

Title: A formalization of one of the main claims of “The cancer glycocalyx mechanically primes integrin-mediated growth and survival” by Paszek et al. 2014

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<http://purl.org/np/RAoo8EvTgfkxJw5SgZXbJvRI5nQG7ygeGaHp8Zud1U4Zw>

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Abstract:

Paszek et al. claimed in previous work that glycocalyx bulk mechanically drives integrin clustering in cancer cells engaged with the extracellular matrix. We present here a formalization of that claim, stating that all things of class “glycocalyx bulk” that are in the context of a thing of class “ecm bound cancer cell” generally have a relation of type “increases” to a thing of class “integrin clustering” in the same context.

1. Introduction

Paszek et al. [1] state that “Expression of large tumour-associated glycoproteins in non-transformed mammary cells promoted focal adhesion assembly and facilitated integrin-dependent growth factor signalling to support cell growth and survival.”. We present here a formalization of the main scientific claim from this quote by using a semantic template called the super-pattern [2].

2. Formalization

Our formalization looks as follows:

CONTEXT-CLASS (“in the context of all ...”): [ecm bound cancer cell](#)

SUBJECT-CLASS (“things of type ...”): [glycocalyx bulk](#)

QUALIFIER: [generally](#)

RELATION-TYPE (“have a relation of [increases](#) type...”):

OBJECT-CLASS (“to things of type...”): [integrin clustering](#)

In the context class we use a new minted class “ecm bound cancer cell” that is a subclass of “cancer cell” (Q4118072) from Wikidata and is related to the class “extracellular matrix” (Q193825) from Wikidata. In the subject class, we use a new minted class “glycocalyx bulk” that is related to the class “glycocalyx” (Q898356) from Wikidata. In the object class we minted a new class “integrin clustering” that is a subclass of “integrin binding” (Q14633861) from Wikidata and is related to the class “focal adhesion” (Q904514) from Wikidata.

3. RDF Code

This is our formalization as a nanopublication in TriG format:

```
@prefix this: <http://purl.org/np/RAoo8EvTgfkxJw5SgZXbJvRl5nQG7ygeGaHp8ZudlU4Zw> .
@prefix sub: <http://purl.org/np/RAoo8EvTgfkxJw5SgZXbJvRl5nQG7ygeGaHp8ZudlU4Zw#> .
@prefix np: <http://www.nanopub.org/nschema#> .
@prefix dct: <http://purl.org/dc/terms/> .
@prefix nt: <https://w3id.org/np/o/ntemplate/> .
@prefix npx: <http://purl.org/nanopub/x/> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix orcid: <https://orcid.org/> .
@prefix prov: <http://www.w3.org/ns/prov#> .
@prefix sp: <https://w3id.org/linkflows/superpattern/terms/> .

sub:Head {
  this: np:hasAssertion sub:assertion ;
  np:hasProvenance sub:provenance ;
  np:hasPublicationInfo sub:pubinfo ;
  a np:Nanopublication .
}
sub:assertion {
  sub:spi a sp:SuperPatternInstance ;
  rdfs:label "Glycocalyx bulk mechanically drives integrin clustering in cancer cells engaged with the extracellular matrix" ;
  sp:hasContextClass <http://purl.org/np/RAa0AF90U6YxAvnchfj0dRtT5HRz320Pz202aGap-VfuI#ecm-bound-cancer-cell> ;
  sp:hasSubjectClass <http://purl.org/np/RA-jkb7qPNTSOe_EXltW_rlQWQ9x3_YlKOzW6J_bbPz4U#glycocalyx-bulk> ;
  sp:hasQualifier <https://w3id.org/linkflows/superpattern/terms/generallyQualifier> ;
  sp:hasRelation <https://w3id.org/linkflows/superpattern/terms/increases> ;
  sp:hasObjectClass <http://purl.org/np/RAFH8AVn-wnTcSGxvPZlUiy_AtOhINlynnAxxiCdcTVWU#integrin-clustering> .
}
sub:provenance {
  sub:activity a sp:FormalizationActivity ;
  prov:used sub:quote , <https://www.nature.com/articles/nature13535> ;
  prov:wasAssociatedWith orcid:0000-0002-0830-7029 .
  sub:assertion prov:wasGeneratedBy sub:activity .
  sub:quote prov:value "Expression of large tumour-associated glycoproteins in non-transformed mammary cells promoted focal adhesion assembly and facilitated integrin-dependent growth factor signalling to support cell growth and survival." ;
  prov:wasQuotedFrom <https://www.nature.com/articles/nature13535> .
}
sub:pubinfo {
  sub:sig npx:hasAlgorithm "RSA" ;
```

```

    npx:hasPublicKey
"MiGfMA0GCSqGSIb3DQEBAQUAA4GNADCBiQKBgQCluZ2msgo70qPkyRoZMLuzpaLX8KRHyDs3J/cZwm6+Vq/CKVIGsGaT7/XH435cE9J8dwCgQ/Jssjlj6oqx+nSI9xXB
tMH9ZeyGHFBzKlCUBy/rRSez4EnwbS1sKMBS4MBCXQ9R3jZ3GpsN0GmIrSlukKkUBQrREBYpb4w5MbGywIDAQAB" ;
    npx:hasSignature
"Mc6yNlGIu3AnhZEmrajdDXbYISe2imFa80BDfBIWbQvJlOdxKaohx+dR9jwbzecksZ+bMNvtojd/ftMxBeLu3126L1DmW0kxIWotvfi+RRhgeaXTkRT/RV7EBmcuEfz
EU6Lk3YkK/v4dOiCP24meilyLdsNRLK4n44AvOr541E=" ;
    npx:hasSignatureTarget this: .
    this: dct:created "2021-11-26T17:14:38.341-07:00"^^xsd:dateTime ;
    dct:creator orcid:0000-0002-0830-7029 ;
    npx:introduces sub:spi ;
    npx:supersedes <http://purl.org/np/RAh1GOK4_HhqeUeJhIyV_DDCFFTY9jeeiKWgbSzooWEi4> ;
    <https://w3id.org/linkflows/reviews/isUpdateOf> <http://purl.org/np/RASZZ5T1Ca5gpCMPubKoypr_0WcSUKHiMaADu9o1BS1Xs> ;
    nt:wasCreatedFromProvenanceTemplate <http://purl.org/np/RAE1wniOy0yO39PlK9QkQ-wqbc3q-R2nXraP5huu8W39k> ;
    nt:wasCreatedFromPubinfoTemplate <http://purl.org/np/RA2vCBXZf-icEcVRGhulJXugTGxpsV5yVr9yqCilbQh4A> ,
<http://purl.org/np/RAA2MfgdBCzmz9yVWjKLXNbyfBNcwsMmOqcNUxkk1maIM> ,
<http://purl.org/np/RAjpbMlW3owYhJUBo3DtsuDlXsNAJ8cnGeWAutDVjuAuI> ;
    nt:wasCreatedFromTemplate <http://purl.org/np/RAv68imZrEjfcP2rnEglhzoBqEVc0cQMtp9_1za0BxNM4> .
}

```

The following nanopublications introduce the newly minted classes in TriG format.

This is the class definition of “ecm bound cancer cell”:

```

@prefix this: <http://purl.org/np/RAaOAF90U6YxAvnchfj0dRtT5HRz320Pz202aGap-VfuI> .
@prefix sub: <http://purl.org/np/RAaOAF90U6YxAvnchfj0dRtT5HRz320Pz202aGap-VfuI#> .
@prefix np: <http://www.nanopub.org/nschema#> .
@prefix dct: <http://purl.org/dc/terms/> .
@prefix nt: <https://w3id.org/np/o/ntemplate/> .
@prefix npx: <http://purl.org/nanopub/x/> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix orcid: <https://orcid.org/> .
@prefix prov: <http://www.w3.org/ns/prov#> .
@prefix skos: <http://www.w3.org/2004/02/skos/core#> .

sub:Head {
  this: np:hasAssertion sub:assertion ;
  np:hasProvenance sub:provenance ;
  np:hasPublicationInfo sub:pubinfo ;
  a np:Nanopublication .
}
sub:assertion {
  sub:ecm-bound-cancer-cell a <http://www.w3.org/2002/07/owl#Class> ;
  rdfs:label "cancer cell engaged in extracellular matrix" ;
  rdfs:subClassOf <http://www.wikidata.org/entity/Q4118072> ;
  skos:definition "cancer cell engaged in extracellular matrix" ;
  skos:relatedMatch <http://www.wikidata.org/entity/Q193825> .
}
sub:provenance {
  sub:assertion prov:wasAttributedTo orcid:0000-0002-0830-7029 .
}
sub:pubinfo {
  sub:sig npx:hasAlgorithm "RSA" ;
  npx:hasPublicKey
"MiGfMA0GCSqGSIb3DQEBAQUAA4GNADCBiQKBgQCluZ2msgo70qPkyRoZMLuzpaLX8KRHyDs3J/cZwm6+Vq/CKVIGsGaT7/XH435cE9J8dwCgQ/Jssjlj6oqx+nSI9xXB
tMH9ZeyGHFBzKlCUBy/rRSez4EnwbS1sKMBS4MBCXQ9R3jZ3GpsN0GmIrSlukKkUBQrREBYpb4w5MbGywIDAQAB" ;
  npx:hasSignature
"J5J3Blgx/OmReiNFC8+4TzqHm34UUmKcQKRhq7SVFq5H0rLE0fqyX4RfZFA0oQg5dfD7vnbVttaGsUQZs1IwldU4r/CYko2IXUQiptdcy28cR76t/4coiBcFCZpqy3GP
TKwIj7uR/aJIUj4UDzA6LCmsWju0hTlbp5NDmNhT+8E=" ;
  npx:hasSignatureTarget this: .
  this: dct:created "2021-11-12T09:21:35.816-08:00"^^xsd:dateTime ;
  dct:creator orcid:0000-0002-0830-7029 ;
  npx:introduces sub:ecm-bound-cancer-cell ;
  npx:supersedes <http://purl.org/np/RAXecDWH8gZVp7FZRP1m_Fg6EXH_uoZGhKN9blfN9lrfI> ;
  <https://w3id.org/linkflows/reviews/isUpdateOf> <http://purl.org/np/RAXecDWH8gZVp7FZRP1m_Fg6EXH_uoZGhKN9blfN9lrfI> ;
  nt:wasCreatedFromProvenanceTemplate <http://purl.org/np/RANwQa4ICWS5SOjw7gp99nBpXBasapwtZF1fIM3H2gYTM> ;
  nt:wasCreatedFromPubinfoTemplate <http://purl.org/np/RAA2MfgdBCzmz9yVWjKLXNbyfBNcwsMmOqcNUxkk1maIM> ,
<http://purl.org/np/RAOGu9Lh0BD4tbIRB9RG6RGRA_ObDh75NTbIgaWgxxs8M> ,
<http://purl.org/np/RAjpbMlW3owYhJUBo3DtsuDlXsNAJ8cnGeWAutDVjuAuI> ;
  nt:wasCreatedFromTemplate <http://purl.org/np/RADpgRpigXtt8iPV9uOPf3wIT3qzOI8Sg2Q72CNV8g-Yo> .
}

```

This is the class definition of “glycocalyx bulk”:

```

@prefix this: <http://purl.org/np/RA-jkb7qPNTSOe_EXltW_rlQWQ9x3_YlKOzW6J_bbPz4U> .
@prefix sub: <http://purl.org/np/RA-jkb7qPNTSOe_EXltW_rlQWQ9x3_YlKOzW6J_bbPz4U#> .
@prefix np: <http://www.nanopub.org/nschema#> .
@prefix dct: <http://purl.org/dc/terms/> .
@prefix nt: <https://w3id.org/np/o/ntemplate/> .
@prefix npx: <http://purl.org/nanopub/x/> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix orcid: <https://orcid.org/> .
@prefix prov: <http://www.w3.org/ns/prov#> .
@prefix skos: <http://www.w3.org/2004/02/skos/core#> .

sub:Head {
  this: np:hasAssertion sub:assertion ;
  np:hasProvenance sub:provenance ;
  np:hasPublicationInfo sub:pubinfo ;
  a np:Nanopublication .
}

sub:assertion {
  sub:glycocalyx-bulk a <http://www.w3.org/2002/07/owl#Class> ;
  rdfs:label "glycocalyx bulk" ;
  skos:definition "Relating to size, density, or bulk of the glycocalyx" ;
  skos:relatedMatch <http://www.wikidata.org/entity/Q898356> .
}

sub:provenance {
  sub:assertion prov:wasAttributedTo orcid:0000-0002-0830-7029 .
}

sub:pubinfo {
  sub:sig npx:hasAlgorithm "RSA" ;
  npx:hasPublicKey
"MIgfMA0GCSqGSIb3DQEBAQUAA4GNADCBiQKBgQCcluZ2msgo7OqPkyRoZMLuzpaLX8KRHyDs3J/cZwm6+Vq/CKVIGsGaT7/XH435cE9J8dwCgQ/Jssjlj6oqX+nSI9xxXB
tMH9ZeyGHFBzKlclUBY/rRSez4EnwbSlsKMBSc4MBCXQ9R3jZ3GpsN0GmIrsLukKkUBQrREBYpb4w5MbGywIDAQAB" ;
  npx:hasSignature
"WlBavo5gWbVaY3li3E/uayLdSkt0IFbe2m+P7z0CEaoghbsTAeshmDjw9pmd2bzPQFblGdiWBr5yhGHXGorM4v3bkV2nIiRecOwhvtu9hm2pIUtS8QwD6kkgHs0lWxzT
4Wqs3GmS63PgN3cxZjEs0ButWUhiXbd2V6gKLUPvaK8=" ;
  npx:hasSignatureTarget this: .
  this: dct:created "2021-11-12T09:27:02.246-08:00"^^xsd:dateTime ;
  dct:creator orcid:0000-0002-0830-7029 ;
  npx:introduces sub:glycocalyx-bulk ;
  npx:supersedes <http://purl.org/np/RACS5sSm45MGbuJrztPrpdulAuLiKxDni-6JcKzN5ZtM> ;
  <https://w3id.org/linkflows/reviews/isUpdateOf> <http://purl.org/np/RACS5sSm45MGbuJrztPrpdulAuLiKxDni-6JcKzN5ZtM> ;
  nt:wasCreatedFromProvenanceTemplate <http://purl.org/np/RANwQa4ICWS5SOjw7gp99nBpXBasapwtZF1fIM3H2gYTM> ;
  nt:wasCreatedFromPubinfoTemplate <http://purl.org/np/RAA2MfgdBczmz9yVWjKLXNbyfBNcwsMmOqcNUxkklmaIM> ,
<http://purl.org/np/RAOGu9Lh0BD4tbIRB9RG6RGRA_ObDh75NTbIqaWgx8M> ,
<http://purl.org/np/RAjpbMlw3owYhJUBo3DtsuDlXsNAJ8cnGeWAutDVjuAuI> ;
  nt:wasCreatedFromTemplate <http://purl.org/np/RAdpgRpigXtt8iPV9uOPf3wIT3qzOI8Sg2Q72CNV8g-Yo> .
}

```

This is the class definition of “integrin clustering”:

```

@prefix this: <http://purl.org/np/RAFh8AVn-wntcSGxvPZlUiY_AtOhINlynnAxxiCdcTVWU> .
@prefix sub: <http://purl.org/np/RAFh8AVn-wntcSGxvPZlUiY_AtOhINlynnAxxiCdcTVWU#> .
@prefix np: <http://www.nanopub.org/nschema#> .
@prefix dct: <http://purl.org/dc/terms/> .
@prefix nt: <https://w3id.org/np/o/ntemplate/> .
@prefix npx: <http://purl.org/nanopub/x/> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix orcid: <https://orcid.org/> .
@prefix prov: <http://www.w3.org/ns/prov#> .
@prefix skos: <http://www.w3.org/2004/02/skos/core#> .

sub:Head {
  this: np:hasAssertion sub:assertion ;
  np:hasProvenance sub:provenance ;
  np:hasPublicationInfo sub:pubinfo ;
  a np:Nanopublication .
}

sub:assertion {
  sub:integrin-clustering a <http://www.w3.org/2002/07/owl#Class> ;
  rdfs:label "integrin clustering" ;
  rdfs:subClassOf <http://www.wikidata.org/entity/Q14633861> ;
  skos:definition "clustering of integrin proteins at a focal adhesion" ;
  skos:relatedMatch <http://www.wikidata.org/entity/Q904514> .
}

sub:provenance {
  sub:assertion prov:wasAttributedTo orcid:0000-0002-0830-7029 .
}

sub:pubinfo {

```

```

    sub:sig npx:hasAlgorithm "RSA" ;
    npx:hasPublicKey
    "MIGfMA0GCSqGSIb3DQEBAQUAA4GNADCBiQKBgQCluZ2msgo7OqPkyRoZMluzpaLX8KRHyDs3J/cZwm6+Vq/CKVIGsGaT7/XH435cE9J8dwCgQ/Jssjlj6oqX+nSI9xxB
    tMH9ZeyGHFBzKlcUBy/rRSez4EnwbS1sKMBS4MBCXQ9R3jZ3GpsN0GmIrS1ukKkUBQrREBYpb4w5MbGywIDAQAB" ;
    npx:hasSignature
    "Bw052zD4Sd8+EkXb26m8oz03UEYZVfzKsvkEbf3j/zJeQJ/2PsYF94kN6QBs0mKoSeHJJQxOM0er6WCcTbYmltvLgG2zQYEF3wkhRMTx5eEVjEMAXx4S57/Ur2a5yh+
    HzyqELJlJg+2JIUQdHKO8F0F0VUqB2tyEf/ZhjMFz10=" ;
    npx:hasSignatureTarget this: .
    this: dct:created "2021-11-12T09:17:34.478-08:00"^^xsd:dateTime ;
    dct:creator orcid:0000-0002-0830-7029 ;
    npx:introduces sub:integrin-clustering ;
    npx:supersedes <http://purl.org/np/RA9UaQM3wVa9xRAmL9CWEXyhDbcgvH1PoGTw4pnKaHYL8> ;
    <https://w3id.org/linkflows/reviews/isUpdateOf> <http://purl.org/np/RA9UaQM3wVa9xRAmL9CWEXyhDbcgvH1PoGTw4pnKaHYL8> ;
    nt:wasCreatedFromProvenanceTemplate <http://purl.org/np/RANwQa4ICWS5SOjw7gp99nBpXBasapwtZF1fIM3H2gYTM> ;
    nt:wasCreatedFromPubinfoTemplate <http://purl.org/np/RAA2MfgdBCzmz9yVWjKLNbyfBNcwsMmOqcNUxkk1maIM> ,
    <http://purl.org/np/RAOGu9Lh0BD4tbIRB9RG6RGRA_ObDh75NTbIqaWgxxs8M> ,
    <http://purl.org/np/RAjpbMlw3owYhJUBo3DtsuD1XsNAJ8cnGeWAutDVjuAuI> ;
    nt:wasCreatedFromTemplate <http://purl.org/np/RAdpgRpigXtt8iPV9uOPf3wIT3qzOI8Sg2Q72CNV8g-Yo> .
}

```

References

- [1] Paszek, M., DuFort, C., Rossier, O. et al. The cancer glycocalyx mechanically primes integrin-mediated growth and survival. *Nature* 511, 319–325 (2014). doi: 10.1038/nature13535.
- [2] Bucur, C.I., Kuhn, T., Ceolin, D., Ossenbruggen, J. van. Expressing high-level scientific claims with formal semantics. In: *Proceedings of the 11th Knowledge Capture Conference* 2021. doi: 10.1145/3460210.3493561.