question

Question
Is there immunity after SARS-CoV-2 infection?
Is there immunity after other HCoV infections?
What is the pattern of antibody response in HCoV infections?
Is there evidence for immunity due to (neutralising) antibodies?

Is there evidence for cellular immunity?
How long does immunity last after infection with other HCoV?
Is there a difference in severity of disease in re-infection with other HCoV?
Is there crossreactivity between Coronaviruses?
Is the built-up immunity steril?

link		
https://jcm.asm.org/content/jcm/12/4/493.full.pdf		
'/www.ncbi.nlm.nih.gov/pmc/articles/PMC2271881/pdf/epidinfect00023-0213.pdf		
https://wwwnc.cdc.gov/eid/article/26/7/20-0841_article		
https://mbio.asm.org/content/mbio/9/5/e01985-18.full.pdf		
s://www.sciencedirect.com/science/article/pii/S0924857914002787?via%3Dihub		
https://wwwnc.cdc.gov/eid/article/21/12/15-1421_article		
s://www.sciencedirect.com/science/article/pii/S0732889317302213?via%3Dihub		
https://wwwnc.cdc.gov/eid/article/23/7/17-0310_article		
		Virus
not known		
yes for some, but not clear for how long		HCoV-229E
yes		HCoV-229E HCoV-OC43
		MERS-CoV
		HCoV-229E
It was observed that higher serum levels of specific IgA and IgG protect from infection		HCoV-229E
not clear: data from RIVM show that samples from mild disease 'patients' have no or very low VNT titer, but are positve in ELISA		SARS-CoV-2
According to this study, not for MERS -> n=3		MERS-CoV
after one year not for all samples detectable neutratlising Ab		MERS-CoV
Indication that humoral resonse not sole mechanism to achieve immunity for SARS-CoV-2: About 30% of recovered patients generated a very low level of NAb titers (ID50: < 500) and Nab of 10 patients below limit of detection (<40)! (all PCR pos) -> 2 week follow-up shwed no major differences.		SARS-CoV-2
Seroconversion in 50% of patients occurred by day 7, and in all by day 14		SARS-CoV-2
neutralising Ab relatively stabil?		SARS-CoV-1
neutralising Ab relatively stabil?		SARS-CoV-1

100 % seropositive until month 16	SARS-CoV-1
indication that memory T-cells for SARS-1 lasted at least 2 years	SARS-CoV-1
maybe there is a dependence on severity of disease (at least for AB levels, no	MERS-CoV
not necessarily immunity, but neutralization titers stable for 7 months	SARS-CoV-1
less severe	HCoV-229E
less severe	HCoV-229E
not between HCoV-OC43 and HCoV-229E and SARS-CoV-1	SARS-CoV-1
indication that boost other HCoV Ab possible	SARS-CoV-2
not between SARS-CoV-2 and MERS?	SARS-CoV-2
not between SARS-CoV-1 and MERS?	SARS-CoV-1 and M
SARS-CoV-1 cannot neutralise SARS-CoV-2	SARS-CoV-1

hCoV	
HCoV-229E	challenge expe
HCoV-229E	challenge expe
MERS-CoV	laboratory
MERS-CoV	retrospective
MERS-CoV	case report
MERS-CoV	cross-sectional
MERS-CoV	prospective
MERS-CoV	prospective

Author, year	link
Callow, 1990	https://www.n
Reed, 1984	https://onlinel
Choe, 2017	ov/eid/article/
Kraaijeveld, 198	https://www.n
Callow, 1990	https://www.n
data not published	
Ko, 2017	ence/article/pi
Okba, 2019	ov/eid/article/
Wu, 2020 (med	Rent/10.1101/2
Wölfel, 2020	ırticles/s41586
Liao, 2007	no access?
Chan, 2005	https://cvi.asm

Cao, 2007 https://www.n

Peng, 2006 ence/article/pi

Alshukairi, 2016 content/mbio/

Chan, 2005 https://cvi.asm

Callow, 1990 https://www.n

Barrow, 1990 https://onlinel

Chan, 2005 https://cvi.asm

Wölfel, 2020 rticles/s41586

Ju, 2020 medRxi https://www.b

Du, 2013 https://www.s

Poh, 2020, BioRx https://www.b

observation
Significant antibody rises correlated well with symptoms, clinical score, and virus shedding.
IgG and IgA antibody levels increased after day 8 in 10 infected individuals
IgG and IgA (n=6) but were detectable after 1 year
Non-severe (n=6) cases, after one year, though some lacked detectable neutralizing antibodies
Antibodies detected at month 18 in 2 of 9 patients with severe symptoms
More variable antibody longevity among patients with milder symptoms
IgG titers peaked 3 weeks after onset of illness, and declined during weeks 4-5.
Delayed antibody responses with the neutralization test were associated with more severe disease
No seroconversion among asymptomatic patients (n=3).
75% of deceased patients did not seroconvert by week 3, compared to 0% of survivors
to mild cases
MERS antibodies decreased throughout the 6 months following disease onset.

observation
15 volunteers -> virus challenge -> 10 infected -> one year later re-challenge -> 6 out of 9 infected
Re-challenged (n = 6) volunteers who had been experimentally infected 8-12 months previousl y. On the first challenge, all 6 developed symptoms and detectable virus and 5 of 6 experienced significant rise in titer. In the second season, 0/6 experienced illness, detectable virus or significant rise in titer. Re-challenged (n=12) volunteers with heterologous virus (not identical to first experimental infection) 8-14 months after first infections. 7/12 developed cold symptoms
Severe cases (that had serological response) tended to have higher antibody responses compared to mild cases MERS antibodies decreased throughout the 6 months following disease onset. Antibody titers in 4 of 6 mild cases were undetectable, even if most had pneumonia. Significant antibody rises correlated well with symptoms, clinical score, and virus shedding.
15 volunteers -> virus challenge -> 10 infected had lower IgA titers
No seroconversion among asymptomatic patients (n=3). 75% of deceased patients did not seroconvert by week 3, compared to 0% of survivors.
IgG antibodies were detectable and maintained in all severe (n=5) and most non-severe (n=6) cases, after one year, though some lacked detectable neutralizing antibodies Antibody responses tended to be higher among severe cases
all done with pseudovirus neutralization assay: NAb titers of elderly and middle-age recovered patients were significantly higher than of young patients ($p<0.0001$ and $p<0.0001$, t test) -> the corresponding median ID50s were 1537, 1255, and 488
All patients showed detectable neutralizing antibodies, the titers of which did not suggest close correlation with clinical course. Case #4, with the lowest virus neutralization titer at end of week 2, seemed to shed virus from stool over prolonged time
Neutralizing antibody titers for 14 cases remained high between days 17-181
Neutralization titers to SARS-CoV remained stable for 7 months

Titers peaked at month 4. IgG and neutralizing antibodies were undetectable in 19.4 % and 11.1% of serum samples, respectively, at month 30, and in 25.8% and 16.1 %, respectively, at month 36
study has demonstrated that both $CD4_+$ and $CD8_+$ T cells are involved in SARS-CoV N-specific memory immunity and that the memory T-cell responses specific for SARS-CoV have been maintained for 2 years in the absence of antigen
Antibodies detected at month 18 in 2 of 9 patients with severe symptoms More variable antibody longevity among patients with milder symptoms Neutralization titers to SARS-CoV remained stable for 7 months
10 first time infections -> 8 volunteers had a cold of the 6 out of 9 re-Infected nobody had a cold Found lower proportions of individuals with high neutralizing titer experienced 'significant colds' upon viral challenge than individuals with low titer
Infections with HCoV-OC43 and HCoV-229E did not lead to antibodies (acute or convalescent phase) against SARS-CoV by IFA or neutralization Results on differential recombinant immunofluorescence assay indicated cross-reactivity or cross-stimulation against the four endemic human coronaviruses in several patients Absence of antibody cross-reactivity with RBDs from SARS-CoV and MERS-CoV. Based on the sequential and structural similarities of RBDs from SARS-CoV-2 and SARS-CoV, we predicted some degree of cross-binding and even cross-neutralization between the two viruses. monoclonal antibodies raised to SARS-CoV RBD did not bind the MERS-CoV RBD even at high concentrations (10ug/mL) and all had low or no neutralizing activity against MERS-CoV pseudovirus Sera from recalled SARS patients could neutralize SARS-CoV, but not the SARS-CoV-2 pseudotyped lentiviruses

first author	year
Kraaijeveld	1980
Callow	1990
Okba	2019
Alshukairi	2016
Spanakis	2014
Park	2015
Ko	2017
Choe	2017

	question	link	hCoV
1	level of immunity against re-infection		SARS-CoV-2
2	length of complete/partial immunity		SARS-CoV

method	observation	first author	year
IFA on Vero cells, WB, VNT	no ab day 4 (onset symptoms), IgG and IgM titers on day 9 and 20 neutralisaing antibodies in VNT (not day 4, but on day 9) negative sera did not neutralise (incl. sera pos. for OC43 and 229E)	Havari	2020
	seroconversion from 4 days after onset disease and in most by 14 days long lasting specific IgG and neutralising antibody as long as 2 years after infection		

title

Serological and molecular findings during SARS-CoV-2 infection: the first case study in Finland, January to February