The Synthetic Biology Open Language 2.0

Bryan Bartley, Jacob Beal, Kevin Clancy, Goksel Misirli, Nicholas Roehner, and Matthew Pocock

IWBDA 2015, Aug 20th

Hierarchy of Biodesign Standards

FASTA

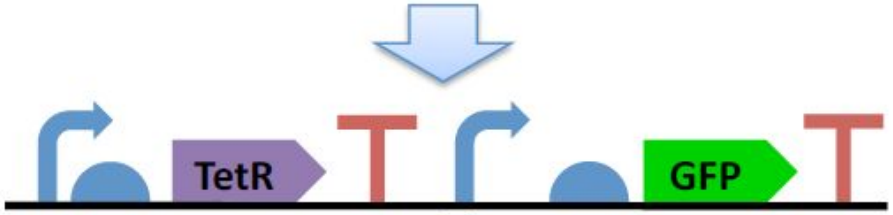
ACTGTGCCGTTAAACGTGATTAAATCCGTACTGATAT…

Hierarchy of Biodesign Standards

FASTA

ACTGTGCCGTTAAACGTGATTAAATCCGTACTGATAT…

GenBank

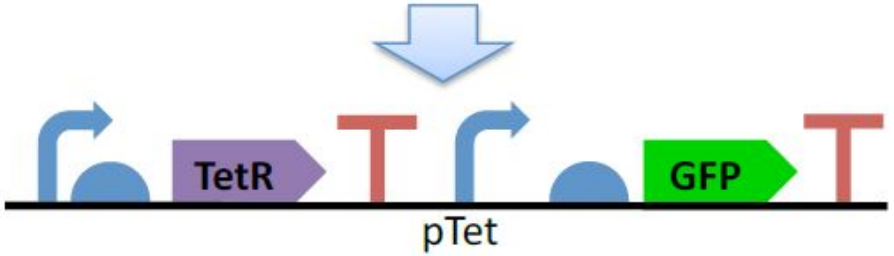


Hierarchy of Biodesign Standards

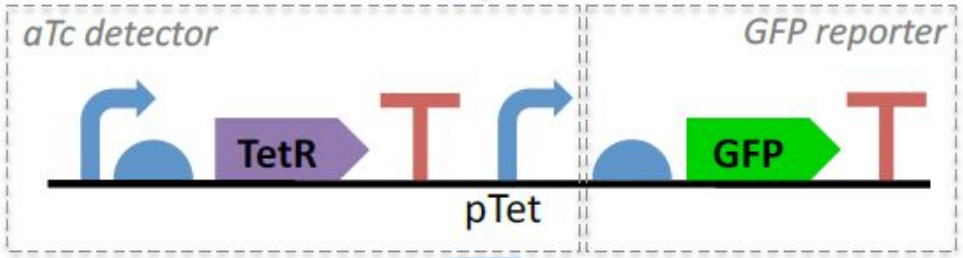
FASTA

ACTGTGCCGTTAAACGTGATTAAATCCGTACTGATAT…

GenBank



SBOL 1.1

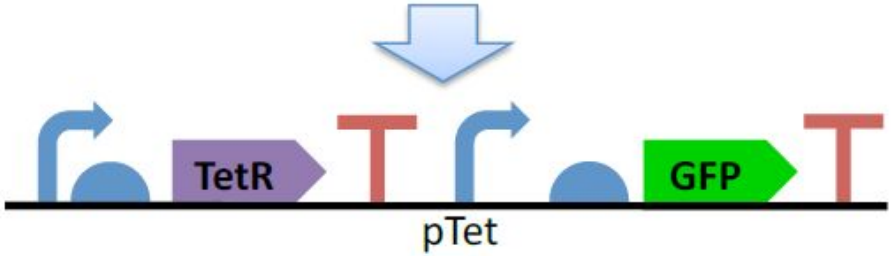


Hierarchy of Biodesign Standards

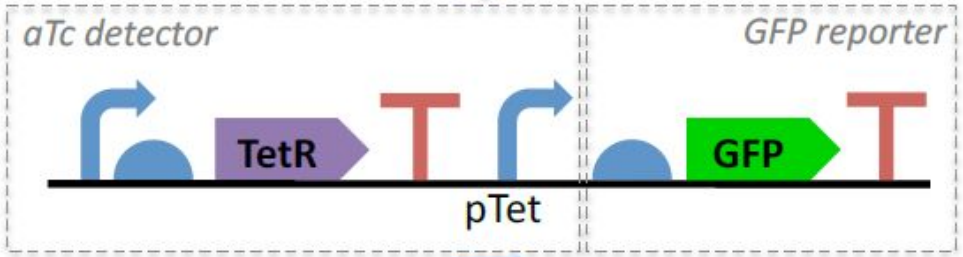
FASTA

ACTGTGCCGTTAAACGTGATTAAATCCGTACTGATAT…

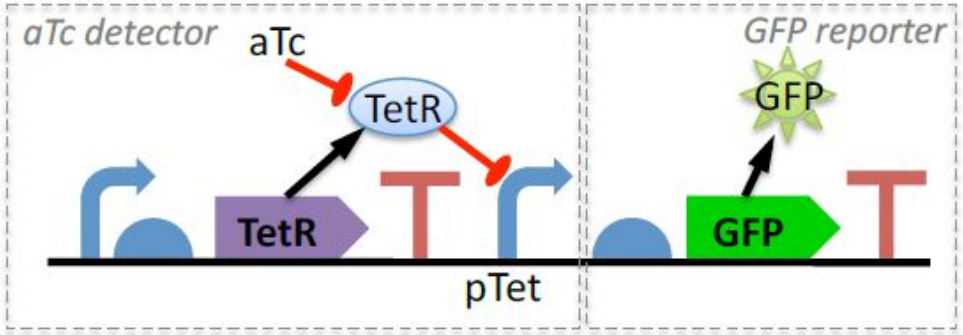
GenBank



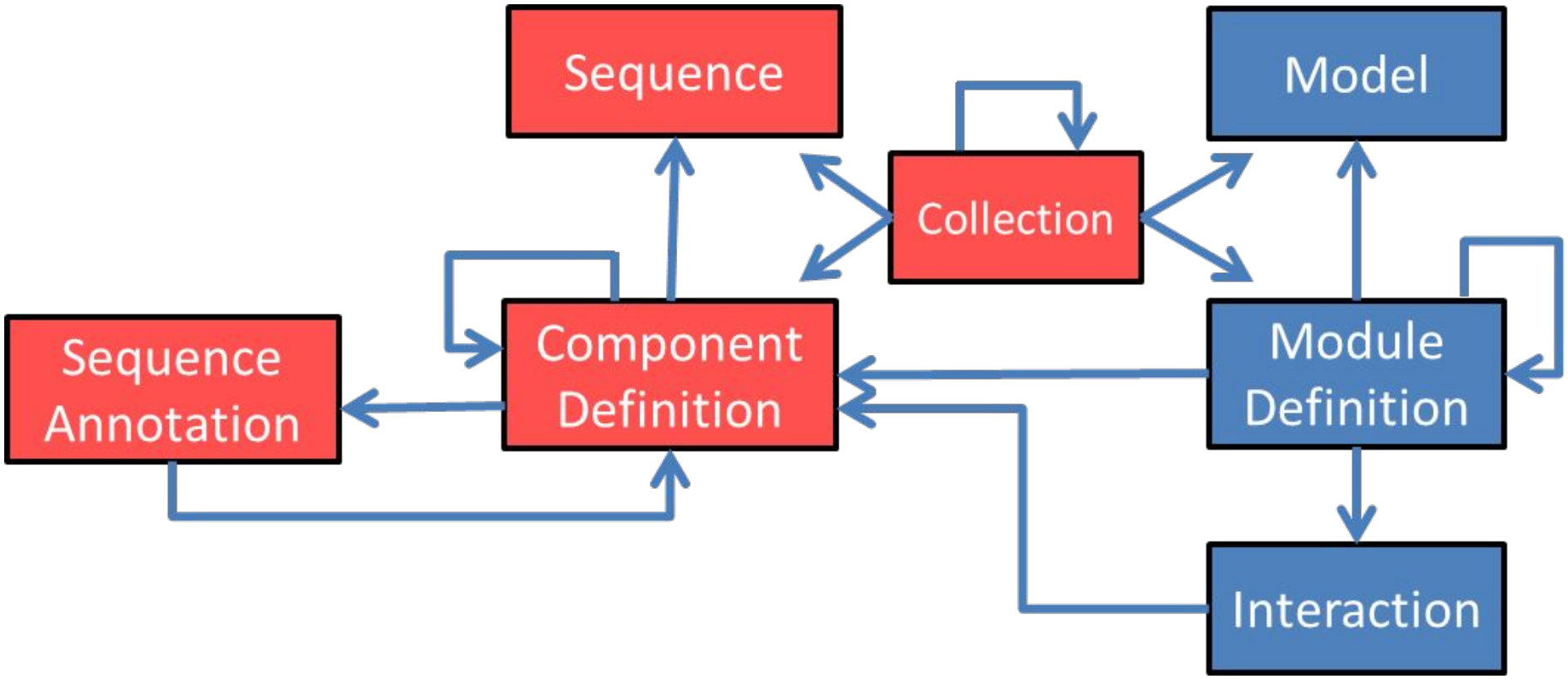
SBOL 1.1



SBOL 2.0



Simplified SBOL 2.0 Data Model



SBOL 2.0 Serialization

```
<?xml version="1.0" ?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#" xmlns:dcterms="http://purl.org/dc/terms/" xmlns:prov="http://www.
      w3.org/ns/prov#" xmlns:sbol="http://sbols.org/v2#">
  <sbol:ComponentDefinition rdf:about="http://partsregistry.org/cd/BBa_J23119">
    <sbol:persistentIdentity rdf:resource="http://partsregistry.org/cd/BBa_J23119"/>
    <sbol:displayId>BBa_J23119</sbol:displayId>
    <prov:wasDerivedFrom rdf:resource="http://partsregistry.org/Part:BBa_J23119"/>
    <dcterms:title>J23119 promoter</dcterms:title>
    <dcterms:description>Constitutive promoter</dcterms:description>
    <sbol:type rdf:resource="http://identifiers.org/chebi/CHEBI:4705"/>
    <sbol:type rdf:resource="http://www.biopax.org/release/biopax-level3.owl#DnaRegion"/>
    <sbol:role rdf:resource="http://identifiers.org/so/SO:0000167"/>
    <sbol:role rdf:resource="http://identifiers.org/so/SO:0000613"/>
    <sbol:sequence rdf:resource="http://partsregistry.org/seq/BBa_J23119"/>
  </sbol:ComponentDefinition>
  <sbol:Sequence rdf:about="http://partsregistry.org/seq/BBa_J23119">
    <sbol:persistentIdentity rdf:resource="http://partsregistry.org/seq/BBa_J23119"/>
    <sbol:displayId>BBa_J23119</sbol:displayId>
    <prov:wasDerivedFrom rdf:resource="http://parts.igem.org/Part:BBa_J23119:Design"/>
    <sbol:elements>ttgacagctagctcagtcctaggtataatgctagc</sbol:elements>
    <sbol:encoding rdf:resource="http://www.chem.qmul.ac.uk/iubmb/misc/naseq.html"/>
  </sbol:Sequence>
</rdf:RDF>
```

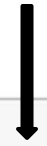
SBOL 2.0 Serialization

```
<?xml version="1.0" ?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#" xmlns:dcterms="http://purl.org/dc/terms/" xmlns:prov="http://www.
    w3.org/ns/prov#" xmlns:sbol="http://sbols.org/v2#">
  <sbol:ComponentDefinition rdf:about="http://partsregistry.org/cd/BBa_J23119">
    <sbol:persistentIdentity rdf:resource="http://partsregistry.org/cd/BBa_J23119"/>
    <sbol:displayId>BBa_J23119</sbol:displayId>
    <prov:wasDerivedFrom rdf:resource="http://partsregistry.org/Part:BBa_J23119"/>
    <dcterms:title>J23119 promoter</dcterms:title>
    <dcterms:description>Constitutive promoter</dcterms:description>
    <sbol:type rdf:resource="http://identifiers.org/chebi/CHEBI:4705"/>
    <sbol:type rdf:resource="http://www.biopax.org/release/biopax-level3.owl#DnaRegion"/>
    <sbol:role rdf:resource="http://identifiers.org/so/SO:0000167"/>
    <sbol:role rdf:resource="http://identifiers.org/so/SO:0000613"/>
    <sbol:sequence rdf:resource="http://partsregistry.org/seq/BBa_J23119"/>
  </sbol:ComponentDefinition>
  <sbol:Sequence rdf:about="http://partsregistry.org/seq/BBa_J23119">
    <sbol:persistentIdentity rdf:resource="http://partsregistry.org/seq/BBa_J23119"/>
    <sbol:displayId>BBa_J23119</sbol:displayId>
    <prov:wasDerivedFrom rdf:resource="http://parts.igem.org/Part:BBa_J23119:Design"/>
    <sbol:elements>ttgacagctagctcagtcctaggtataatgctagc</sbol:elements>
    <sbol:encoding rdf:resource="http://www.chem.qmul.ac.uk/iubmb/misc/naseq.html"/>
  </sbol:Sequence>
</rdf:RDF>
```

SBOL 2.0 Serialization

```
<?xml version="1.0" ?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#" xmlns:dcterms="http://purl.org/dc/terms/" xmlns:prov="http://www.
     w3.org/ns/prov#" xmlns:sbol="http://sbols.org/v2#">
  <sbol:ComponentDefinition rdf:about="http://partsregistry.org/cd/BBa_J23119">
    <sbol:persistentIdentity rdf:resource="http://partsregistry.org/cd/BBa_J23119"/>
    <sbol:displayId>BBa_J23119</sbol:displayId>
    <prov:wasDerivedFrom rdf:resource="http://partsregistry.org/Part:BBa_J23119"/>
    <dcterms:title>J23119 promoter</dcterms:title>
    <dcterms:description>Constitutive promoter</dcterms:description>
    <sbol:type rdf:resource="http://identifiers.org/chebi/CHEBI:4705"/>
    <sbol:type rdf:resource="http://www.biopax.org/release/biopax-level3.owl#DnaRegion"/>
    <sbol:role rdf:resource="http://identifiers.org/so/SO:0000167"/>
    <sbol:role rdf:resource="http://identifiers.org/so/SO:0000613"/>
    <sbol:sequence rdf:resource="http://partsregistry.org/seq/BBa_J23119"/>
  </sbol:ComponentDefinition>
  <sbol:Sequence rdf:about="http://partsregistry.org/seq/BBa_J23119">
    <sbol:persistentIdentity rdf:resource="http://partsregistry.org/seq/BBa_J23119"/>
    <sbol:displayId>BBa_J23119</sbol:displayId>
    <prov:wasDerivedFrom rdf:resource="http://parts.igem.org/Part:BBa_J23119:Design"/>
    <sbol:elements>ttgacagctagctcagtcctaggtataatgctagc</sbol:elements>
    <sbol:encoding rdf:resource="http://www.chem.qmul.ac.uk/iubmb/misc/naseq.html"/>
  </sbol:Sequence>
</rdf:RDF>
```

SBOL 2.0 Custom Annotation

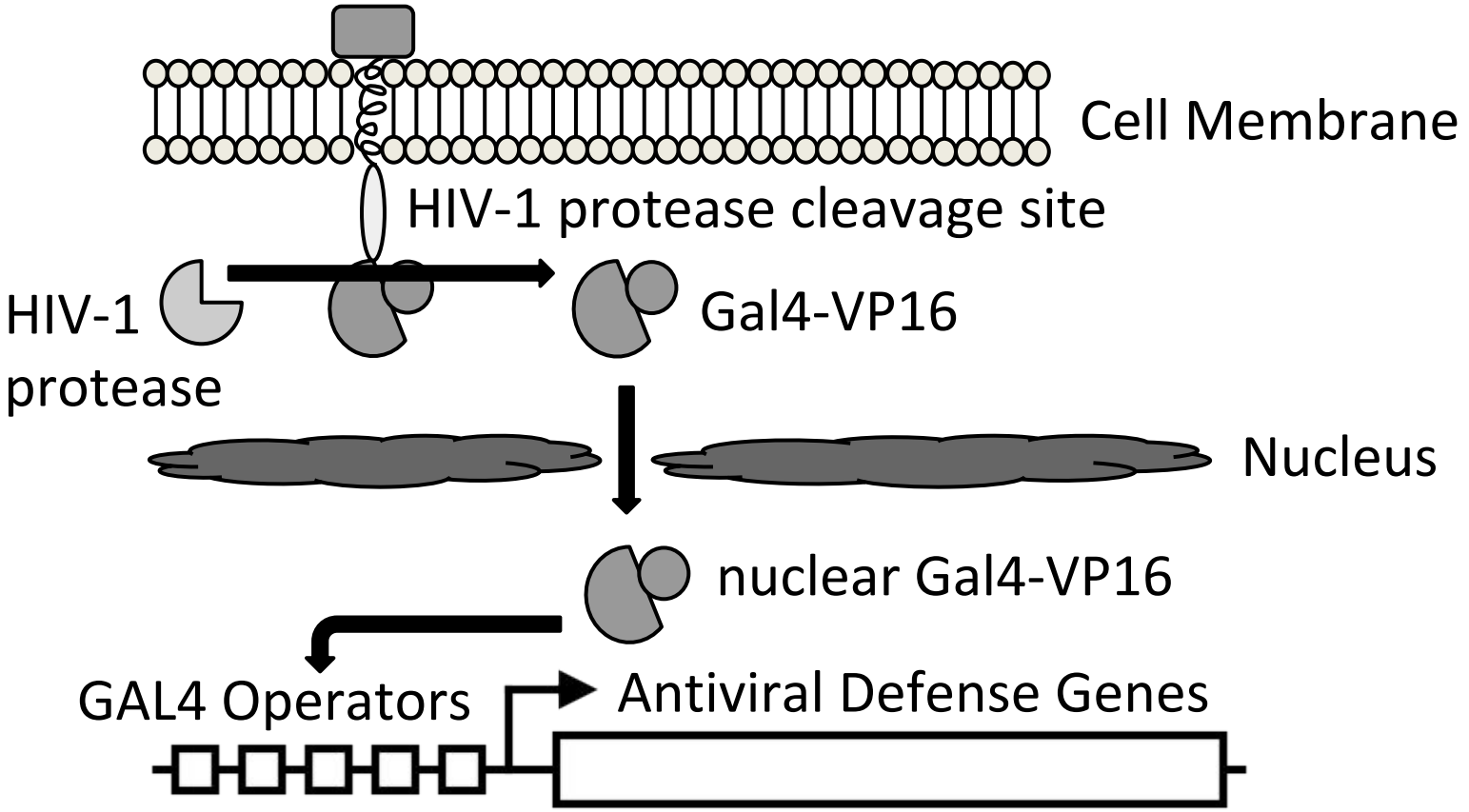


```
<?xml version="1.0" ?>
<rdf:RDF xmlns:myapp="http://www.myapp.org/" xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#" xmlns:dcterms="http://purl.
     org/dc/terms/" xmlns:prov="http://www.w3.org/ns/prov#" xmlns:sbol="http://sbols.org/v2#">
  <sbol:ComponentDefinition rdf:about="http://partsregistry.org/cd/BBa_J23119">
    <sbol:persistentIdentity rdf:resource="http://partsregistry.org/cd/BBa_J23119"/>
    <sbol:displayId>BBa_J23119</sbol:displayId>
    <prov:wasDerivedFrom rdf:resource="http://partsregistry.org/Part:BBa_J23119"/>
    <dcterms:title>J23119 promoter</dcterms:title>
    <dcterms:description>Constitutive promoter</dcterms:description>
    <sbol:type rdf:resource="http://identifiers.org/chebi/CHEBI:4705"/>
    <sbol:type rdf:resource="http://www.biopax.org/release/biopax-level3.owl#DnaRegion"/>
    <sbol:role rdf:resource="http://identifiers.org/so/SO:0000167"/>
    <sbol:role rdf:resource="http://identifiers.org/so/SO:0000613"/>
    <sbol:sequence rdf:resource="http://partsregistry.org/seq/BBa_J23119"/>
  </sbol:ComponentDefinition>
  <myapp:Datasheet rdf:about="http://www.partsregistry.org/gen/datasheet1">
    <sbol:persistentIdentity rdf:resource="http://www.partsregistry.org/gen/datasheet1"/>
    <sbol:displayId>datasheet1</sbol:displayId>
    <myapp:characterizationData rdf:resource="http://www.myapp.org/measurement/1"/>
    <myapp:transcriptionRate>1</myapp:transcriptionRate>
    <dcterms:title>Datasheet 1</dcterms:title>
  </myapp:Datasheet>
</rdf:RDF>
```

Examples

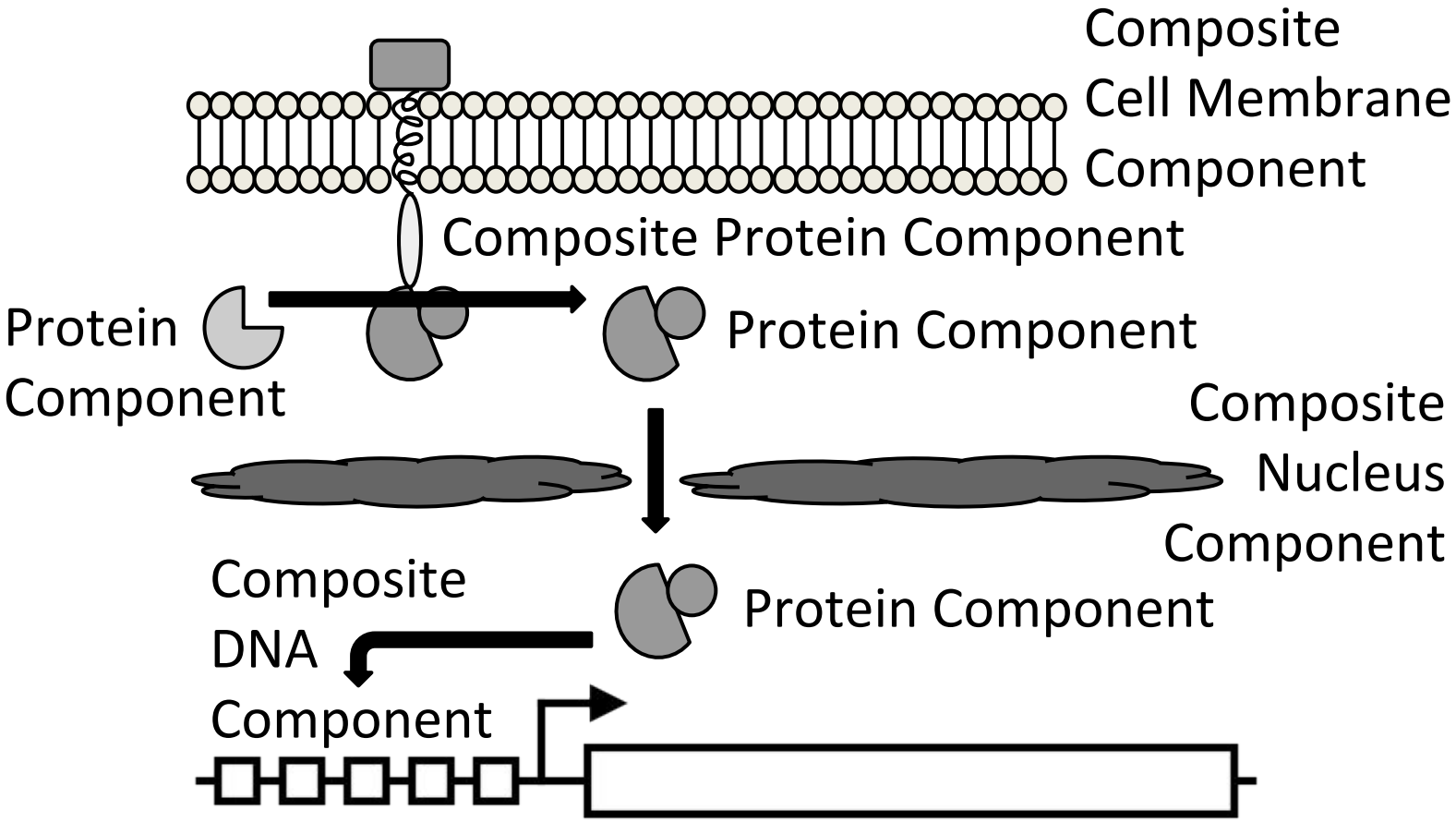

June 2015 • Volume 4, Issue 6
ACS
SyntheticBiology
pubs.acs.org/synthbio
ACS Publications
www.acs.org

HIV-1 Signaling Device



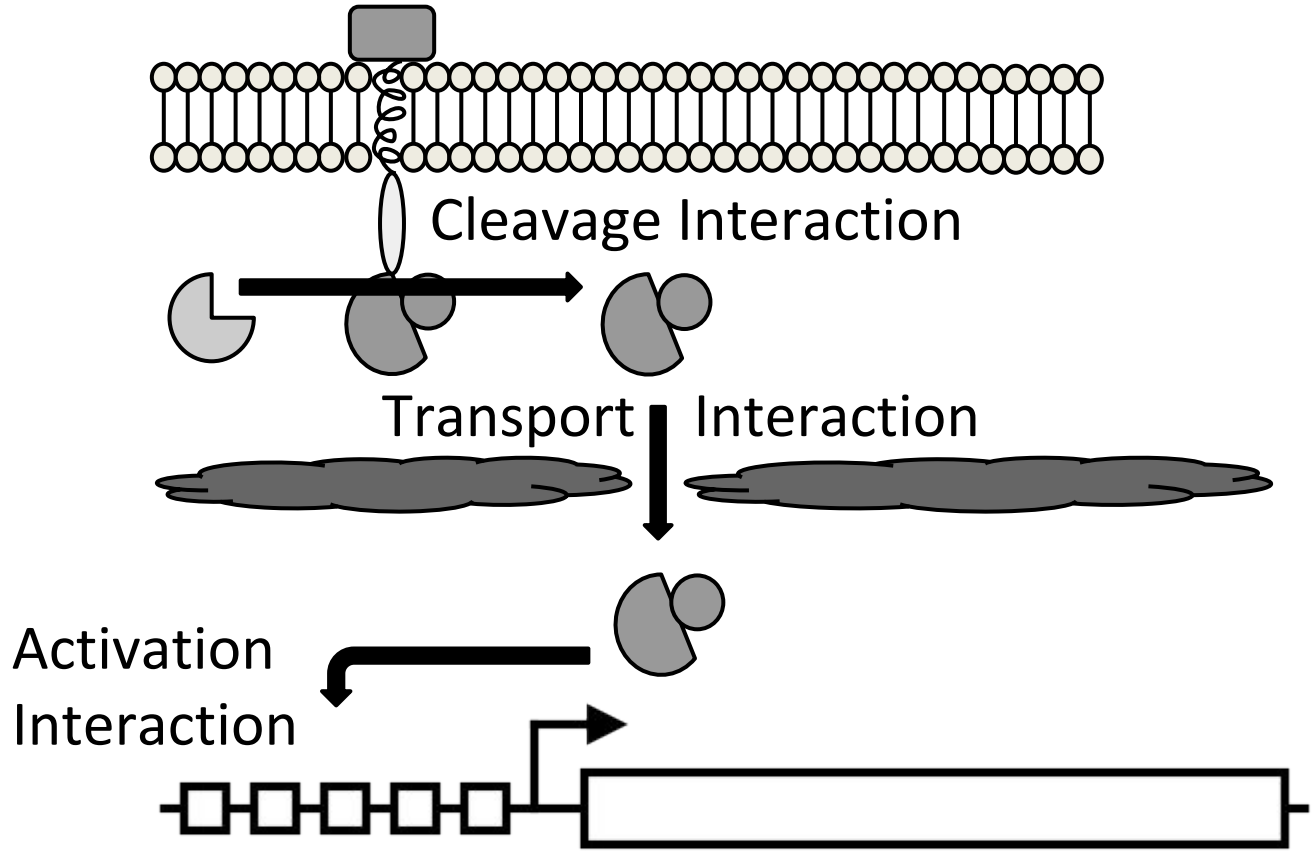
Andreja Majerle, Rok Gaber, Mojca Bencina, and Roman Jerala. Function-Based Mutation-Resistant Synthetic Signaling Device Activated by HIV-1 Proteolysis. *ACS Synth. Biol. 2015, 4,* 667-672.

HIV-1 Signaling Components



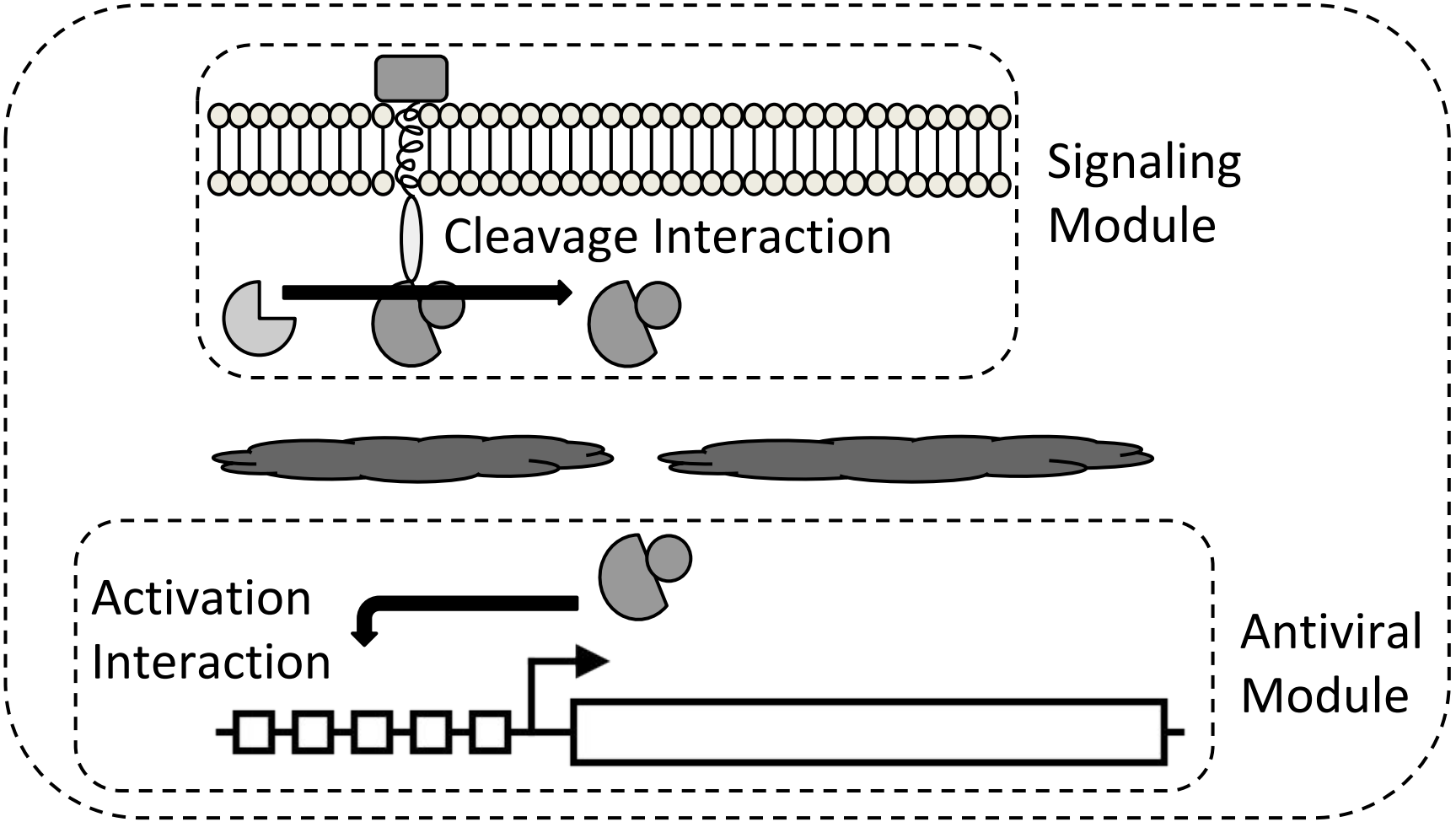
Andreja Majerle, Rok Gaber, Mojca Bencina, and Roman Jerala. Function-Based Mutation-Resistant Synthetic Signaling Device Activated by HIV-1 Proteolysis. *ACS Synth. Biol. 2015, 4,* 667-672.

HIV-1 Signaling Interactions



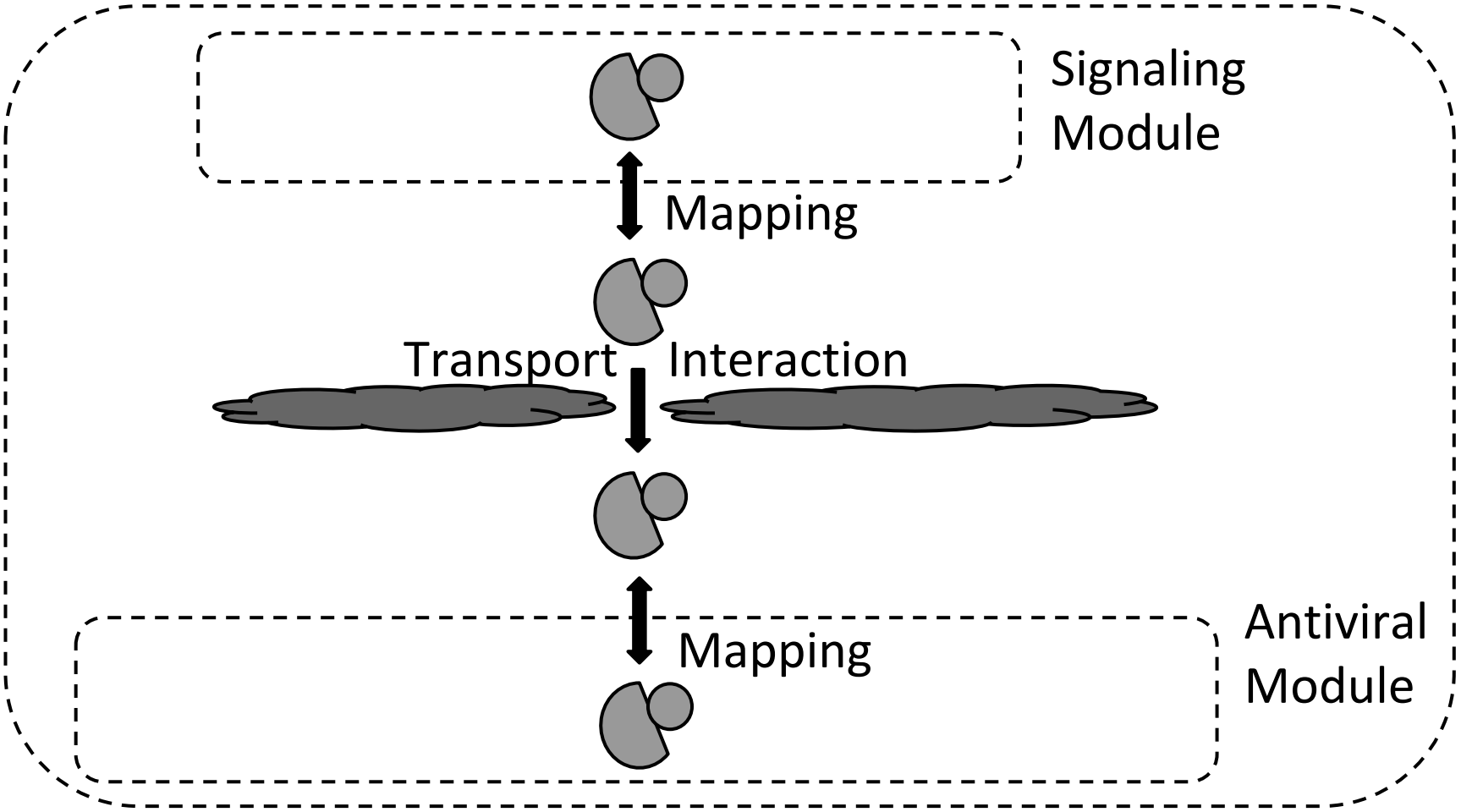
Andreja Majerle, Rok Gaber, Mojca Bencina, and Roman Jerala. Function-Based Mutation-Resistant Synthetic Signaling Device Activated by HIV-1 Proteolysis. *ACS Synth. Biol. 2015, 4,* 667-672.

HIV-1 Signaling Module



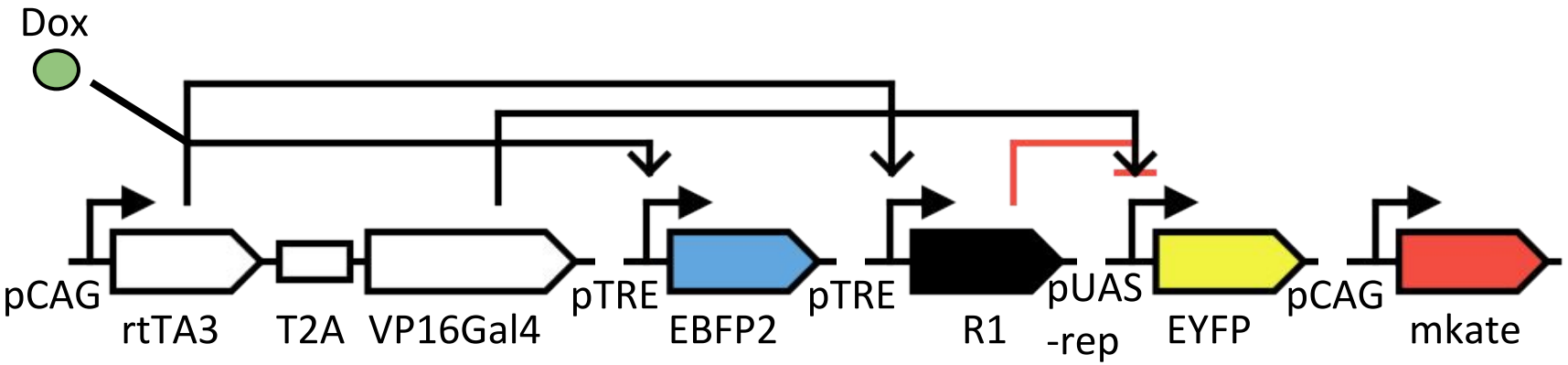
Andreja Majerle, Rok Gaber, Mojca Bencina, and Roman Jerala. Function-Based Mutation-Resistant Synthetic Signaling Device Activated by HIV-1 Proteolysis. *ACS Synth. Biol. 2015, 4,* 667-672.

HIV-1 Signaling Module



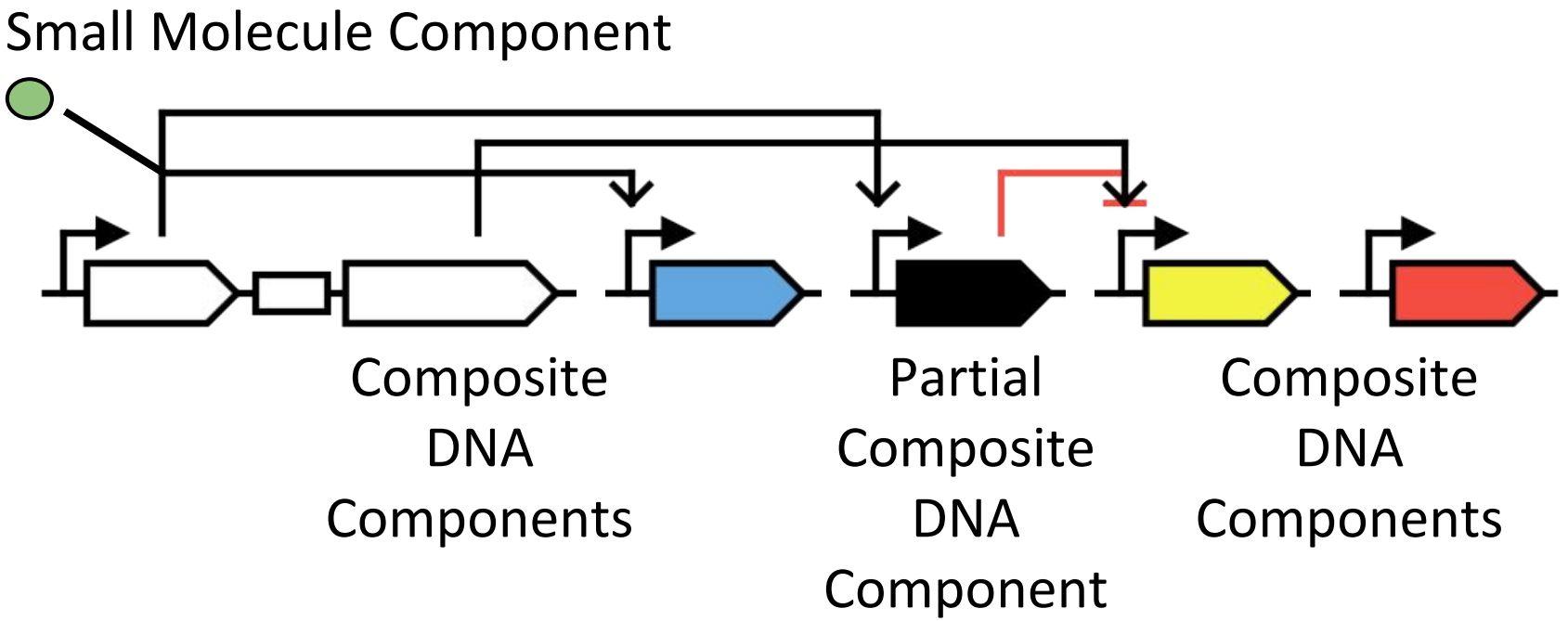
Andreja Majerle, Rok Gaber, Mojca Bencina, and Roman Jerala. Function-Based Mutation-Resistant Synthetic Signaling Device Activated by HIV-1 Proteolysis. *ACS Synth. Biol. 2015, 4,* 667-672.

EQuIP Characterization Circuit



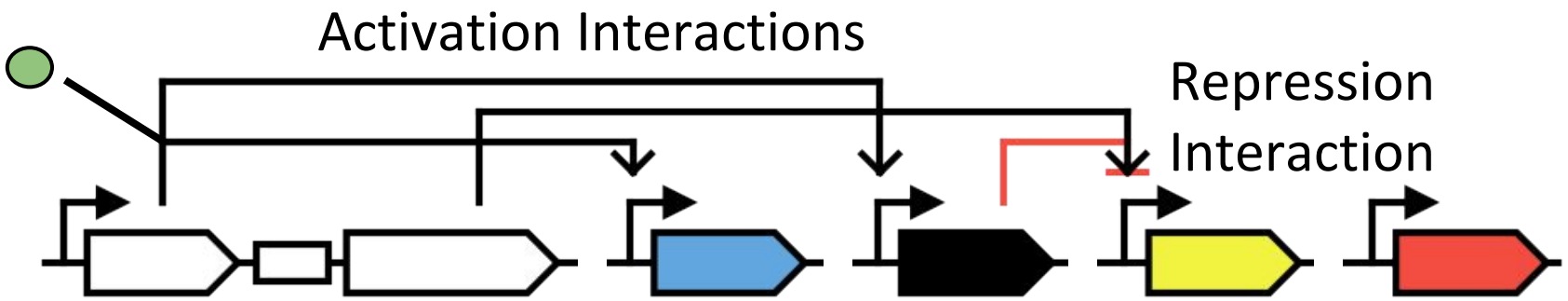
Noah Davidsohn, Jacob Beal, Samira Kiani, Aaron Adler, Fusun Yaman, Yingqing Li, Zhen Xie, and Ron Weiss. Accurate Predictions of Genetic Circuit Behavior from Part Characterization and Modular Composition. *ACS Synth. Biol. 2015, 4,* 673-681.

EQuIP Char. Components



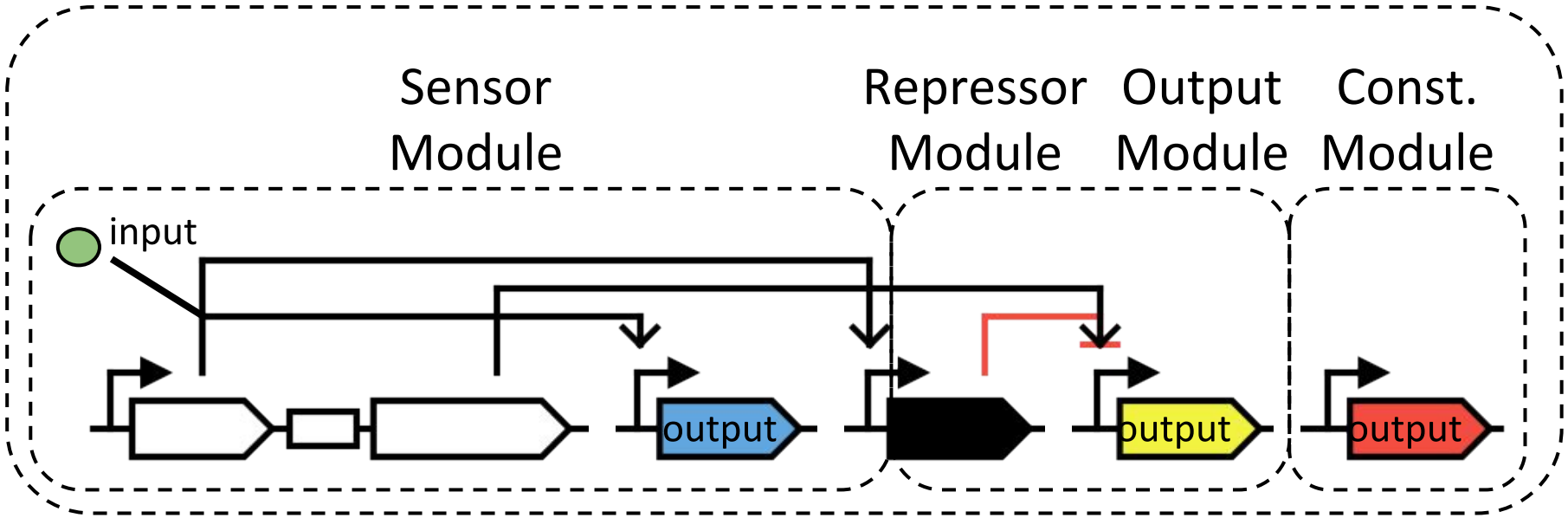
Noah Davidsohn, Jacob Beal, Samira Kiani, Aaron Adler, Fusun Yaman, Yingqing Li, Zhen Xie, and Ron Weiss. Accurate Predictions of Genetic Circuit Behavior from Part Characterization and Modular Composition. *ACS Synth. Biol. 2015, 4,* 673-681.

EQuIP Char. Interactions



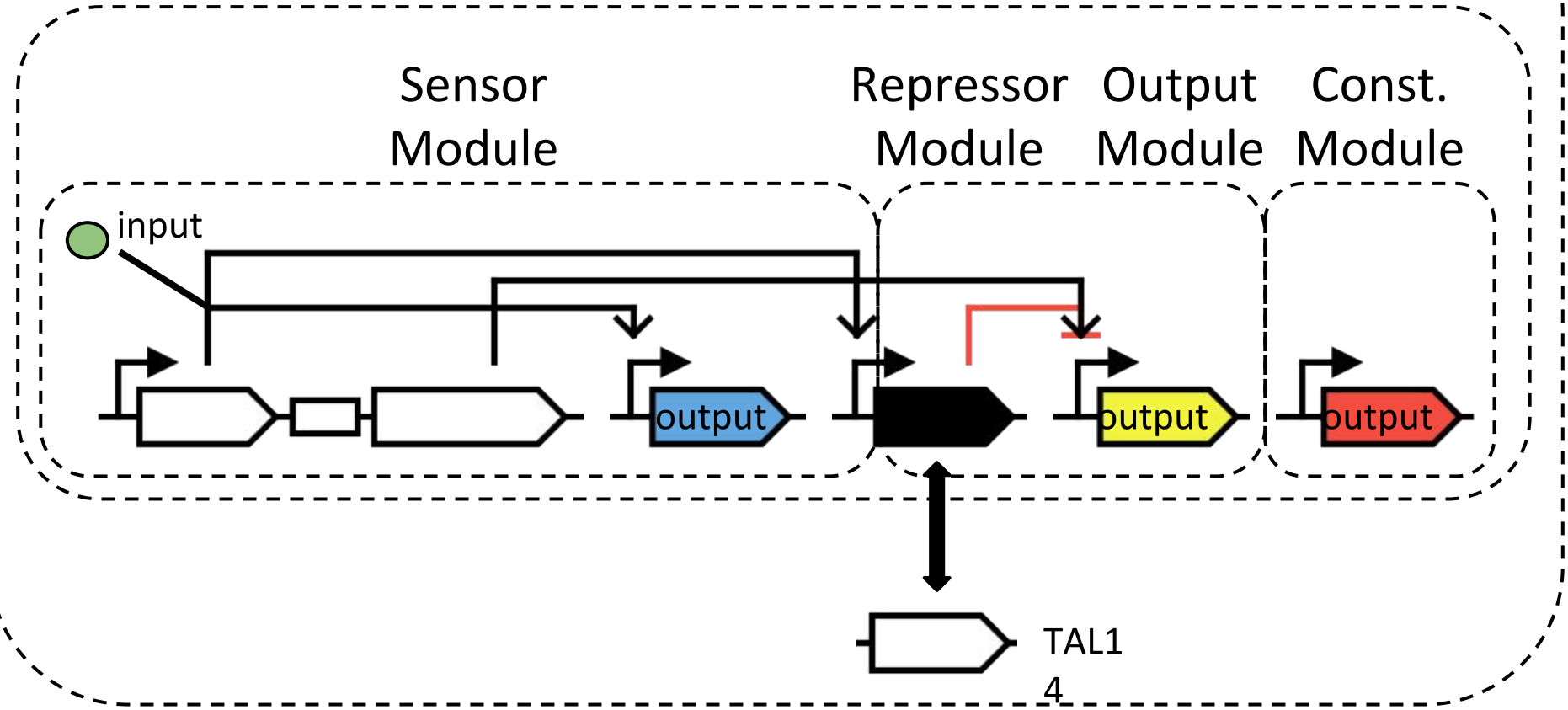
Noah Davidsohn, Jacob Beal, Samira Kiani, Aaron Adler, Fusun Yaman, Yingqing Li, Zhen Xie, and Ron Weiss. Accurate Predictions of Genetic Circuit Behavior from Part Characterization and Modular Composition. *ACS Synth. Biol. 2015, 4,* 673-681.

EQuIP Characterization Module



Noah Davidsohn, Jacob Beal, Samira Kiani, Aaron Adler, Fusun Yaman, Yingqing Li, Zhen Xie, and Ron Weiss. Accurate Predictions of Genetic Circuit Behavior from Part Characterization and Modular Composition. *ACS Synth. Biol. 2015, 4,* 673-681.

EQuIP Characterization Module



Noah Davidsohn, Jacob Beal, Samira Kiani, Aaron Adler, Fusun Yaman, Yingqing Li, Zhen Xie, and Ron Weiss. Accurate Predictions of Genetic Circuit Behavior from Part Characterization and Modular Composition. *ACS Synth. Biol. 2015, 4,* 673-681.

SBOL 2.0 Specification

Synthetic Biology Open Language (SBOL) Version 2.0.0

Editors:

Bryan Bartley	*University of Washington, USA*
Jacob Beal	*Raytheon BBN Technologies, USA*
Kevin Clancy	*ThermoFisher Scientific, USA*
Goksel Misirli	*Newcastle University, UK*
Nicholas Roehner	*Boston University, USA*

Chair:

Herbert Sauro	*University of Washington, USA*

editors@sbolstandard.org

Additional authors, by institution:

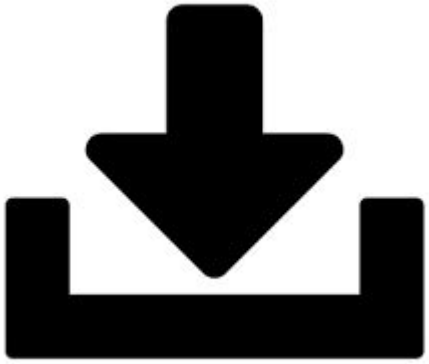
Ernst Oberortner	*DOE Joint Genome Institute, USA*
Curtis Madsen, Matthew Pocock, Anil Wipat	*Newcastle University, UK*
Tramy Nguyen, Zhen Zhang, Chris Myers	*University of Utah, USA*
John H. Gennari	*University of Washington, USA*
Michael Bissell	*Amyris, Inc., USA*

Version 2.0.0

July 31, 2015

More examples can be found in the SBOL 2.0 spec at http://sbolstandard.org/downloads/specification-data-model-2-0/

SBOL 2.0 Libraries

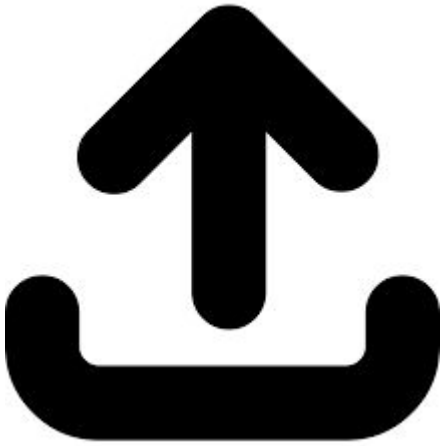


- The Java library supporting SBOL 2.0 is available as a beta release at

  http://sbolstandard.org/libsbol/get-the-libraries/java/

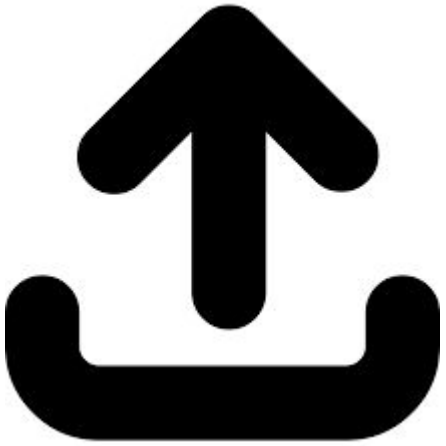
- C and Python libraries supporting SBOL 1.1 are also available and are undergoing development to support SBOL 2.0

Beyond SBOL 2.0



Labs doing similar research need to exchange SBOL 2.0 files so that new best practices and meta -standards can be defined for different areas of synthetic biology.

Beyond SBOL 2.0



SBOL needs to enable researchers and tools to designate design context.

- Conditions under which the design operates properly
- Marking which structural and functional entities are part of the design environment

Summary

SBOL 2.0 enables researchers and software tools to specify, exchange, and reuse unambiguous, heterarchical, modular descriptions of both the structure and function of biological designs.

Acknowledgements

University of Utah

- Prof. Chris Myers
- Tramy Nguyen
- Zhen Zhang

University of Washington

- Prof. Herbert Sauro
- Prof. John Gennari

Newcastle University

- Prof. Anil Wipat
- Curtis Madsen

DOE JGI

- Ernst Oberortner

Amyris, Inc.

- Michael Bissell

NSF Grants DBI-1356041 and DBI-1355909

EPSRC Grant EP/J02175X/1 EPSRC