich regions

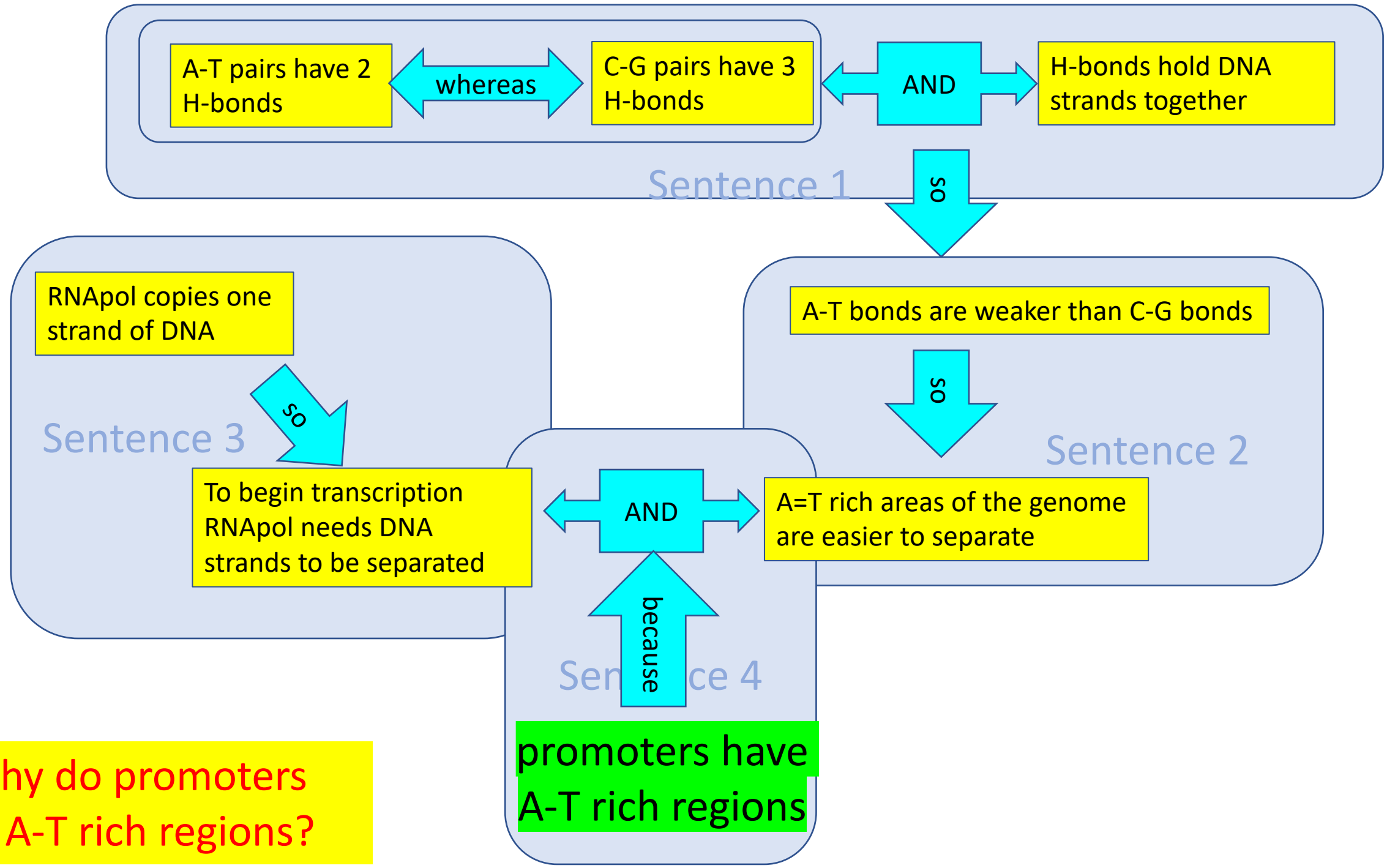
ALTERNATE ORDERING - TO COMPLEX STUDENT ANSWER



Q. Why do promoters have A-T rich regions?

1. promoters have A-T rich regions because to begin transcription RNApol needs DNA strands to be separated, AND A=T rich areas are easier to separate.
2. The reason why <RNApol needs DNA strands to be separated> is that RNApol copies one strand of DNA.
3. And the reason why <A=T rich areas are easier to separate> is because A-T bonds are weaker than C-G bonds.
4. This is because, A-T pairs have 2 hydrogen bonds, whereas C-G pairs have 3 h-bonds, AND H bonds hold DNA strands together.

ALTERNATE TRANSLATION TO COMPLEX STUDENT ANSWER



Q. Why do promoters have A-T rich regions?

1. A-T pairs have 2 hydrogen bonds, whereas C-G pairs have 3 h-bonds, AND H bonds hold DNA strands together, so A-T bonds are weaker than C-G bonds.
2. This means that A=T rich areas are easier to separate.
3. RNApol copies one strand of DNA, so to begin transcription RNApol needs DNA strands to be separated.
4. So that's why, promoters have A-T rich regions