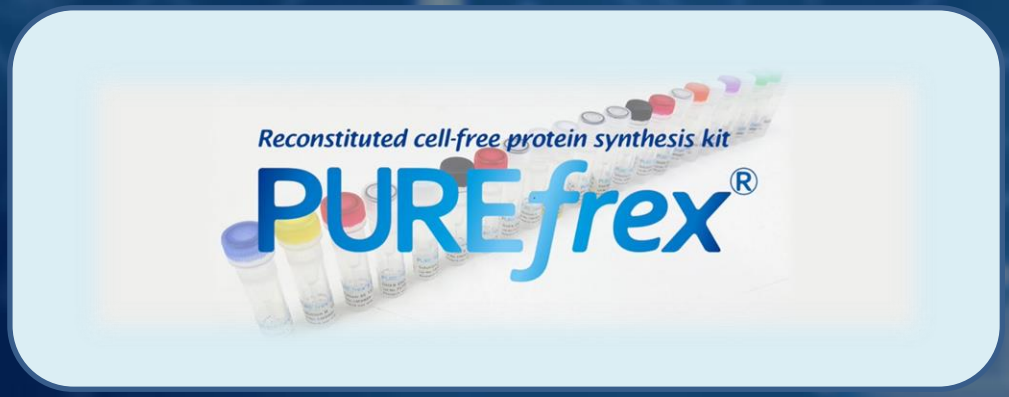
PUREfrex® : The Re-built Protein Factory



Takashi (Ebi) Ebihara, Ph.D.
COO
GeneFrontier Corporation

GeneFrontier

Discovery & Development
15-16 of June, 2026

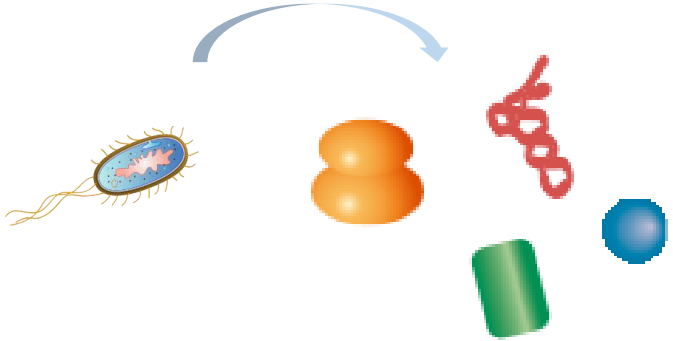
Corporate Summary

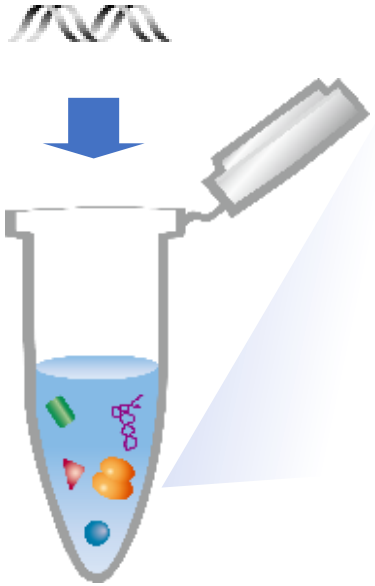
GeneFrontier

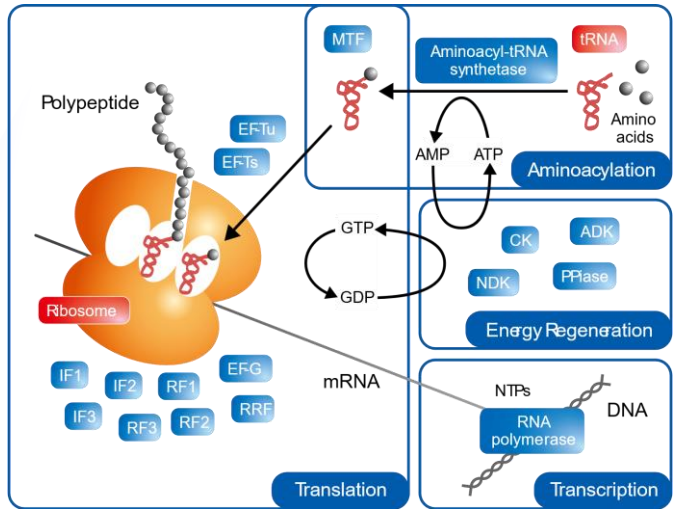
Founded :	*Oct 13th, 2010 (renewed)*
Shareholder :	*KANEKA Corporation (100%)*
People :	*17 (Ph.D. 8, MS 1)*
Place :	*Chiba, Japan*

Mission :	*Rebuilding and Manipulating Biological system for Inspiring the world!*

Only necessary molecules
for transcription/translation





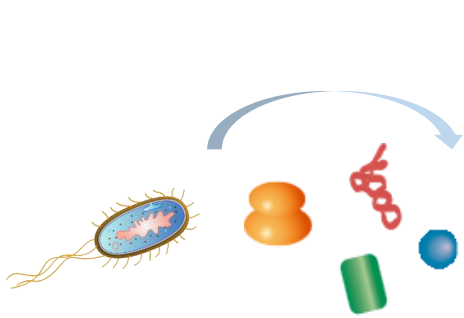


=Breaking down & Building up

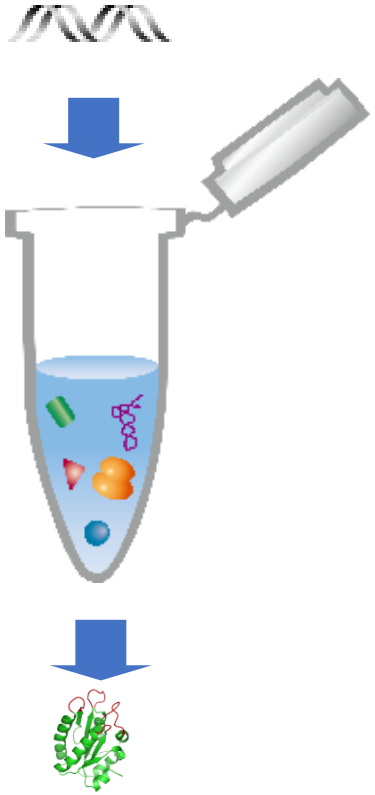
PURE system

(Protein synthesis Using Recombinant Elements)

Shimizu Y. et al. Nature Biotechnology
vol 19, p751–755 (2001)



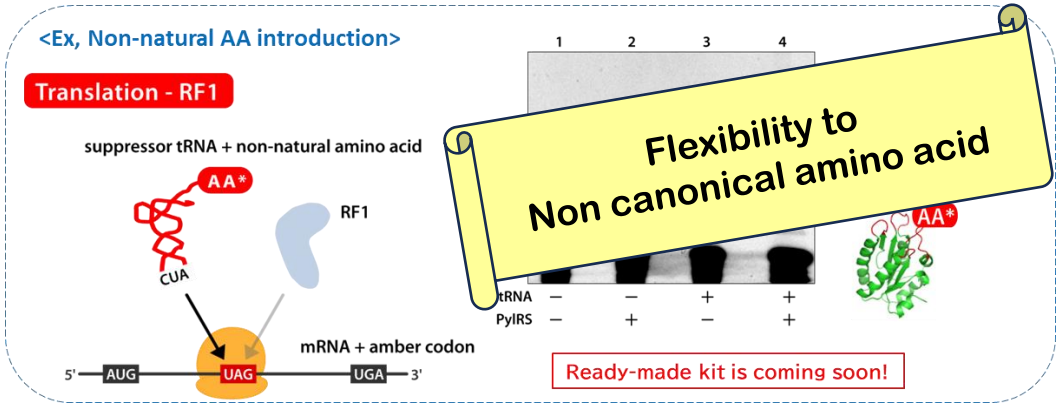
PURE system



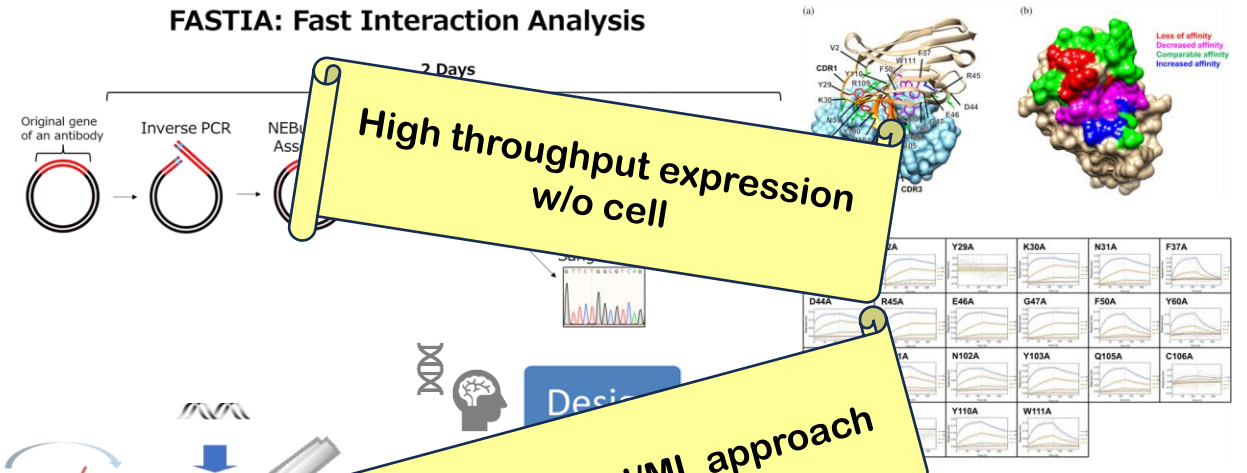
Reconstituted cell-free protein synthesis kit

PURE*frex*®

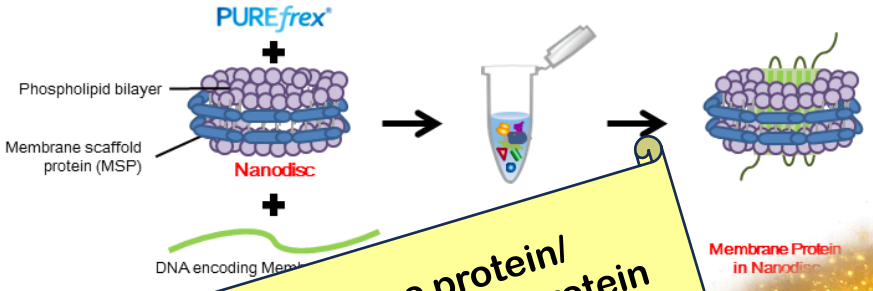
For Designing Central Dogma



Flexibility to Non canonical amino acid



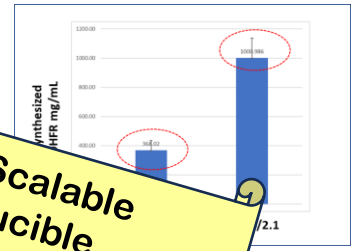
High throughput expression w/o cell



Membrane protein/ Difficult-to-express protein

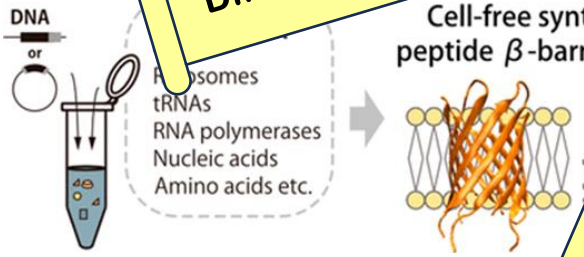
Protein Sci. Mar;34(3):e70065. doi: 10.1002/pro.70065.

Suitable for AI/ML approach



Speedy & Scalable & Reproducible reaction

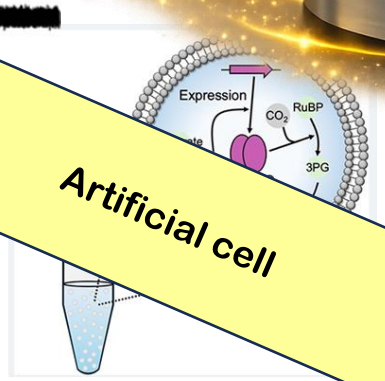
μL ～ L scale



Cell-free synthesizable peptide β-barrel nanopore

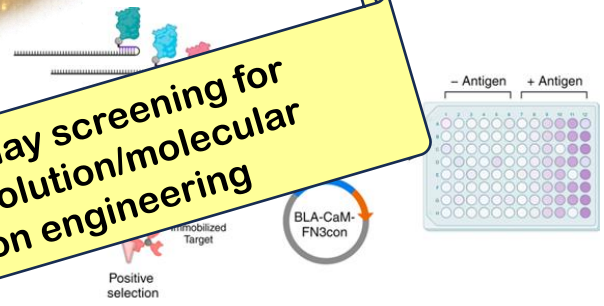
Fujita et al. (2023) ACS Nano. vol.17(4) p.33

Artificial cell



Sugii et al. (2023) Synth. Biol. vol.8, p1

In vitro display screening for Directed evolution/molecular evolution engineering



Chui Z. et al. (2024) ACS Sens, 9(6):2846-2857.

Reconstituted cell-free protein synthesis kit

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–Primary Applications（analysis of papers in 2025）–

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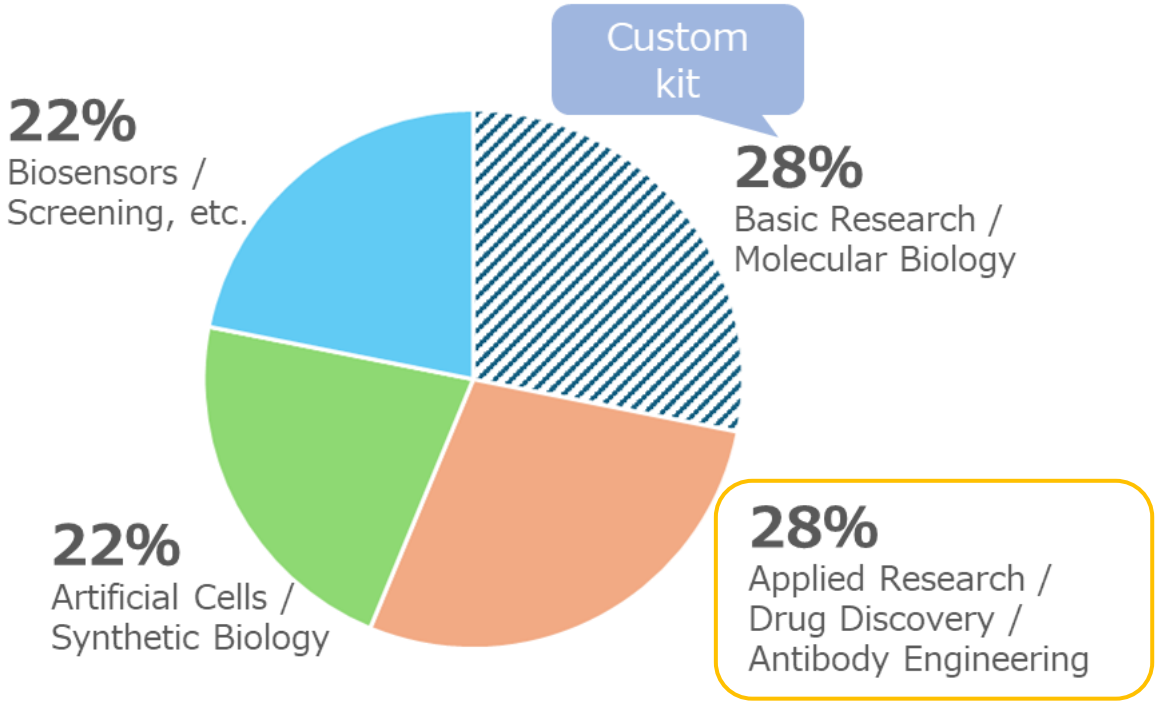
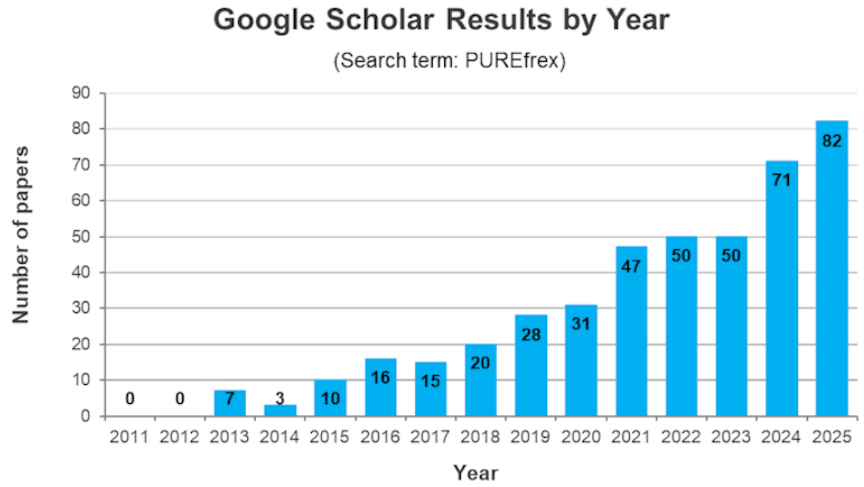
Applications	Screening Structural Analysis（X-ray、NMR、Cryo-EM） Functional Analysis Enzyme Engineering and Protein Modification





PURExpress Is Recommended If You:

- Require only a few hundred μg
- Want to synthesize multiple proteins
  (including **for AI/ML**)
- Drug discovery/Screening especially for
  antibody-related protein expression
- Want to skip purification

Reconstituted cell-free protein synthesis kit

PURE*frex*®

-Improve Validation from Weeks to Days-

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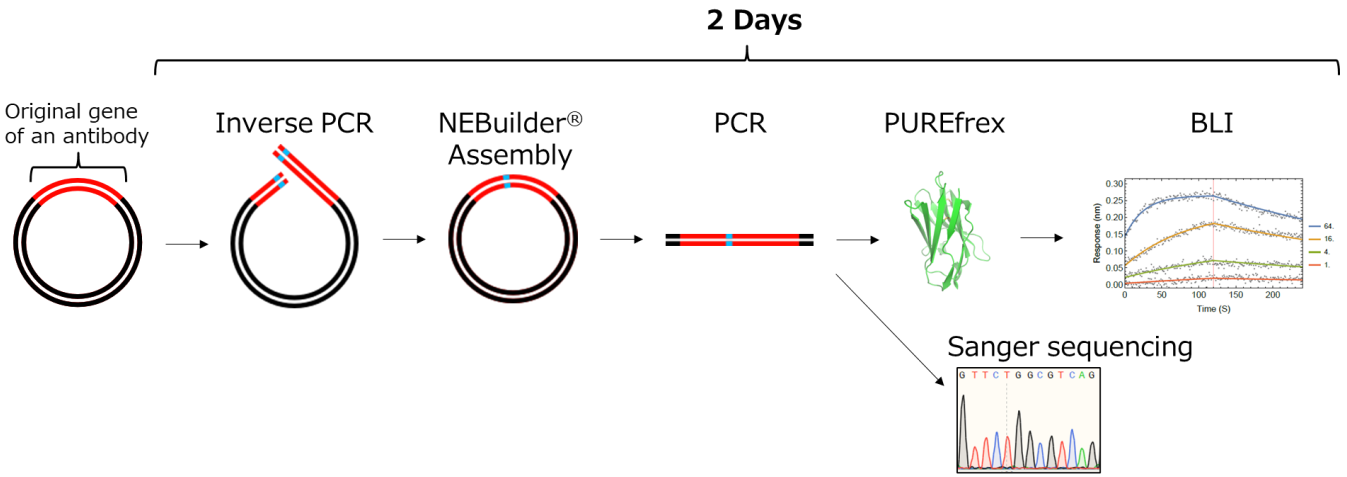
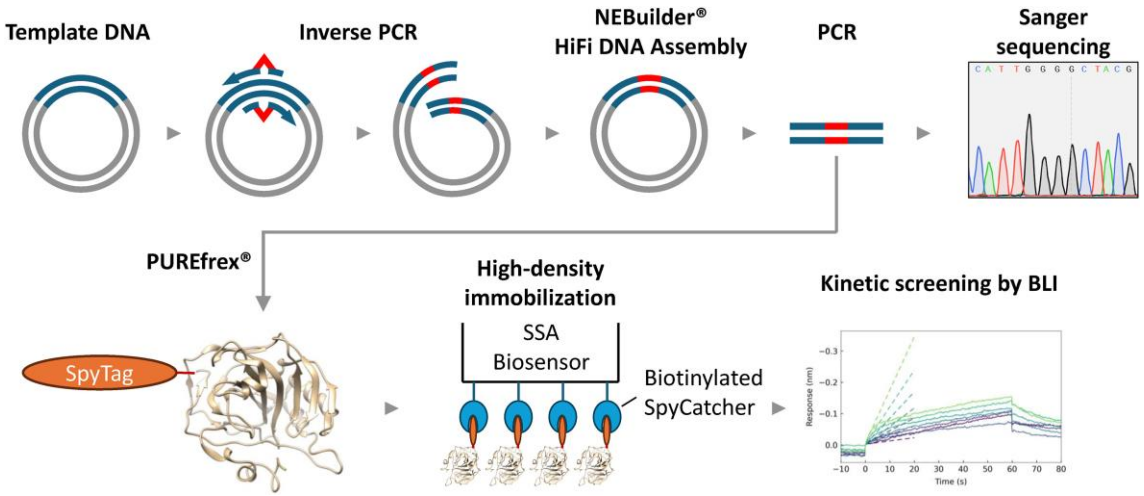
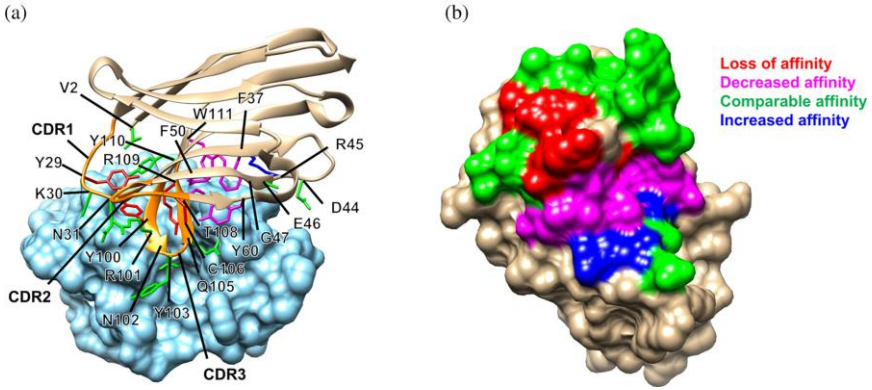
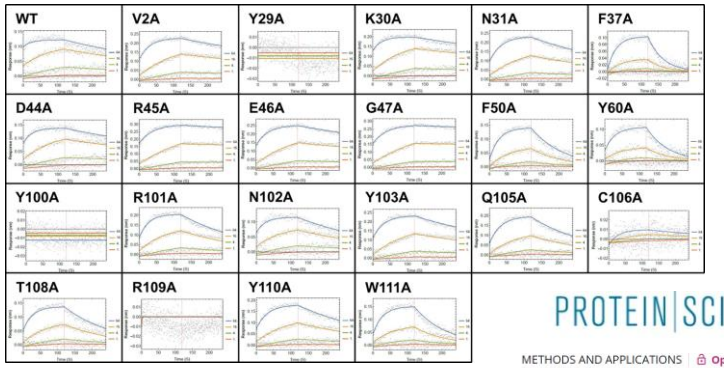
FASTIA: Fast Interaction Analysis



smFASTIA








PROTEIN SCIENCE

METHODS AND APPLICATIONS | Open Access

FASTIA: A rapid and accessible platform for protein variant interaction analysis demonstrated with a single-domain antibody

Ryo Matsunaga, Kouhei Tsumoto

First published: 21 February 2025 | https://doi.org/10.1002/pro.70065 | VIEW METRICS

Matsunaga et al. (2025) Protein Sci. Mar;34(3):e70065. doi: 10.1002/pro.70065.

Tokunaga et al. (2026) BBRC. Feb 19:801:153300. doi: 10.1016/j.bbrc.2026.153300.

Reconstituted cell-free protein synthesis kit

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-For High Throughput Platform-

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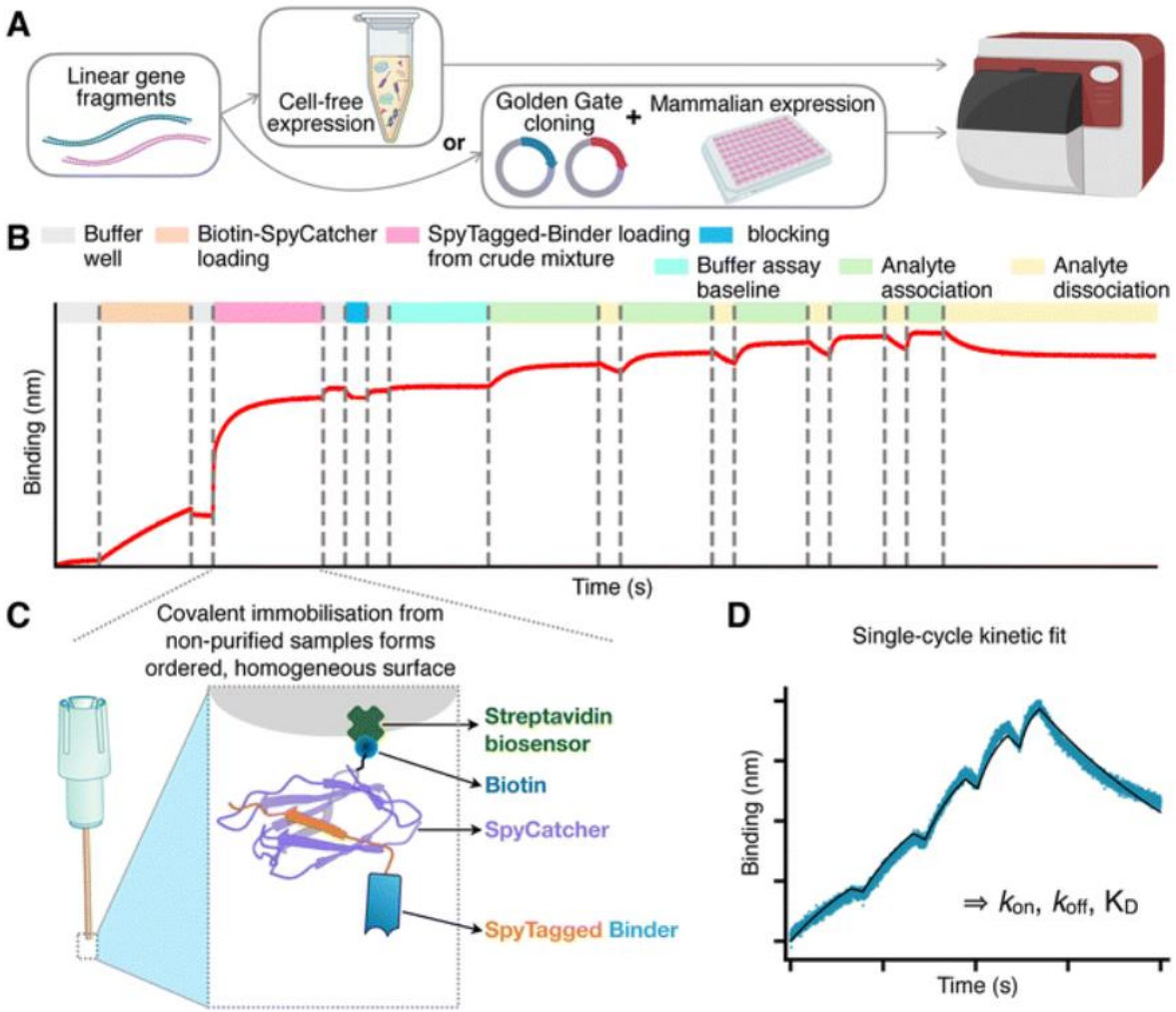
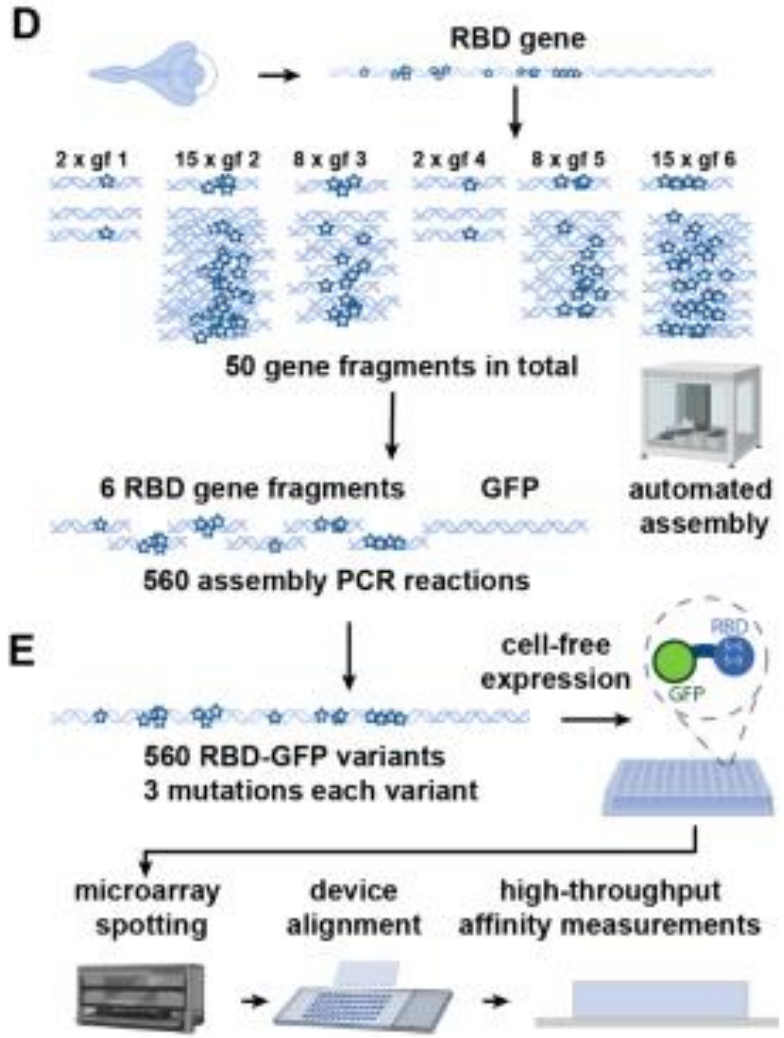


Predenia et al. (2025) RSC Chem. Biol, 6(1313).



Grasemann et al. (2025) bioRxiv. https://doi.org/10.1101/2025.09.23.678000.

Reconstituted cell-free protein synthesis kit

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-Expression of scFv, Fab, IgG and more-

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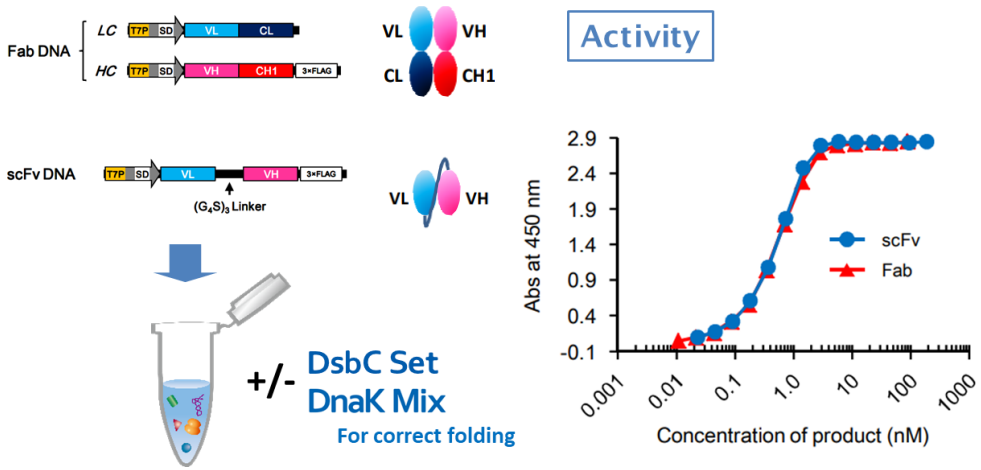
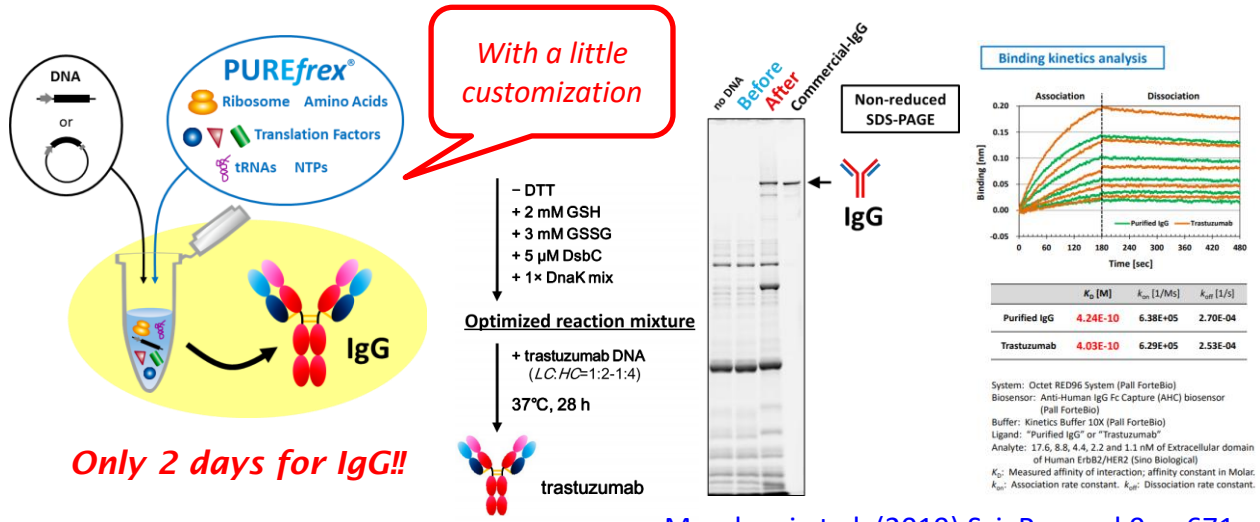
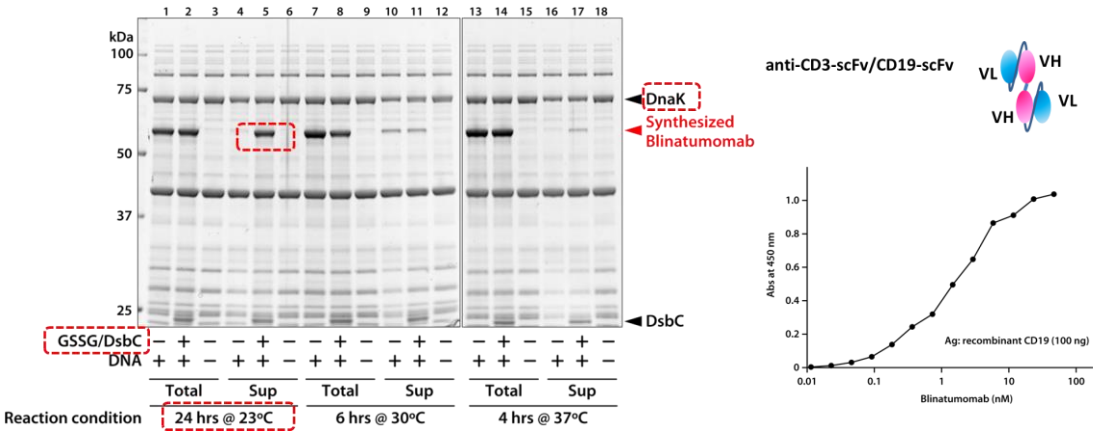


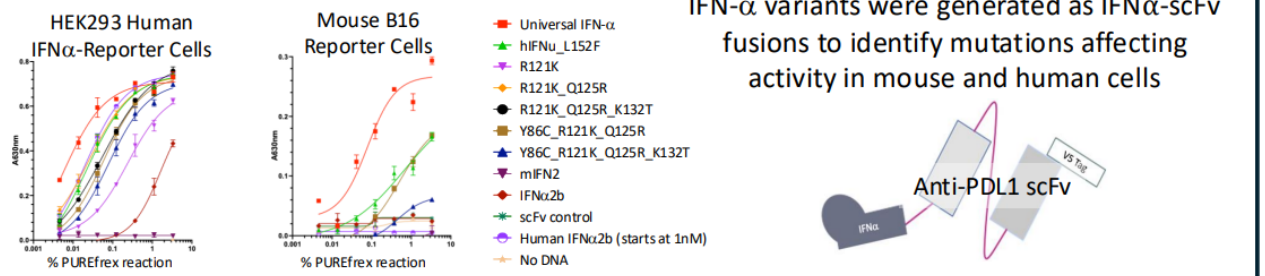
Murakami et al. (2019) Sci. Rep. vol.9, p.671. (Supplementary Information)



Murakami et al. (2019) Sci. Rep. vol.9, p.671.



Round 1: IFN-α variants tested by in vitro transcription/translation



IFNa-scFv protein was generated with an anti-PDL1 antibody by in vitro transcription/translation using the PURExpress® system (CosmoBIO USA). Protein mixture was serially diluted and protein was captured via an anti-V5 tag coated to the wells of the plate. Proteins were assayed for PD-L1 binding to assess expression (data not shown) or the ability to stimulate an IFN-α response in receptor reporter cell lines

Killebrew et al. (2024) SITC 2024 Annual Meeting (Poster, BONUMTX.com).

Reconstituted cell-free protein synthesis kit

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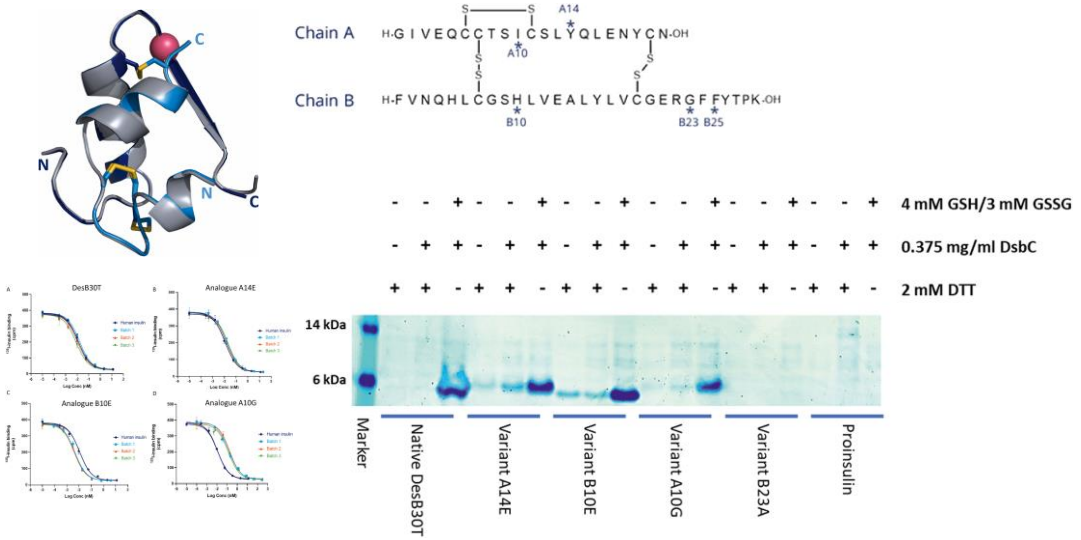
-Application for complex molecule-

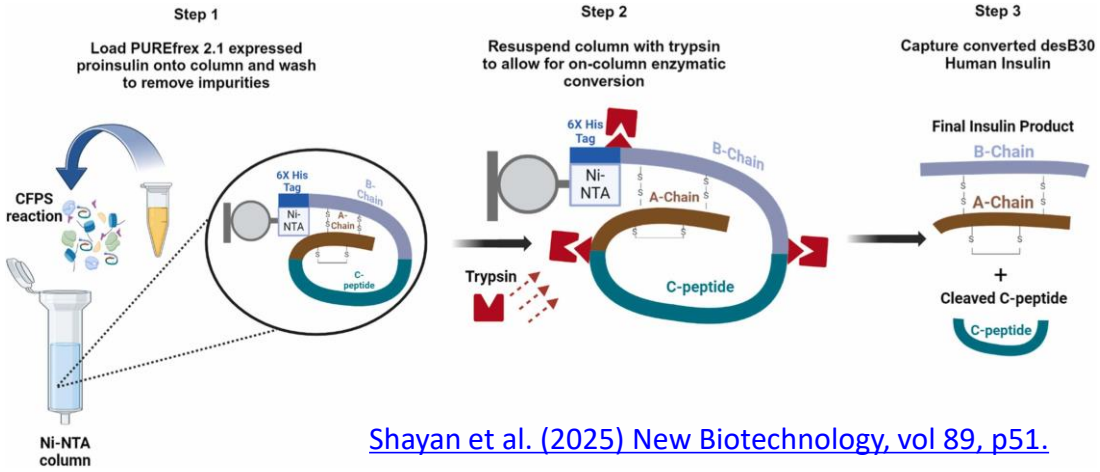
GeneFrontier



Jensen et al. (2021) Protein Expr. Purif., 186, 105910.

	1	2	3	4	5	6	7	8	9	10
	Proinsulin Aspart	Proinsulin Lispro	Proinsulin Glargine	Regular Proinsulin	Insulin A Chain	Insulin B Chain	Insulin A Chain Heterodimer	Insulin B Chain Heterodimer	Oxytocin	Glucagon
PURE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Clm24	X	X	X	X	✓	X	✓	✓	✓	✓
BL21	X	X	X	X	✓	X	✓	✓	✓	X
759	✓	✓	✓	✓	✓	✓	✓	✓	✓	X
	11	12	13	14	15	16	17	18	19	20
	Glucagon Like Peptide 1 mutant (GLP-1 mut)	Glucagon Like Peptide 1 (GLP-1)	Insulin Like Growth Factor	Growth Hormone (GH)	Leptin	Vaso-pressin	Angiotensin II	Parathyroid Hormone (PTH)	Somato-statin	Leuprolide
PURE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Clm24	✓	✓	X	✓	✓	✓	✓	✓	✓	✓
BL21	X	X	X	X	X	X	✓	✓	✓	✓
759	✓	✓	X	✓	✓	✓	✓	X	✓	✓

DeWinter et al. (2023) ACS Synth. Biol. vol.12, 4, p1216. (Supplementary Information)



Shayan et al. (2025) New Biotechnology, vol 89, p51.

Reconstituted cell-free protein synthesis kit

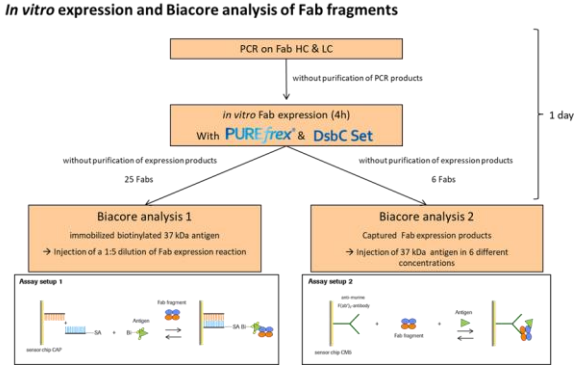
PURE*frex*®

-as a platform for many companies-

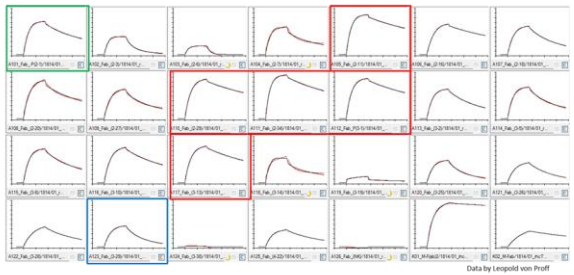
GeneFrontier

Roche

In vitro expression and Biacore analysis of Fab fragments



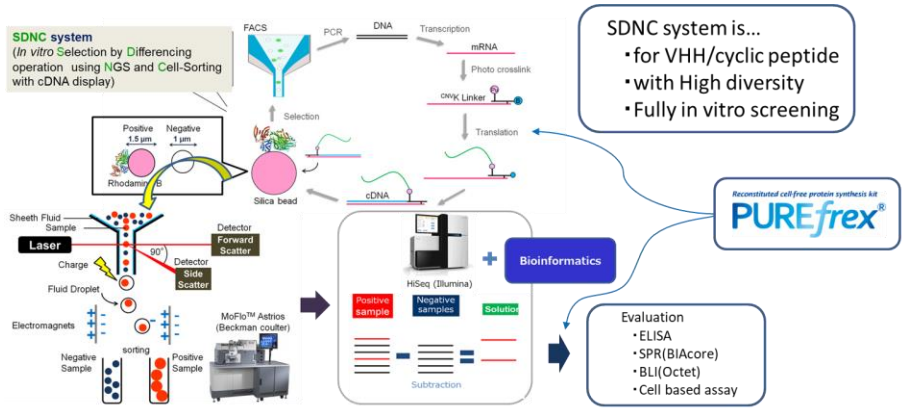
Kinetic analysis of 25 Fab binders



→ Selection of Fabs for further kinetic analysis

Epsilon Molecular Engineering

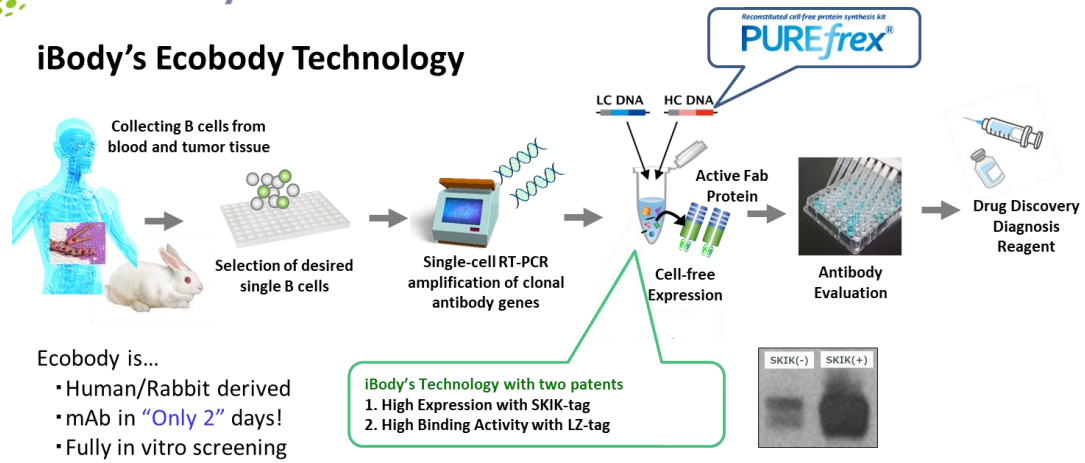
Molecular Design for Human Life



https://www.epsilon-mol.co.jp/eng/

iBody

iBody's Ecobody Technology



Ecobody is...
- Human/Rabbit derived
- mAb in "Only 2" days!
- Fully in vitro screening
- No culture

https://www.ibody.co.jp/en/

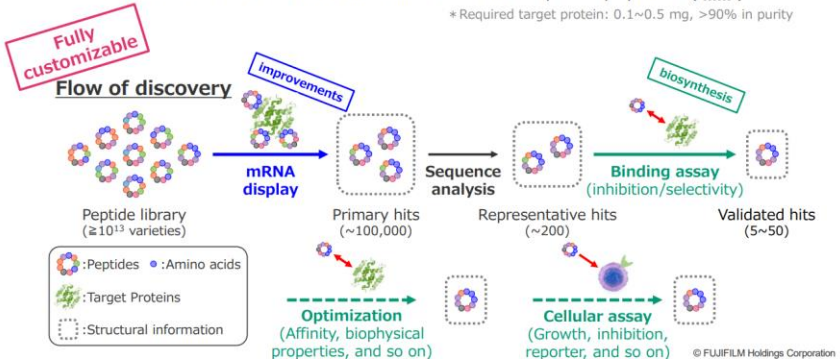
FUJIFILM peptide discovery services

collaborated with PURE*frex*®

- ✓ **Innovative improvements** in **mRNA display** enable screening from >10^{13} peptides
- ✓ **Practical biosynthesis & assays** enable rapid selection and activity explorations.
  → Peptides hits with **wide varieties** and **high-affinities** can be obtained.

We provide a CRO service, in which we receive target ( ) from the customer*
and return the structural information of the acquired peptides ( ).

*Required target protein: 0.1~0.5 mg, >90% in purity



Reconstituted cell-free protein synthesis kit

PURE*frex*®

-as a platform for in vitro display-

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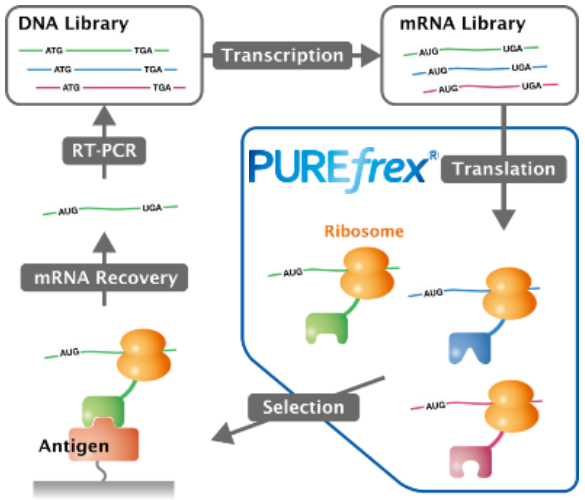
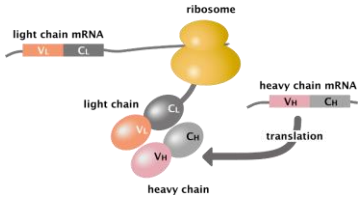
in vitro protein selection technology

PURE*frex*® RD





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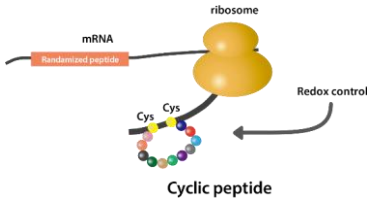
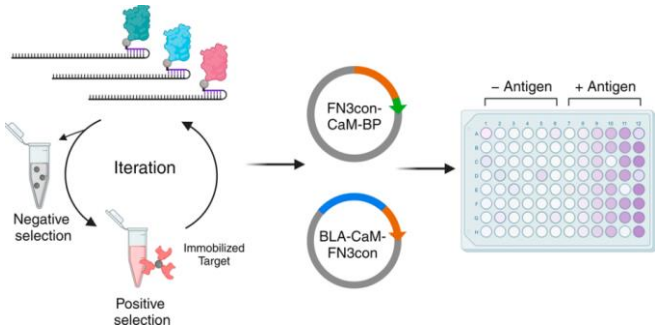
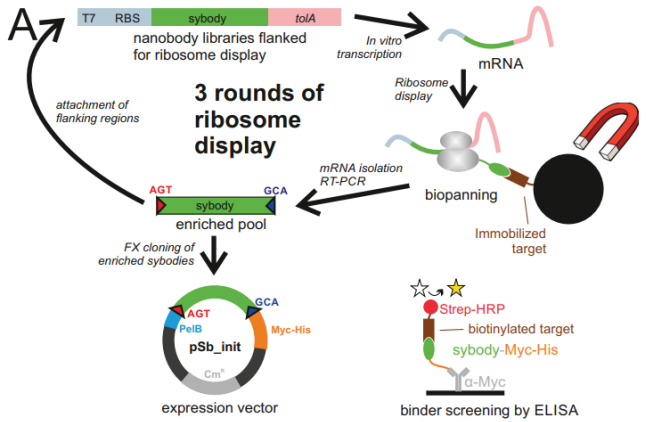
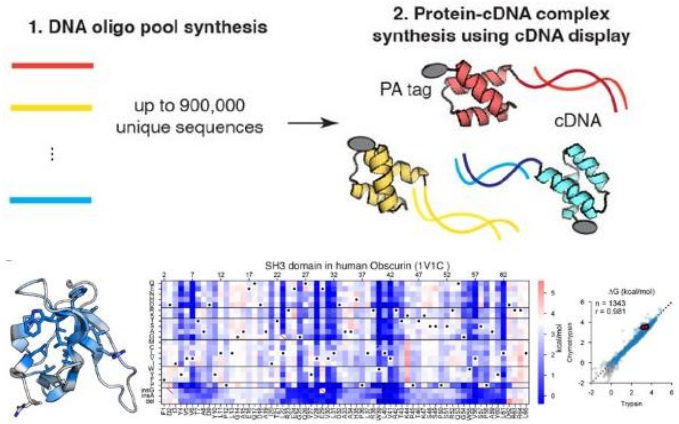




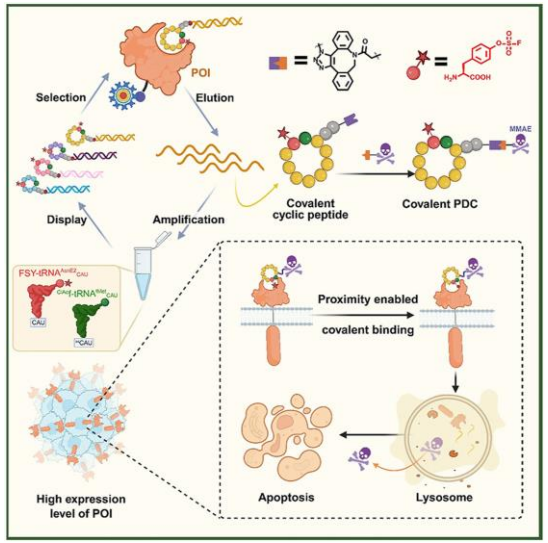
Chui Z. et al. (2024) ACS Sens, 9(6):2846-2857.



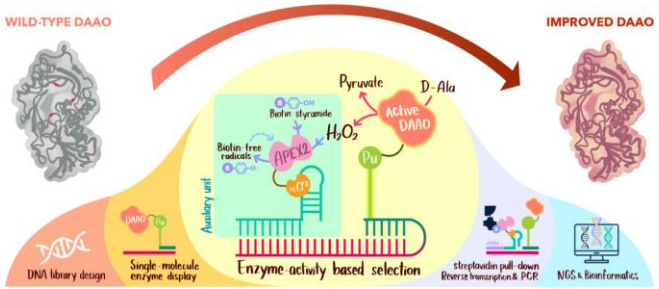
Zimmermann I. et al. (2018) eLife, 7, e34317.



Tsuboyama et al. (2023) Nature, 620, p434.



Wang et al. (2025) Acta Pharmaceutica Sinica B. vol.15(5474).



Munaweera et al. (2026) ACS Synth Biol. Feb 23. doi: 10.1021/acssynbio.5c00968.

Reconstituted cell-free protein synthesis kit

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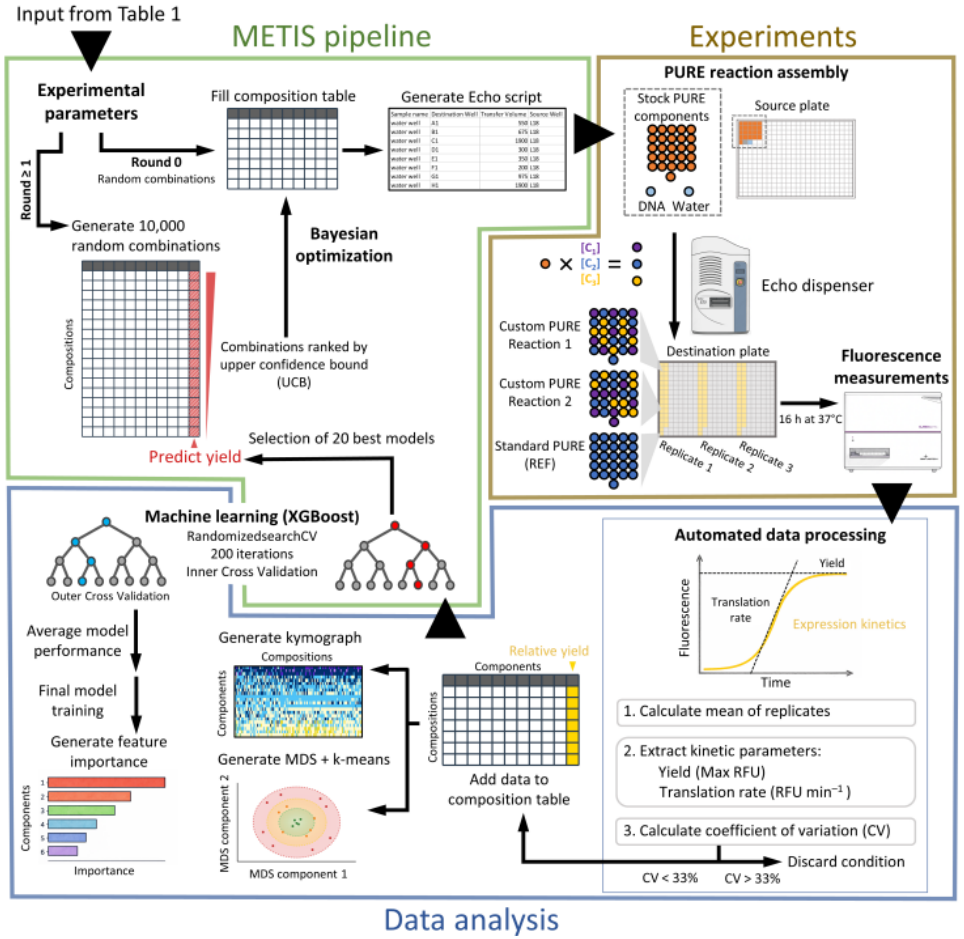
-Broad applications, yet to come!-

GeneFrontier

Abbreviation	Components	Function	PURE*frex* 2.0 solution	Calibration
hepes	HEPES-KOH	Buffer and reducing agents	I	GPSA
k-glut	Potassium glutamate	Buffer and reducing agents	I	GPSA
mg-acet	Magnesium acetate	Buffer and reducing agents	I	GPSA
gsh	Glutathione	Buffer and reducing agents	I	GP
spermidine	Spermidine	Buffer and reducing agents	I	GPSB
fthf	10-formyl-tetrahydrofolate	Aminoacylation	I	GPSA
cp	Creatine phosphate	Energy regeneration	I	GP
aa18	All amino acids except tyrosine & cysteine	Aminoacylation	I	GPSA
tyr	Tyrosine	Aminoacylation	I	GPSA
cys	Cysteine	Aminoacylation	I	GP
atp-gtp	Adenosine triphosphate, guanosine triphosphate	Transcription / Aminoacylation / Translation	I	GPSB
ctp-utp	Cytidine triphosphate, uridine triphosphate	Transcription	I	GPSA
tRNAs	Transfer RNA mix	Aminoacylation / Translation	I	GP
aaRSs-mtf	All aminoacyl-tRNA synthetases, Methionyl-tRNA formyltransferase	Aminoacylation	II	GP
IFs	Initiation factors: IF-1, IF-2, IF-3	Translation	II	GP
EFs	Elongation factors: EF-Tu, EF-Ts, EF-G	Translation	II	GP
RFs	Release factors: RF-1, RF-2, RF-3	Translation	II	GPSB
t7pol	T7 RNA polymerase	Transcription	II	GP
ndk-mk-ck-ppiase	Energy regeneration enzymes: nucleoside diphosphate kinase, myokinase, creatine kinase, pyrophosphatase	Energy regeneration	II	GPSA
factors	Other cofactors/stabilizers (proprietary)	-	II	GPSB
ribosomes	Ribosomes	Translation	III	GPSA
DNA	*meyfp* gene	-	-	GP
Water	Water	-	-	GP



Bernard-Lapeyre Y et al. (2026) https://doi.org/10.64898/2026.03.23.713685.

- ✓ **Perfect fit to AI/ML approach with great controllability & reproducibility.**
- ✓ **Unique expression platform will give you great advantage in R&D.**

Reconstituted cell-free protein synthesis kit

PURE*frex*®

-KSF; AT rich codon on N-term-

GeneFrontier

Fab Heavy Chain (Herceptin)

Herceptin Fab HC

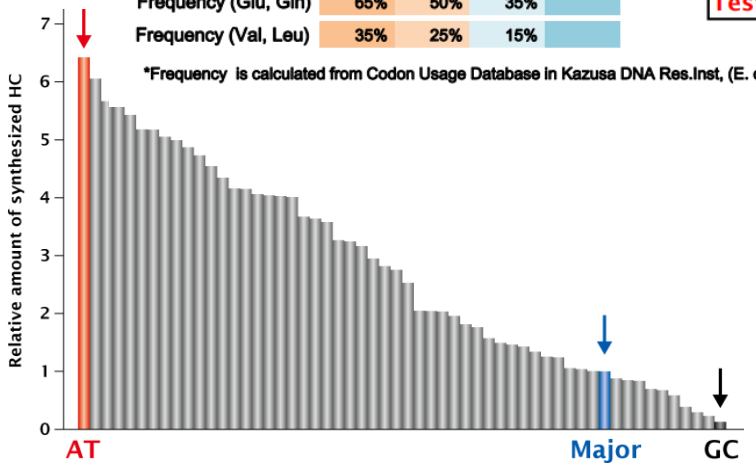
Met- Glu-Val-Gln-Leu-Val- FLAG

2		3		4		5		6	
Glu		Val		Gln		Leu		Val	
codon	freq (%)	codon	freq (%)	codon	freq (%)	codon	freq (%)	codon	freq (%)
gaa	70	gtt	25	caa	30	ttg	15	gtt	25
gag	30	gtc	18	cag	70	tta	12	gtc	18
		gta	17			ctt	12	gta	17
		gtg	40			ctc	10	gtg	40
						cta	5		
						ctg	46		

All clones; 384
Tested clones; 56

Frequency (Glu, Gln)	65%	50%	35%
Frequency (Val, Leu)	35%	25%	15%

*Frequency is calculated from Codon Usage Database in Kazusa DNA Res.Inst, (E. coli K-12 strain)

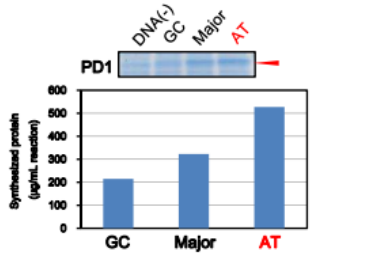


[Design of DNA template is important.](#)
[Manual is Free to download from our Web site here.](#)

PD1

Organism	*Homo sapiens*
Synthesized region	36Thr-150Glu-(Hisx8)
Length	124 a.a.
Molecular weight	14,148 Da

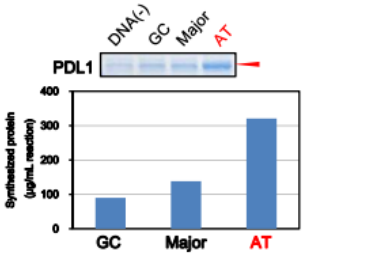
N-term type	1 Met	2(36) Thr	3(37) Phe	4(38) Ser	5(39) Pro	6(40) Ala	GC(%) 1-6 a.a.
GC	atg	acc	ttc	tcc	ccg	gcg	67%
Major	atg	acc	ttt	tct	ccg	gcg	56%
AT	atg	act	ttt	tca	cca	gct	39%



PDL1

Organism	*Homo sapiens*
Synthesized region	18Ala-239Thr-(Hisx8)
Length	231 a.a.
Molecular weight	26,593 Da

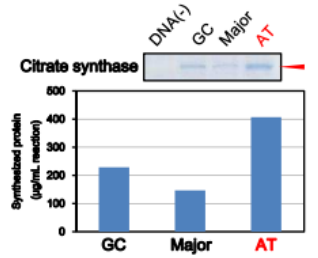
N-term type	1 Met	2(18) Ala	3(19) Phe	4(20) Thr	5(21) Val	6(22) Thr	GC(%) 1-6 a.a.
GC	atg	gcg	ttc	acc	gtg	acc	61%
major	atg	gcg	ttt	acc	gtg	acc	56%
AT	atg	gct	ttt	act	gta	aca	33%



Citrate Synthase

Organism	*Saccharomyces cerevisiae*
Synthesized region	38Ser-479Asn
Length	443 a.a.
Molecular weight	49,346 Da

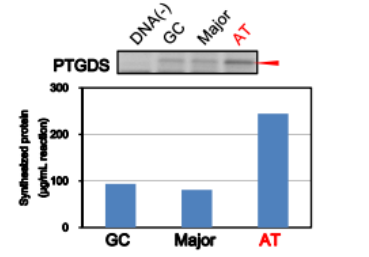
N-term type	1 Met	2(38) Ser	3(39) Ser	4(40) Ala	5(41) Ser	6(42) Glu	GC(%) 1-6 a.a.
GC	atg	tcc	tcc	gcg	tcc	gag	67%
major	atg	tct	tct	gcg	tct	gaa	44%
AT	atg	tca	tca	gct	tca	gaa	39%



PTGDS

Organism	*Homo sapiens*
Synthesized region	23Ala-190Gln
Length	169 a.a.
Molecular weight	18,829 Da

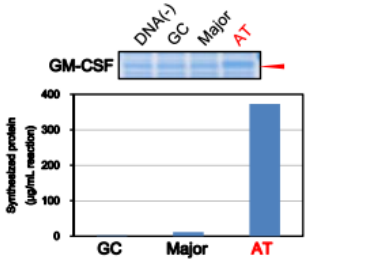
N-term type	1 Met	2(23) Ala	3(24) Pro	4(25) Glu	5(26) Ala	6(27) Gln	GC(%) 1-6 a.a.
GC	atg	gca	ccg	gaa	gca	cag	61%
major	atg	gcg	ccg	gaa	gcg	cag	72%
AT	atg	gca	cct	gaa	gct	caa	50%



GM-CSF

Organism	*Homo sapiens*
Synthesized region	18Ala-144Glu
Length	128 a.a.
Molecular weight	14,608 Da

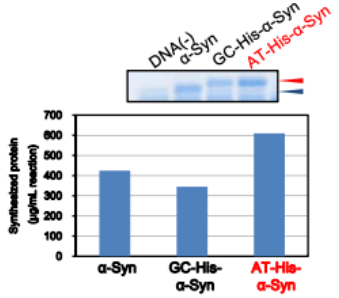
N-term type	1 Met	2(18) Ala	3(19) Pro	4(20) Ala	5(21) Arg	6(22) Ser	GC(%) 1-6 a.a.
GC	atg	gcg	ccg	gcg	cgc	tcc	83%
major	atg	gcg	ccg	gcg	cgc	tct	78%
AT	atg	gca	cct	gct	aga	tca	50%



His-α-Synuclein

Organism	*Homo sapiens*
Synthesized region	(Hisx6)-(Gly-Ser)-2(10)Asp-140(148)Ala
Length	148 a.a.
Molecular weight	15,427 Da

Tag type	1 Met	2 His	3 His	4 His	5 His	6 His	7 His	8 Gly	9 Ser	GC(%) 1-9 a.a.
GC	atg	cac	cac	cac	cac	cac	cac	ggt	tct	59%
AT	atg	cat	cat	cat	cat	cat	cat	ggt	tct	37%



DNA design for PURExfrex

Amino acid sequence entry form

Consultation is free of charge!

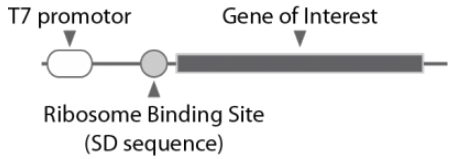
Reconstituted cell-free protein synthesis kit

PURE*frex*®

-KSF; Quality of DNA-

GeneFrontier

#	Construct	Size (bp)	Elegen's ENFINIA DNA	Supplier B	Supplier C
			Format	Format	Format
1	HisTEV-sfGFP(G4Y)-PPG-FLAG	978	Linear dsDNA	N/A	Linear dsDNA
2	HisTEV-PPG-sfGFP(G4Y)-FLAG	978	Linear dsDNA	N/A	Linear dsDNA
3	HisTEV-sfGFP(G4Y)-FLAG	888	Linear dsDNA	Linear dsDNA	Linear dsDNA
4	sfGFP(G4Y)-FLAG	840	Linear dsDNA	Linear dsDNA	Linear dsDNA



DNA

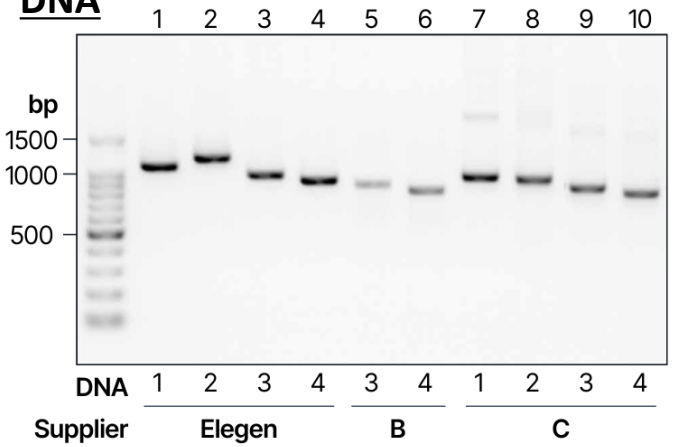
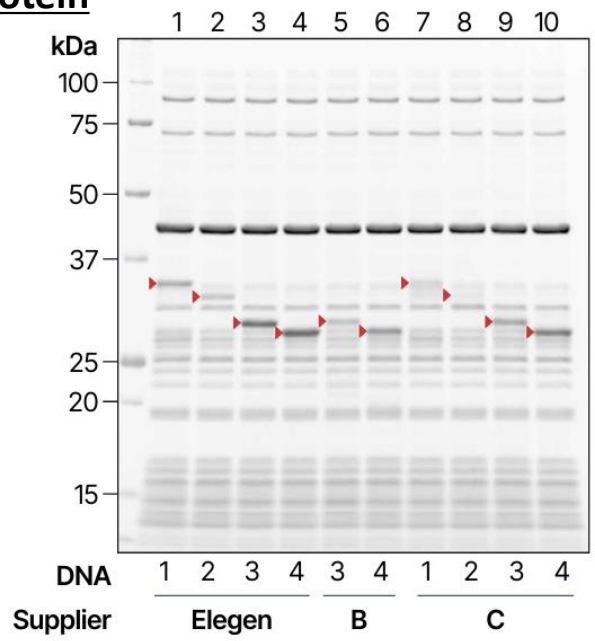
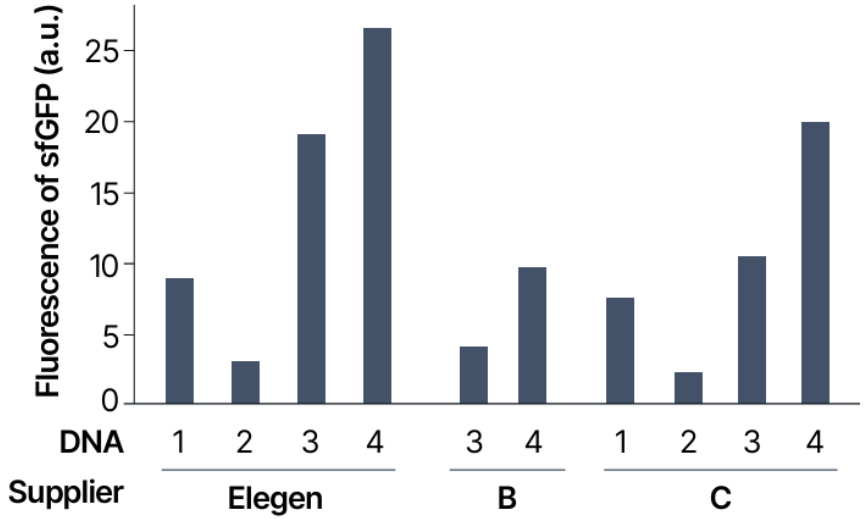


Figure 1. Analysis of DNA synthesized by three vendors. DNA synthesized by Elegen (Supplier A), Supplier B, and Supplier C was quantified using a Qubit Fluorometer (Thermo Fisher Scientific) and subjected to agarose gel electrophoresis.

Protein





ELEGEN

To learn more about ENFINIA DNA, visit elegenbio.com
or contact us at info@elegenbio.com

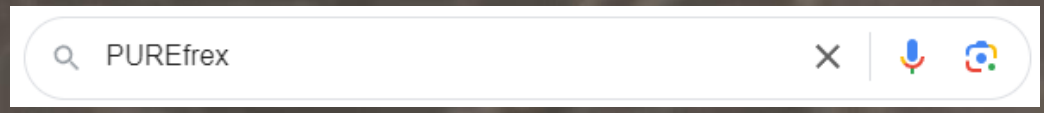
Contact information

Reconstituted cell-free protein synthesis kit

PURE*frex*®

For reagent use for expression / screening of biologics /designing central dogma

https://purefrex.genefrontier.com/



in vitro protein selection technology

PURE*frex*® RD

For screening service / collaboration / technology transfer for generation of new biologics

Takashi Ebihara, Ph.D., COO, GeneFrontier

E-mail: ebihara@genefrontier.com

Eurogentec

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- *E. coli*

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- Control of critical fermentation parameters
- Animal-free media

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- Additional custom QC development available
- QP release