

1 **S1 Appendix: Genetic circuits**

2 Each of the four genetic circuits producing proteins X and Y (parallel, cascade, series
3 uncoupled, and series coupled) are implemented as a set of reactions describing transcription,
4 translation, protein export, and protein binding, as outlined below for each circuit. The following
5 abbreviations are used in this appendix:

6 P : Promoter

7 $RNAP$: RNA polymerase

8 $RNAP_{gene}$: RNA polymerase bound to DNA, in RNA elongation phase

9 $mrna$: Transcribed mRNA sequence

10 Rib : Ribosome

11 X / Y : Protein X / Y (in the cellular interior)

12 $X.out / Y.out$: Protein X / Y (exterior to the cell)

13 $sca.sca$: Scaffold protein, with two unoccupied binding sites

14 $X/Y.sca$: Scaffold protein, with one binding site occupied by protein X / Y

15 $X.X$: Scaffold protein, occupied by two X proteins (termed XX)

16 $X.Y$: Scaffold protein, occupied by an X protein and a Y protein (termed XY)

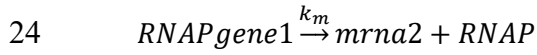
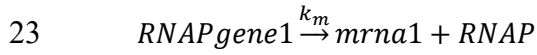
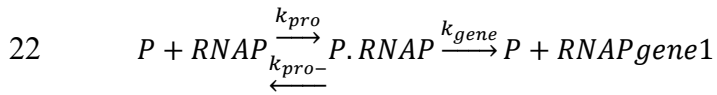
17 $Y.Y$: Scaffold protein, occupied by two Y proteins (termed YY)

18 PRO : Second polymerase co-generated with protein X in the cascade genetic circuit

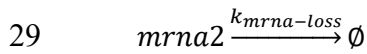
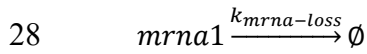
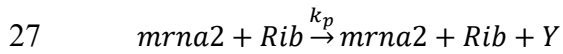
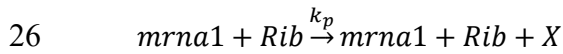
19 \emptyset : Used to indicate loss of a reactant

20 **Parallel Genetic Circuit**

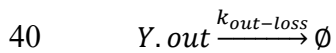
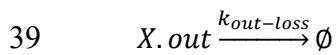
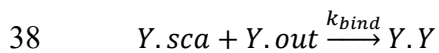
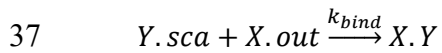
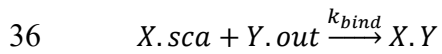
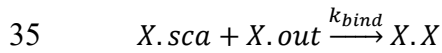
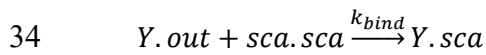
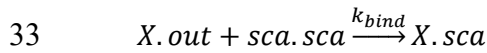
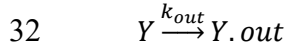
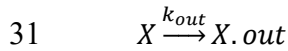
21 Transcription



25 Translation



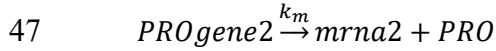
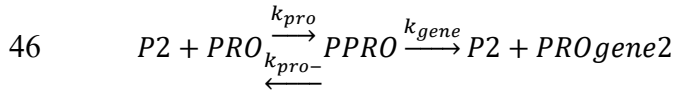
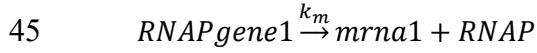
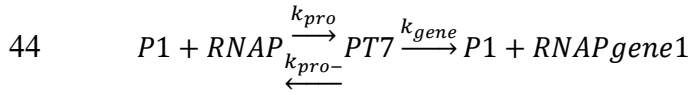
30 Protein export / binding



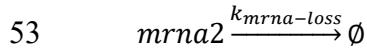
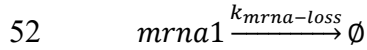
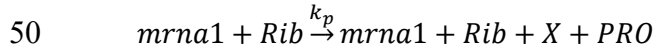
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42 Cascade Genetic Circuit

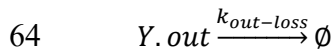
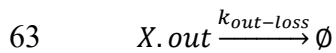
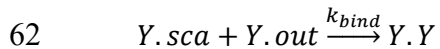
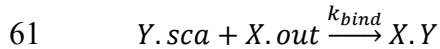
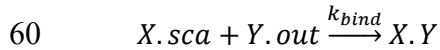
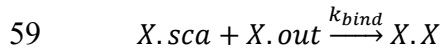
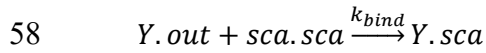
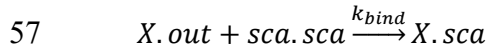
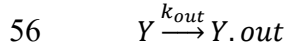
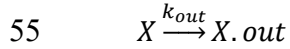
43 Transcription



49 Translation



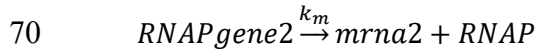
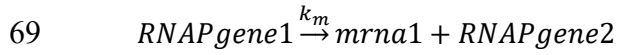
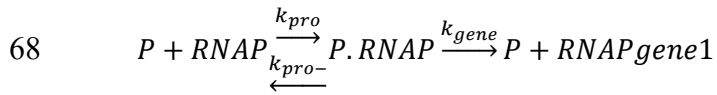
54 Protein export / binding



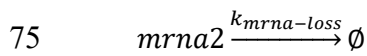
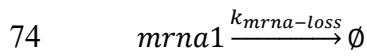
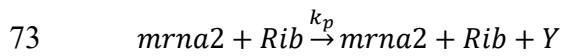
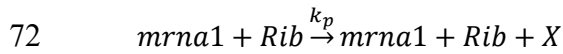
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66 **Series Uncoupled Genetic Circuit**

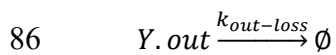
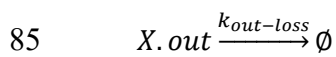
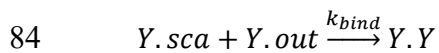
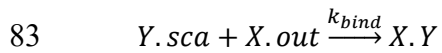
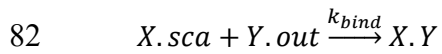
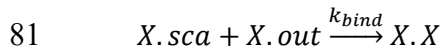
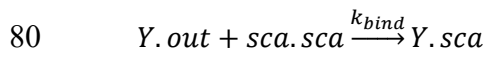
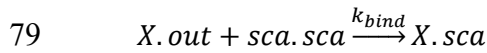
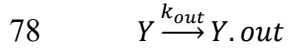
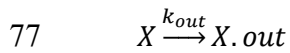
67 Transcription



71 Translation



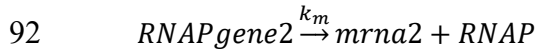
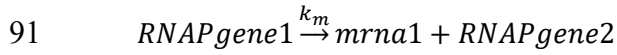
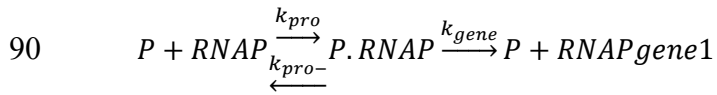
76 Export / binding



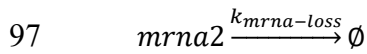
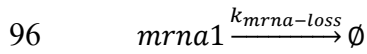
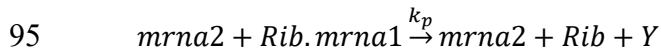
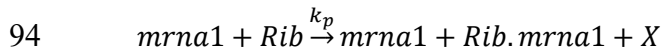
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88 Series Coupled Genetic Circuit

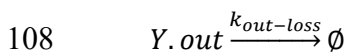
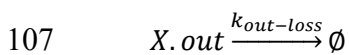
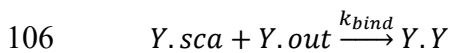
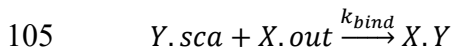
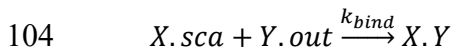
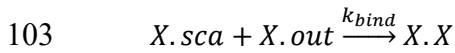
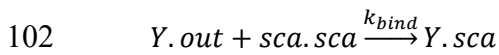
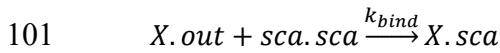
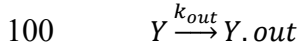
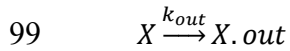
89 Transcription



93 Translation



98 Protein export / binding



109