

**TOKYO Metropolitan
COVID-19 Task force
Technical Advisor**



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感染症の場合は 特に スピードが重視されますので



スーパーコンピュータ「富岳」



FUJITSU

COVID-19 research
by in silico

人獣共通感染症CAVID-19の原因ウイルスであるSARS-CoV-2の感染機構をバイオインフォマティクス技術を用いて解明する。

具体的には、SARS-CoV-2は、宿主側の受容体アンジオテンシン変換酵素2(ACE2)と結合することが、感染の第一歩である。SARS-CoV-2は、ハムスター、犬やミンク、猫や大型猫(虎・ライオン)などの哺乳動物に感染する。一方、ヒトACE2と比較して、豚やマウスなどのACE2の主要立体構造は高く保存されているが、SARS-CoV-2は、豚やマウスなどの哺乳動物には全く感染しない。

これまでの研究報告より、猫間同士やハムスター間同士 で、SARS-CoV-2のエアゾル感染が認められている。SARS-CoV-2の感染過程において、ACE2 とセリンプロテアーゼTMPRSS2以外の重要な宿主側の細胞性因子が関与している可能性が考えられる。人獣共通感染症 CAVID-19 の原因ウイルスであるSARS-CoV-2の感染機構をバイオインフォマティクスを用いて解明する。

スペイン、新型コロナウイルス感染のミンク約10万頭を殺処分へ

2020年7月17日

COVID-19 research by *in silico*



オランダ、米国のミンク農場からCOVID-19のミンクが認められた。

スペイン西部アラゴン州で、飼育されていたミンクが新型コロナウイルスに感染していることが判明し、10万頭近くが処分された。

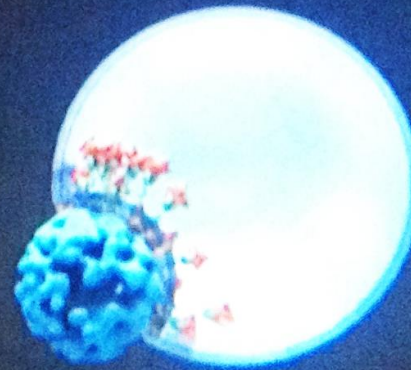
このミンク農場では、従業員の妻が5月に新型コロナウイルスに感染。この従業員を含む7人がウイルス検査で陽性と判明した。

SARS-CoV
(2002–2003)

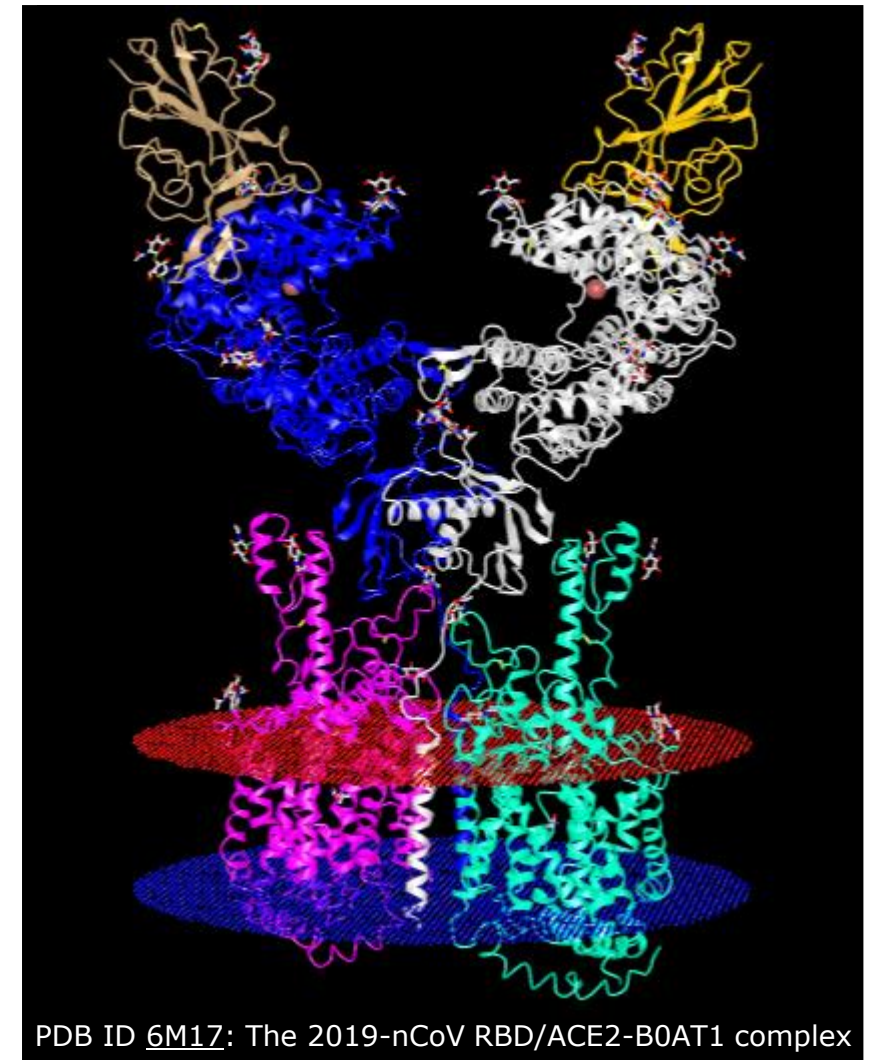
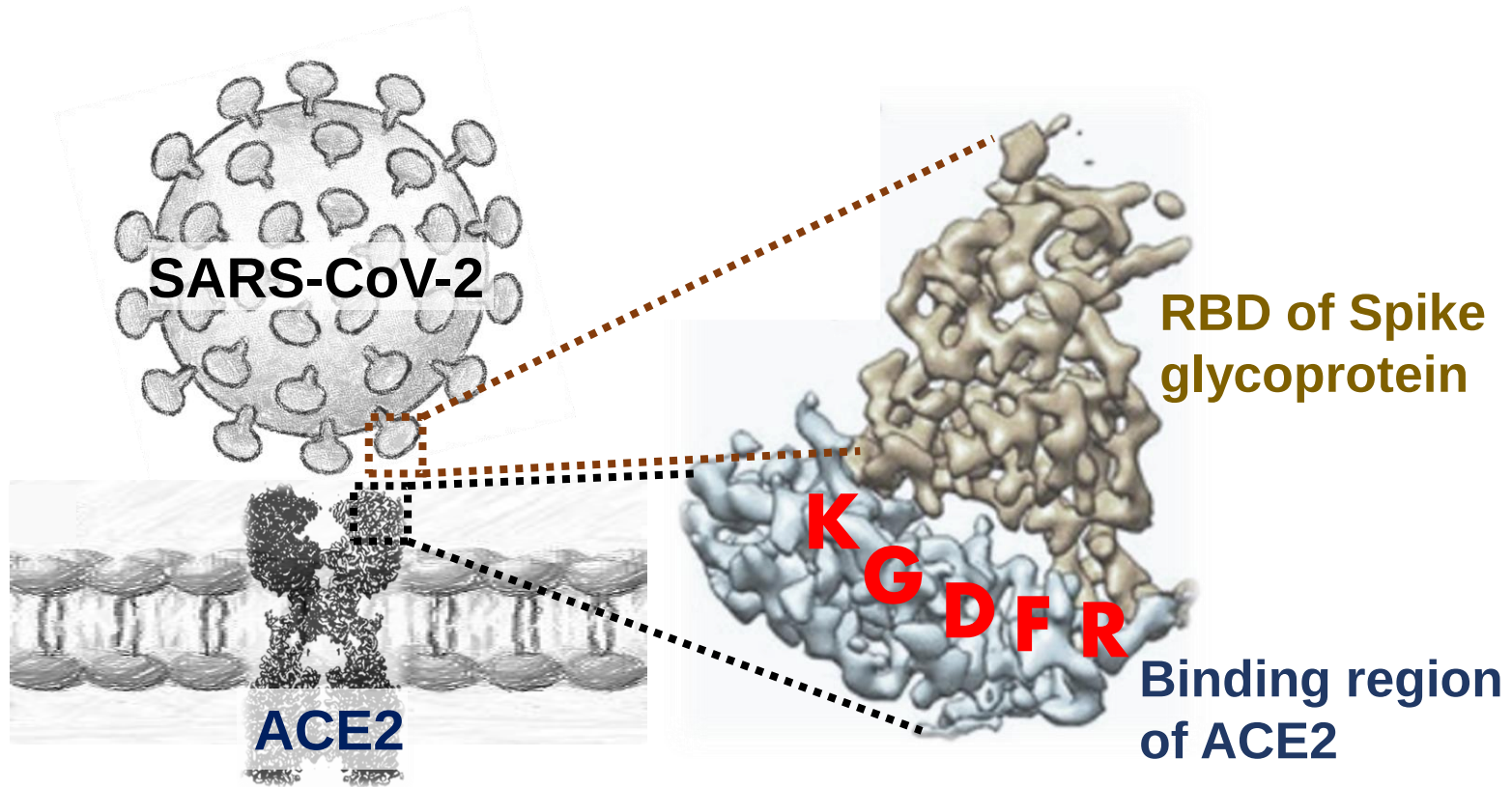
SARS-CoV-2
(2019–)



ACE2



Hayashi *et al.* Figure 1



Searching for the best animal model to study COVID-19

Comparison of currently available animal models for SARS-CoV-2 infection and COVID-19.

ANIMAL MODEL	UPPER RESPIRATORY TRACT*	LOWER RESPIRATORY TRACT†	FECES/ FECAL SWAB	CONTACT TRANSMISSION	AIRBORNE TRANSMISSION	WEIGHT LOSS	SOURCE
Cat (6 to 9 months)	Y‡	N	Y	NR	Y (33%)	NR	(1)
Chicken	N	N	NR	N	NR	NR	(1)
Dog	N	N	Y	N	NR	NR	(1)
Duck	N	N	NR	N	NR	NR	(1)
Ferret	Y‡	Y§	Y	Y (100%)	Y (30%)	NR	(1, 14)
hACE2 mouse	NR	Y‡	Y‡	NR	NR	Y	(8)
Hamster	Y‡	Y‡	Y‡	Y (100%)	NR	Y	(10)
Kitten	Y‡	Y‡	NR	NR	Y (33%)	NR	(1)
Macaque	Y	Y	NR	NR	NR	N	(2, 9)
Pig	N	N	NR	N	NR	NR	(1)

* Includes nasal washes, nasal swabs, nasal turbinate, soft palate, trachea. †Includes lung sections. ‡ Denotes detection of infectious virus.

§ Infectious titer in the ferret lung was only reported in (14). COVID-19, coronavirus disease 2019; hACE2, human angiotensin-converting enzyme 2; NR, not reported; SARS-CoV-2, severe acute respiratory syndrome–coronavirus 2.

	Dogs			Cats		
Risk factor	No. + (total)	%	<i>p</i>	No. + (total)	%	<i>p</i>
Household			0.004			>0.999
COVID+	6 (47)	12.8%		1 (22)	4.5%	
COVID-	2 (133)	1.5%		1 (38)	2.6%	
Sex			0.045			0.492
Male	7 (83)	8.4%		2 (31)	6.5%	
Female	2 (105)	1.9%		0 (30)	0.0%	
Male	2	Tested total 31		0	Tested total 12	
Female	0			0		

Seven more big cats test positive for coronavirus at Bronx Zoo

Following a National Geographic inquiry, the zoo confirms that four more tigers and three lions have the virus. This comes the same day as two pet cats in New York become the first in the U.S. to test positive.

BY NATASHA DALY

PUBLISHED APRIL 22, 2020

SARS-CoV-2 transmission from Human to Big Cats



Four more tigers and three lions at the Bronx Zoo in New York City have tested positive for the virus that causes COVID-19, the zoo announced Wednesday afternoon, following a National Geographic inquiry. This comes nearly three weeks after one tiger at the zoo was confirmed to have the virus and six other cats were said to be exhibiting symptoms.

The diagnosis of the tiger, named Nadia, represented “the first time, to our knowledge, that a [wild] animal has gotten sick from COVID-19 from a person,” Paul Calle, chief veterinarian for the Bronx Zoo, said April 5. The big cats likely contracted the coronavirus from an infected but asymptomatic zookeeper whose identity is unknown, Calle says: “It’s the only thing that makes sense.” Calle says.

A angiotensin-converting enzyme 2 precursor [Homo sapiens]

NCBI Reference Sequence: [NP_001358344.1](#)

353..357 **kgdfr** /region_name="Interaction with SARS-CoV spike glycoprotein" /note="propagated from UniProtKB/Swiss-Prot (Q9BYF1.2)"

Species	Protein ID	Whole Homology							
Homo.	NP_001358344.1		301	awdaqrifke	aekffvsvgl	pnmtqggfwen	smltdpgnvq	kavchptawd	lg kgdfr ilm
Dog#1	NP_001158732.1	91.0%	301	wdarkifkea	ekffvsvglp	nmtqefwgns	mltepsdsrk	vvchptawdl	g kgdfr ikmc
Dog#2	XP_005641049.1	92.0%	301	wdarkifkea	ekffvsvglp	nmtqefwens	mltepsdsrk	vvchptawdl	g kgdfr ikmc
Dog#3	XP_013966804.1	92.0%	301	wdarkifkea	ekffvsvglp	nmtqefwens	mltepsdsrk	vvchptawdl	g kgdfr ikmc
Dog#4	XP_022271214.1	79.0%	181	darkifkeae	kffvsvglpn	mtqefwensm	ltepsdsrkv	vchptawdlg	kgdfr ikmct
Cat#1	XP_023104564.1	91.0%	301	nqswdarriif	keaekffvsv	glpnmtqggf	ensmltep	gd srkvvchpta	wdlg kgdfr i
Cat#2	NP_001034545.1	92.0%	301	swdarriifke	aekffvsvgl	pnmtqggfwen	smltepgdsr	kvvchptawd	lg kgdfr ikm
Tiger#1	XP_007090142.1	92.0%	291	nqswdarriif	keaekffvsv	glpnmtqggf	ensmltep	gn sqkvvchpta	wdlg kgdfr i
Mink	CCP86723.1	93.0%	1		gl	pnmtegfwn	qnsmltepgdn	rkvvchptawd	lg khdfr ikm
Bat#1	XP_014399780.1	88.0%	301	wdaekifkea	ekfyisvglp	smtpgfwnns	mltepgdgrk	vvchptawdl	g kgdfr ikmc
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Bat#3	XP_014399782.1	89.0%	301	wdaekifkea	ekfyisvglp	smtpgfwnns	mltepgdgrk	vvchptawdl	g kgdfr ikmc
Bat#4	XP_014399783.1	80.0%	301	wdaekifkea	ekfyisvglp	smtpgfwnns	mltepgdgrk	vvchptawdl	g kgdfr ikmc
Bat#5	XP_024425698.1	88.0%	301	wdaqrifkea	ekffksvglf	smtqggfdns	mltkpddgre	vvchptawdl	gn kdf rikmc
Bat#6	XP_024425699.1	81.0%	231	dqswdaqrif	keaekffksv	glfsmtqggf	dnsmltkpdd	grevvchpta	wdlgn kdf ri
Bat#7	XP_008153150.1	88.0%	301	wdaekifkea	ekfymsvglp	smtpgfwnns	mltepgdgrk	vvchptawdl	g kndfr ikmc
Bat#8	XP_027986092.1	88.0%	301	wdaekifkea	ekfymsvglp	smtpgfwnns	mltepgdgrk	vvchptawdl	g kndfr ikmc
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Bat#12	XP_028378317.1	87.0%	301	aqrifkeaek	ffvsvglfnm	tqggfdnsml	tkpddgre	vvchptawdlg	k kdf rikmctk
Bat#13	XP_019522936.1	89.0%	301	kwdakkifqe	aekffvsvgl	pnmtkgfwen	smltepgdgr	kvvchptawd	lg kgdfr ikm
Bat#14	XP_019522943.1	89.0%	301	kwdakkifqe	aekffvsvgl	pnmtkgfwen	smltepgdgr	kvvchptawd	lg kgdfr ikm
Bat#15	XP_019522954.1	89.0%	301	kwdakkifqe	aekffvsvgl	pnmtkgfwen	smltepgdgr	kvvchptawd	lg kgdfr ikm
Pan#1	XP_017505746.1	91.0%	301	twdanrifke	aekffvsvgl	pkmtqtfwen	smltepgdgr	kvvchptawd	lg khdfr ikm
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Sna#1	XP_026530754.1	75.0%	361	ekkwtdvsif	kaaehffisi	glfnmtesfw	knsmlleepkd	grkvvchpta	wdmg kedy ri
Sna#2	XP_032082934.1	74.0%	321	tkkwtdvsif	kaaeffftsi	glfpmtdnfw	nnsmlleepkd	grkvvchpta	wdmg kkdy ri



Mink populations burgeon in the spring, when pups are born, raising concerns about new SARS-CoV-2 outbreaks.

RUSLAN SHAMUKOV/TASS VIA GETTY IMAGES

Coronavirus rips through Dutch mink farms, triggering culls to prevent human infections

SARS-CoV-2 transmission from Minks to Human

By **Martin Enserink** | Jun. 9, 2020 , 3:30 PM

Science . 2020 Jun 12;368(6496):1169. doi: 10.1126/science.368.6496.1169.

B CLUSTAL 2.1 multiple sequence alignment

```

Homo.      --AWDAQRIFKEAEKFFVSVGLPNMTQGFWENSMLTDPGNVQKAVCHPTAWDLGKGDFRIILM--
Dog#1      ---WDARKIFKEAEKFFVSVGLPNMTQEFWGN SMLTEPSDSRKVVCHPTAWDLGKGDFRIKMC-
Dog#2      ---WDARKIFKEAEKFFVSVGLPNMTQEFWENSMLTEPSDSRKVVCHPTAWDLGKGDFRIKMC-
Dog#3      ---WDARKIFKEAEKFFVSVGLPNMTQEFWENSMLTEPSDSRKVVCHPTAWDLGKGDFRIKMC-
Dog#4      ----DARKIFKEAEKFFVSVGLPNMTQEFWENSMLTEPSDSRKVVCHPTAWDLGKGDFRIKMCT
Cat#1      NQSWDARRIFKEAEKFFVSVGLPNMTQGFWENSMLTEPGDSRKVVCHPTAWDLGKGDFRI----
Cat#2      --SWDARRIFKEAEKFFVSVGLPNMTQGFWENSMLTEPGDSRKVVCHPTAWDLGKGDFRIKM--
Tiger#1    NQSWDARRIFKEAEKFFVSVGLPNMTQGFWENSMLTEPGNSQKVVCHPTAWDLGKGDFRI----
Mink       -----GLPNMTEGFWQNSMLTEPGDNRKVVCHPTAWDLGKHDFRIKM--

```

*****: ** *****:*.: :*.***** *****

Angiotensin-converting enzyme 2, partial [Neovison vison]

Sequence ID: [CCP86723.1](#) Length: 471 Number of Matches: 1

Human vs Mink

Range 1: 1 to 471 [GenPept](#) [Graphics](#)

▼ [Next Match](#) ▲ [Pr](#)

Score	Expect	Method	Identities	Positives	Gaps
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Sbjct	1	GLPNMT+GFW+NSMLT+PG+ +K VCHPTAWDLGK DFR	MCTKVTMDDFLTAHHEMGH	60

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Sbjct	61	IQYDMAYAAQPFLLRNGANEGFHEAVGEIMSLSAATPNHLKNI	GLLPPDFSEDSETDINF	120

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Sbjct	121	LLKQALTIVGTLPFTYMLEKWRWMVFKGEIPK+QWM+KWWEMKR+IVGVVEP+PHDETYC		180

Query	499	DPASLFHVSNDYSFIRYYTRTLYQFQFQEALCQAAKHEGPLHKCDISNSTEAGQKLFNML		558
Sbjct	181	DPA+LFHV+NDYSFIRYYTRT+YQFQFQEALCQ AKHEGPL+KCDISNS EAGQKL ML		240

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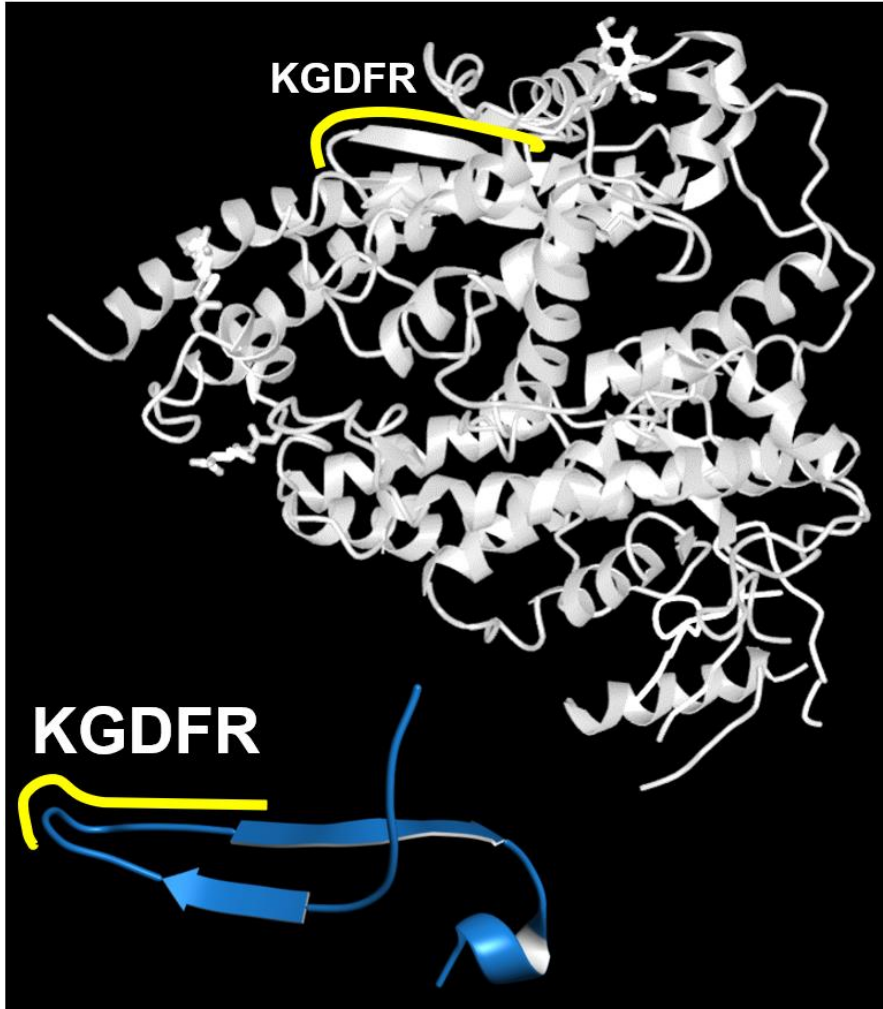
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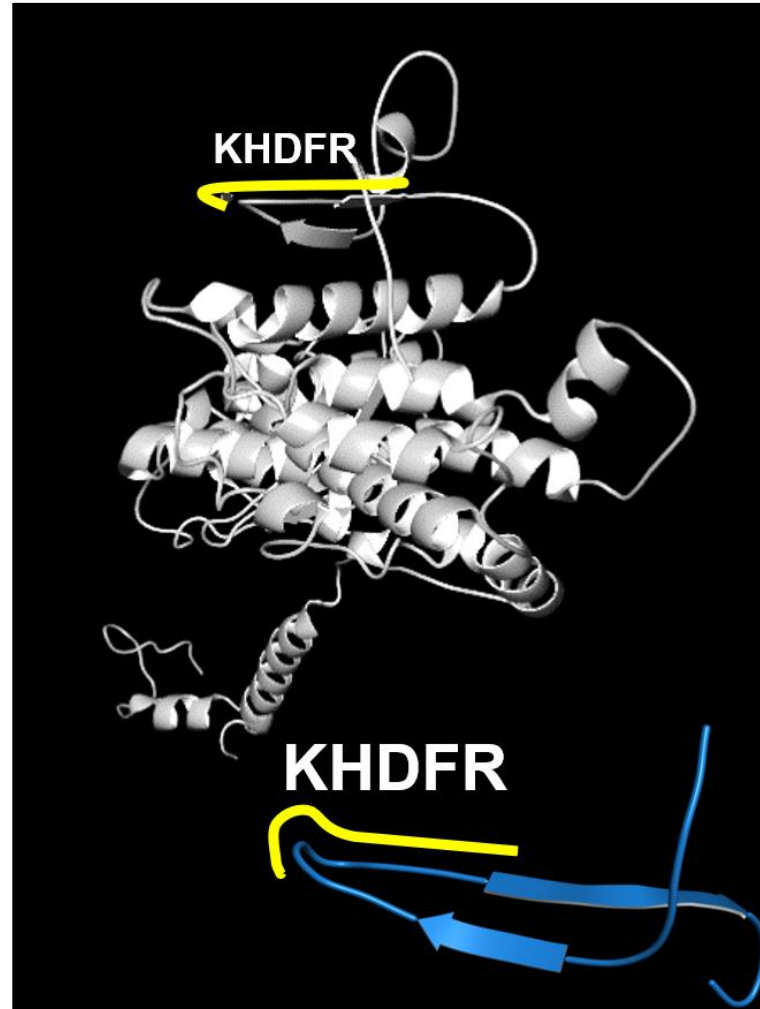
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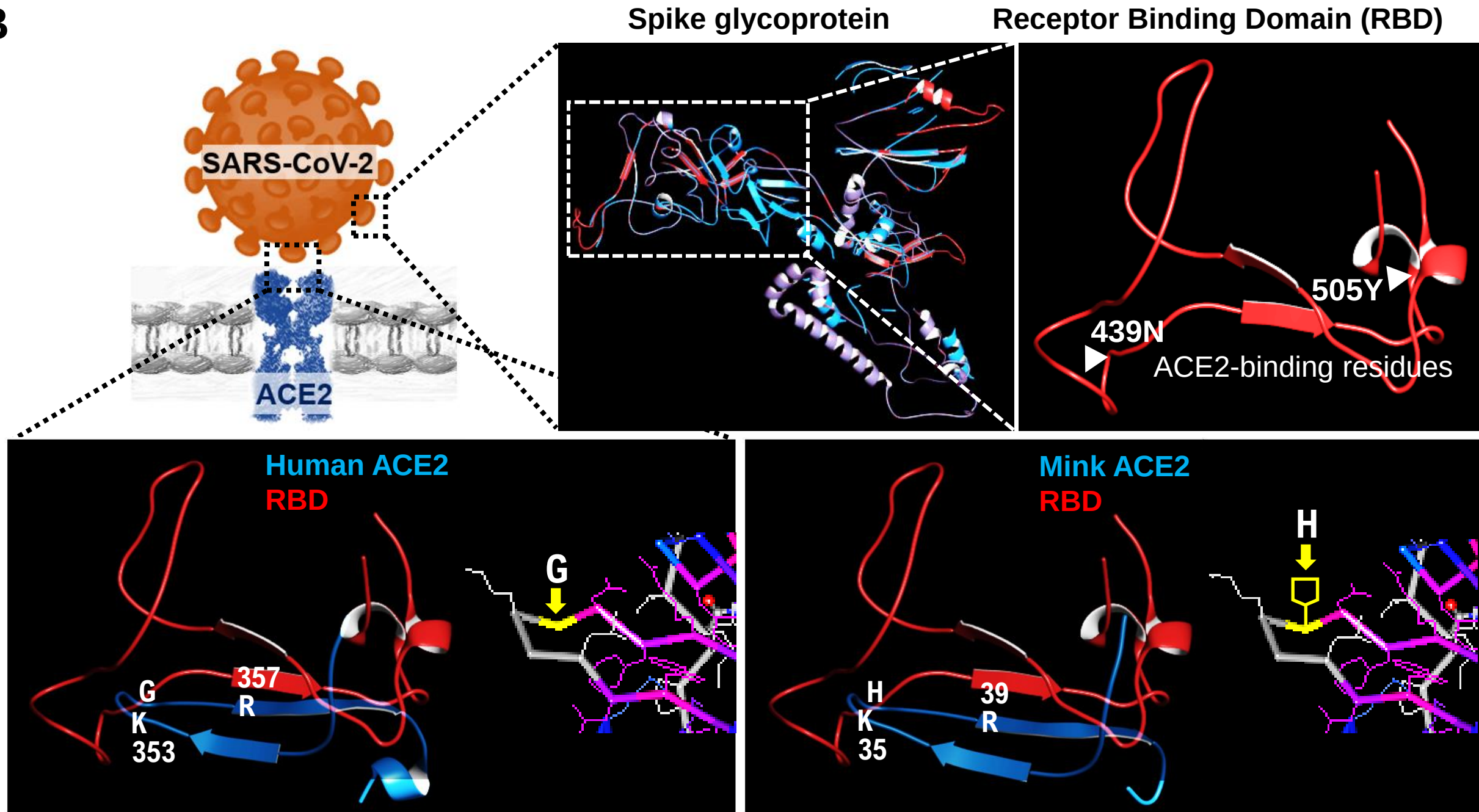
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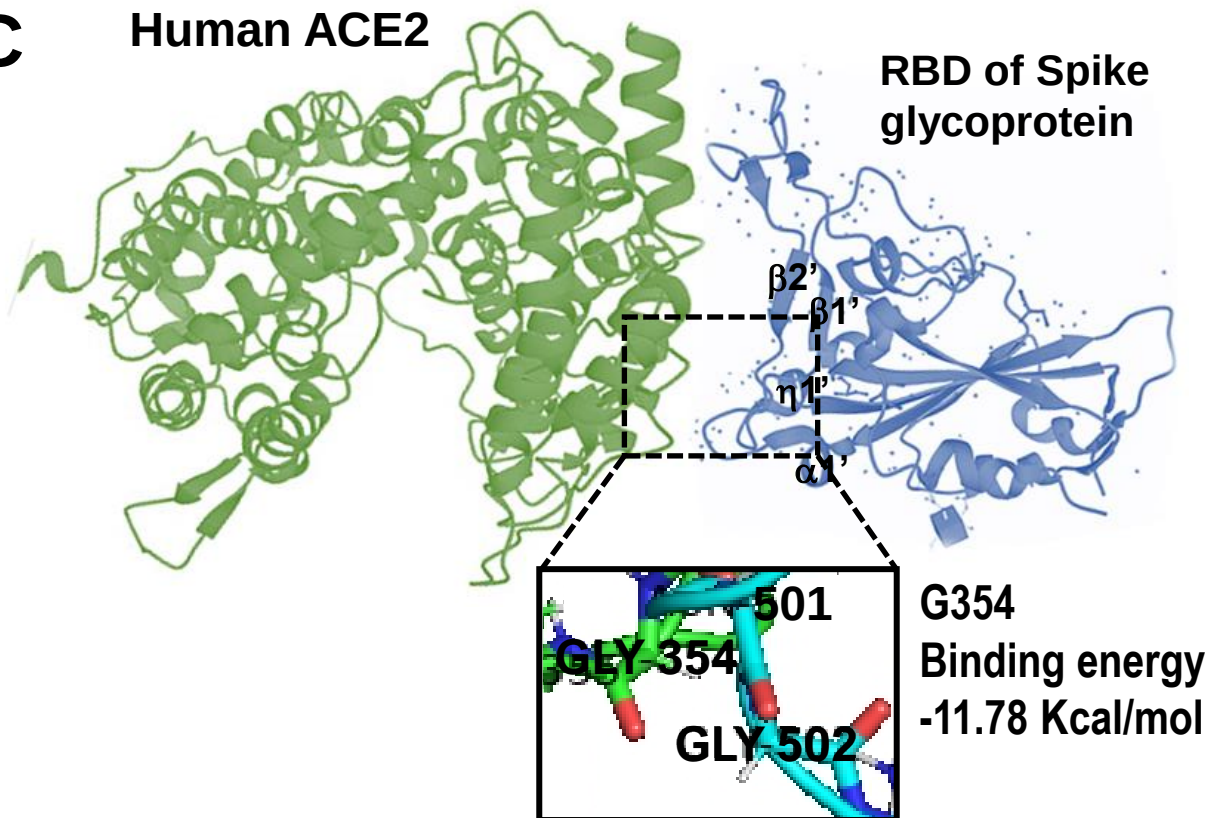
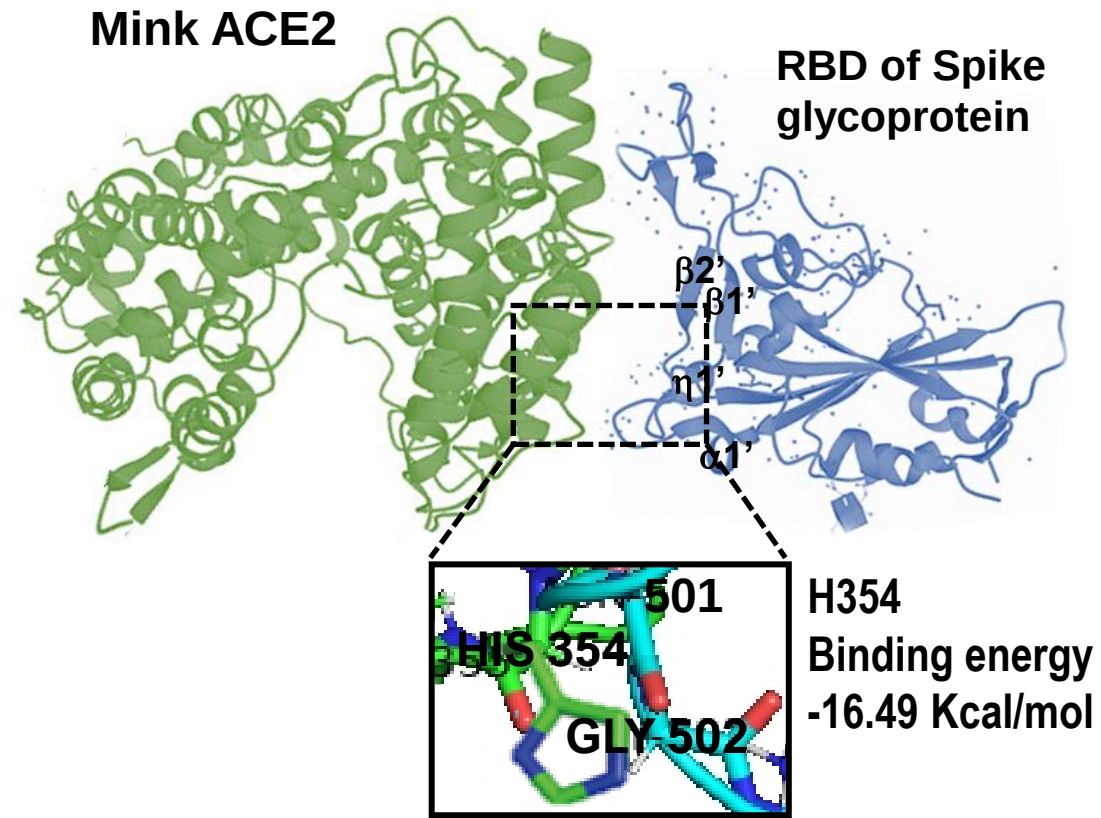
A Homo sapiens (human)



Neovison vison (American mink)



B

C**Human ACE2****Mink ACE2****ACE2 Sequence/Alignment Viewer**

hACE2 GLPNMTQGFWENSMLTDPGNVQKAVCHPTAWDLGKGDFRIILMCTKVTMDDFLTAHHEMGHI

mACE2 GLPNMTEGFWQNSMLTEPGDNRKVVCHPTAWDLGKHDFRIKMCTKVTMDDFLTAHHEMGHI

*****:***:*****:***: :*.***** *****

354

3D structure analysis by *in silico*

