

A microscopic image of a coronavirus particle, showing its characteristic crown-like structure with numerous spike proteins extending from its surface. The image is rendered in shades of blue and green, with a prominent red horizontal band across the top. The text 'COVID-19 IN QUARANTINE' is overlaid on this red band in white, bold, sans-serif font. Below the red band, the text 'A Patent Landscape' is written in a smaller, white, sans-serif font. In the bottom left corner, the logo for 'PATENT WIRE' is displayed, featuring the word 'PATENT' in a stylized font with a registered trademark symbol, and 'WIRE' in a white box below it. Underneath the logo is the tagline 'Where Inventions Live Long' in a small, white, sans-serif font.

COVID-19 IN QUARANTINE

A Patent Landscape

INTRODUCTION

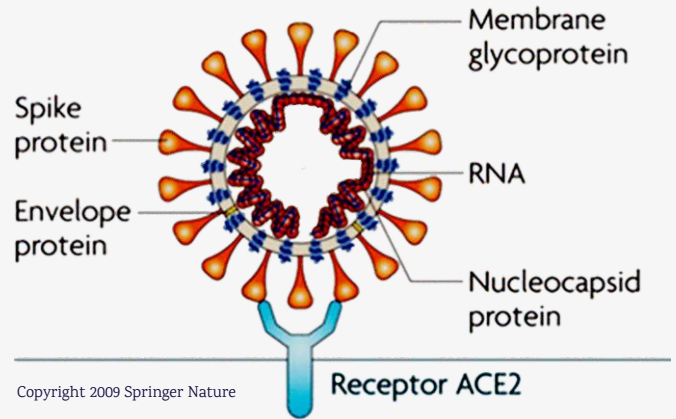
Human civilization is at a juncture where the entire world is praying to get rid of home quarantine and all talented researchers are trying to find ways to quarantine the lethal COVID-19. The COVID-19 is going to be most infectious virus of the era. It has shown strange characteristics in terms of morbidity and mortality in various demographic locations. At present, there is no vaccine available to prevent this infection. However, many attempts have been taken and many patent applications have been filed pertaining to this particular Corona Virus across the globe. This landscape exercise is to identify the relevant active and efficient patents or patent applications and Non-patent Literature that could help positioning of target compound or molecules or cure, potential commercialization pipeline, sale, or use of the research findings across the globe.

COVID-19 Profile

COVID-19 is a new pathogen first identified in recent Wuhan epidemic and is called coronavirus disease 2019 (COVID-19). COVID-19 belongs to family Coronaviridae in the order Nidovirales. Currently, there are four genera in the subfamily Coronavirinae of the family Coronaviridae: **Alphacoronavirus**, **Betacoronavirus**, **Deltacoronavirus** and **Gammacoronavirus**. Before the current COVID-19 epidemic, there were six recognised human respiratory coronaviruses, including HCoV-229E (**Alphacoronavirus**), HCoV-OC43 (**Betacoronavirus**), HCoV-NL63 (**Alphacoronavirus**) and HKU1 (**Betacoronavirus**) that often cause mild respiratory tract infection as well as SARSCoV and MERS-CoV which in contrast can lead to severe or even fatal lower respiratory tract disease. The seventh human coronavirus, SARS-CoV-2, belongs to the genus **Betacoronavirus**, which also contains SARS-CoV and MERS-CoV.

Coronaviruses (CoVs) are relatively large viruses containing a single-stranded positive-sense RNA genome encapsulated within a membrane envelope. The viral membrane is studded with glycoprotein spikes that give coronaviruses their crownlike appearance.

Among all known RNA viruses, coronaviruses have the largest genomes, ranging from 26 kb to 32 kb in length. COVID-19 was found to cause Severe Acute Respiratory (SARI) symptoms, including fever, dyspnea, asthenia and pneumonia.



Mechanism of Action

COVID-19 infection is known to survive by the virtue of host immune response. Angiotensin-converting enzyme 2 (ACE-2) is the cell surface receptor protein for SARS-CoV2, which is expressed on cells of kidney, GI tract, heart, blood vessels and lung alveolar epithelial cells. The SARS-CoV2 infection results in downregulation of ACE-2 followed by over-expression of angiotensin-2 (a vasoconstrictor), an increased pulmonary permeability and excessive lung damage.

Coronaviruses contain positive sense single stranded RNA genome. This helps them to survive in the host cells using molecular mechanisms of replication, transcription and translation. Once infiltrated into the host cell, the viral RNA genome gets released into the host cytoplasm and replication process is initiated. This, on the other hand, results in the upregulation of pro-inflammatory cytokines and chemokines, resulting in Cytokine Release Syndrome (CRS). Most severe COVID infections have been characterized with increased levels of cytokines (interleukin-1 β [IL-1 β], IL-2, IL-6, IL-7, IL-8, tumor necrosis factor- α [TNF]) and chemokines (CXCchemokine ligand 10 [CXCL10] and CC-chemokine ligand 2 [CCL2]). This hyperimmune response is thus clinically responsible for high fever, difficulty in breathing and cough in COVID infections.

Morbidity and Mortality

The first case of COVID-19 was reported in December 2019 from Wuhan Province in China and has quickly become a global lethal outbreak. In last three months period this virus has made chaos on entire planet. So far, no drugs, monoclonal antibodies or vaccines have been approved or identified to effectively treat this COVID-19 infection.



LETHAL SITUATION

Globally

13, 53, 361 confirmed
79, 235 deaths

European Region

7, 20, 219 confirmed
57, 639 deaths

Region of the Americas

4, 17, 416 confirmed
12, 587 deaths

Western Pacific Regions

1, 14, 667 confirmed
3, 922 deaths

Eastern Mediterranean Region

81, 993 confirmed
4,314 deaths

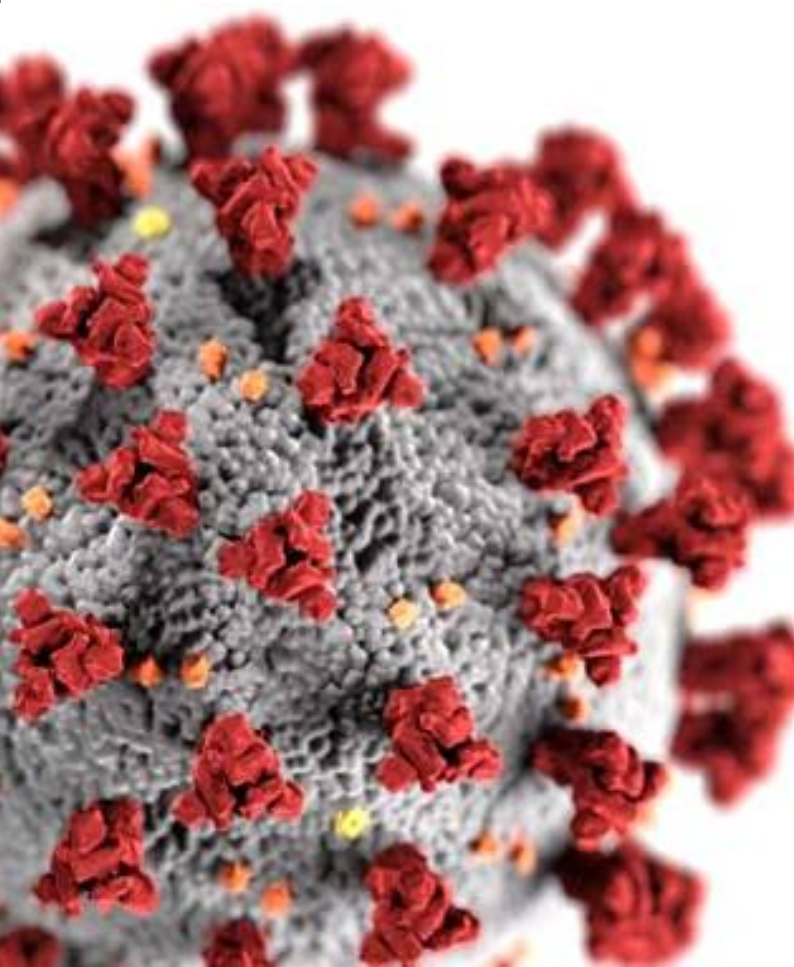
South-East Asia Regions

10, 707 confirmed
426 deaths

African Region

7, 647 confirmed
326 deaths

COVID-19 Pandemic [as of April 9th, 2020]



Country, Other	Total Cases	Total Deaths
World	15,34,126	89,756
USA	4,35,167	14,797
Spain	1,52,446	15,238
Italy	1,39,422	17,669
Germany	1,13,296	2,349
France	1,12,950	10,869
China	81,865	3,335
Iran	64,586	3,993
UK	60,733	7,097
Turkey	38,226	812

COVID-19

Inactivated By

Lipid solvents including ether (75%), ethanol, chlorine-containing disinfectant, peroxyacetic acid and chloroform except for chlorhexidine

Incubation Period

Within 14 days following exposure, with most cases occurring approximately four to five days after exposure

Homology Modeling

SARS-CoV and SARS-CoV-2 share a highly conserved receptor-binding domain (RBD), a domain of S protein, and 76% of sequence similarity in their S proteins

Genetic Material

Positive-stranded RNA virus having spike glycoproteins on the envelope

Nomenclature

SARS-CoV2

Family

Coronaviridae

Sub-Family

Orthocoronavirinae

Genus

Betacoronavirus

Species

7 species
-229E, -OC43, -NL63, HKU1, SARS, MERS, and the latest COVID-19

Size

Diameter of approximately 60–140 nm

Sensitive To

Ultraviolet rays and heat

Similar To

SARS-CoV
MERS-CoV

Binding Region

Angiotensin-converting enzyme 2 (ACE2)

Period of Infectivity

Uncertain

Transmission Source

Suspected transmission Directly from bats or through some other mechanism

Transmission

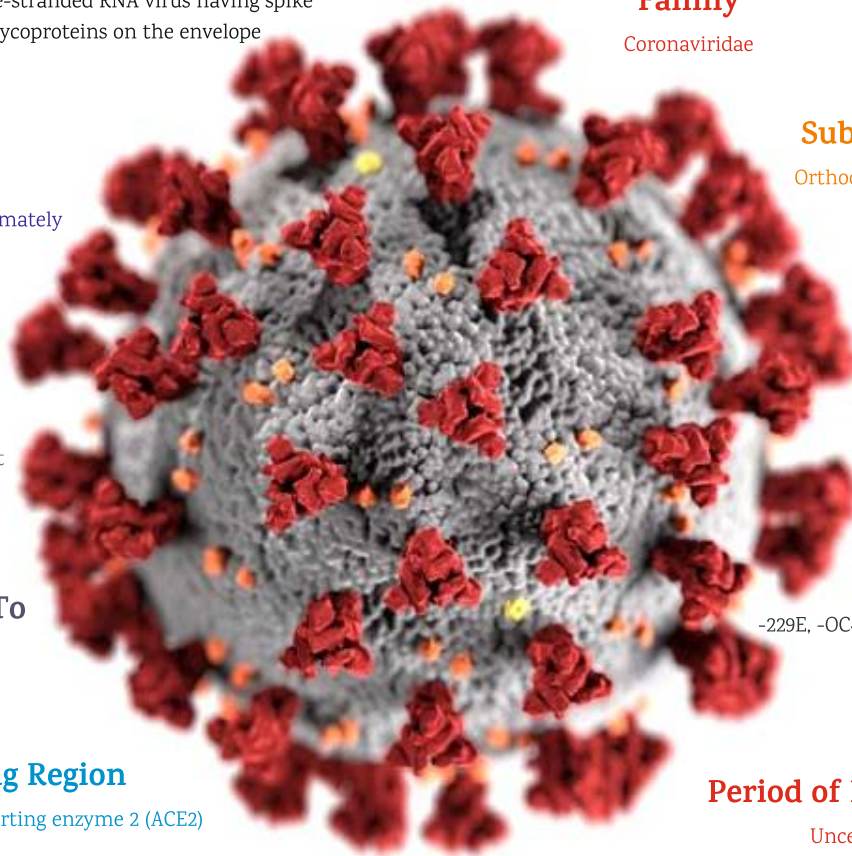
Through respiratory droplets from coughing and sneezing. Aerosol transmission is also possible in case of protracted exposure to elevated aerosol concentrations in closed spaces

Sequence Similarity

RdRp and 3CLpro protease of SARS-CoV-2 has 95% of sequence similarity with those of SARS-CoV but the two viruses exhibit only 79% sequence similarity at the genome level

Common Symptom

Fever in 99 percent
Fatigue in 70 percent
Dry cough in 59 percent
Anorexia in 40 percent
Myalgias in 35 percent
Dyspnoea in 31 percent
Sputum production in 27 percent



Patent Landscape

Till date, there are no COVID-19 specific antiviral agents. Global researchers have been working hard to find possible treatments to save lives and produce vaccines for future prevention. Though there have been many efforts taken in the development of therapeutic agents and vaccines for human coronaviruses since 1973. A subset of analysis of patent and non-patent literature databases indicate the same in this report.

Search Strategy

Data

The data used in this report was extracted from the patent databases of the Indian Patent Database (IPO), United States Patent and Trademark Office (USPTO), the Japan Patent Office (JPO), the European Patent Office (EPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), and the International Bureau of the World Intellectual Property Office (WIPO). For accurate and extensive search, the Questel Orbit and Patent Lens Patent Databases have been used.

Search Terms

International Patent Classification (IPC), applicant, and keywords (including possible keywords), either alone or in combination were used to identify and extract relevant citations from the databases. IPC symbols have an advantage of being language-independent and generally assigned to patent applications in a uniform manner across different countries.

Keywords

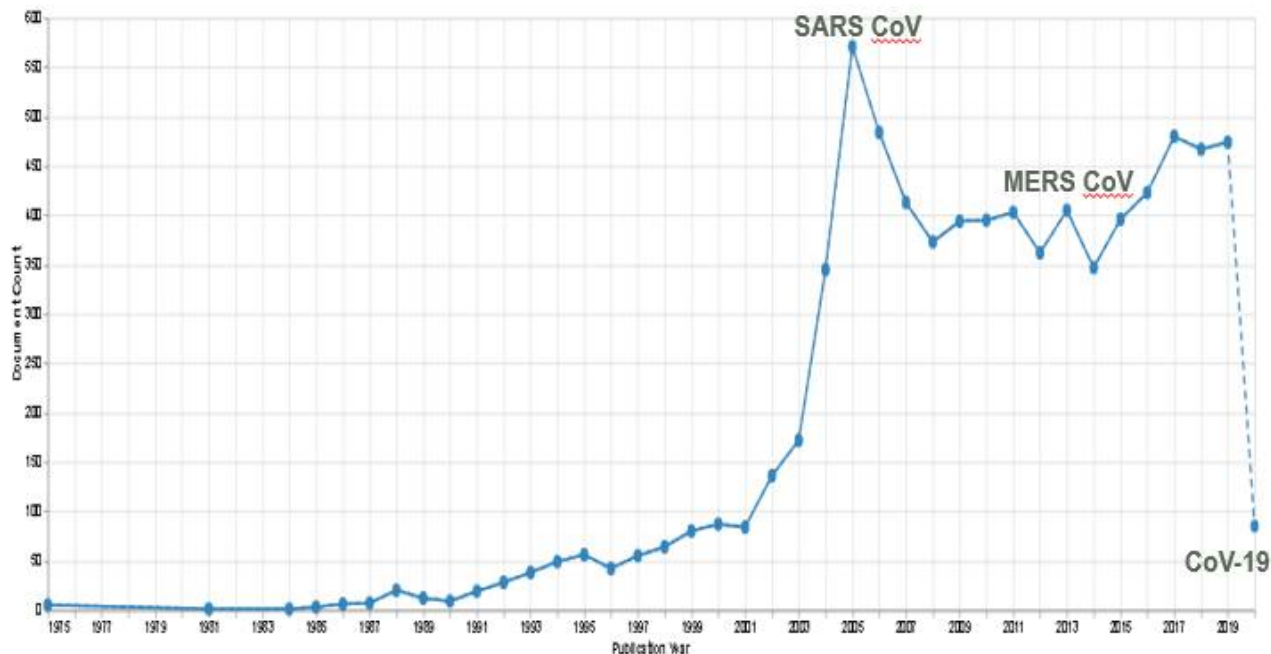
Using the commercial patent database Orbit, we implemented the following search queries to create our patent dataset.

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(title:(Coronavirus) OR abstract:(Coronavirus) OR claims:(Coronavirus)) OR (title:("Severe acute Respiratory syndrome") OR abstract:("Severe acute Respiratory syndrome") OR claims:("Severe acute Respiratory syndrome")) OR (title:("coronaviridae") OR abstract:("coronaviridae") OR claims:("coronaviridae")) OR claims:("SARS-CoV") OR claims:("MERS-CoV") OR claims:("COVID 19") OR claims:("Wuhan coronavirus") OR claims:("2019-nCoV") OR claims:("Middle East respiratory") OR claims:(alphacoronavirus) OR claims:(betacoronavirus) OR claims:(gammacoronavirus) OR claims:(deltacoronavirus) OR claims:(sarbecovirus) OR claims:(murine hepatitis virus) OR claims:(Hedgehog coronavirus) OR claims:(middle east respiratory syndrome) OR claims:(middle east respiratory syndrome related coronavirus) OR claims:(Severe acute Respiratory syndrome related coronavirus) OR claims:(HKU5) OR claims:(HKU4) OR claims:(HKU1) OR claims:(HKU9) OR claims:(HCOV) OR claims:(Tylonycteris Pipistrellus) OR claims:(Bat Coronavirus) OR claims:(Human Coronavirus) OR claims:(Rousettus) OR claims:(Pi Batcov) OR claims:(Rhinolophus) OR claims:(2019 NCOV) OR claims:(NCOV) OR claims:(Wuhan Virus) OR claims:(OC43)
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The queries were combined using the 'OR' 'AND' operator to search in title, abstract, and claims and a patent set of 8000 records with one data per family was generated. The publications included in the report are updated as of 6th April 2020.

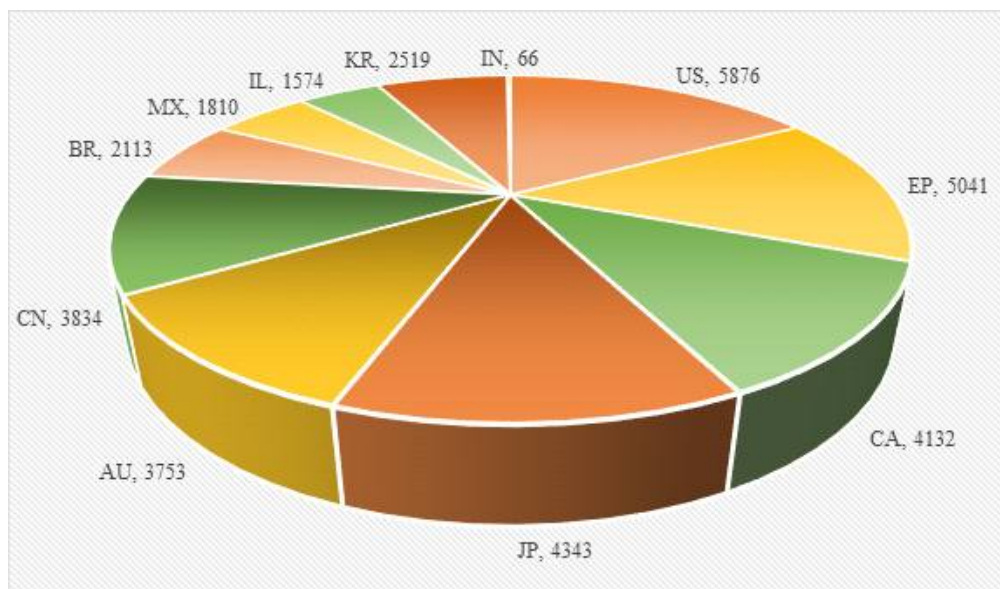
Year-wise Patents

The year wise trend of the patent applications has been shown. The trend shows that prior to 2003, there were lesser patents related to treatment of Coronavirus but it has shown a drastic change from 2003 to 2020 and specifically in year 2005. It is noteworthy that SAR-CoV outbreak happened in 2003 and thereafter these peaks are indicative of patent filing trend. Further, the first MERS-CoV case in the United Arab Emirates (UAE) was reported in July 2013 which substantiate ongoing research and hence the consistent peaks. Accordingly, there have been 1640 patent applications filed after year 2015.



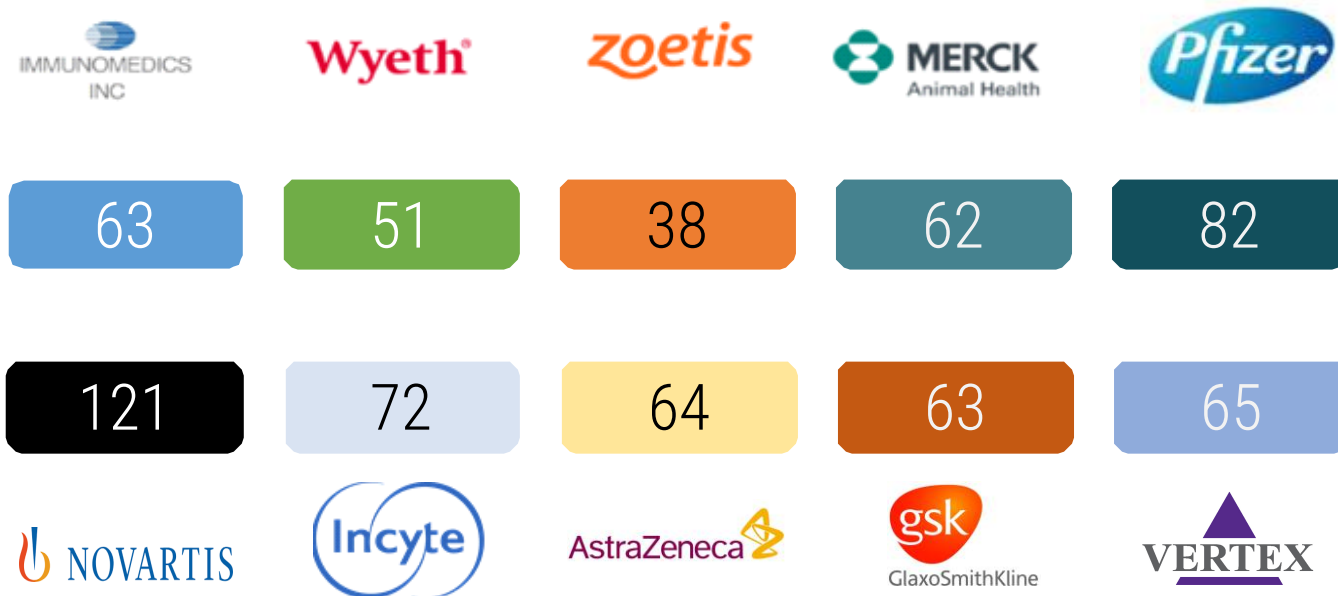
Jurisdiction wise Patents

From the publication trend, it appears that the US marks the peak publication mark with around 5876 records followed by Europe, Japan, Canada, China, Australia, Brazil, Korea and India. The peak trends show the maximum research activity. The US has been building IP for treating coronavirus and has been quite consistent and going strong in the years. India has shown 2130 published patent applications.



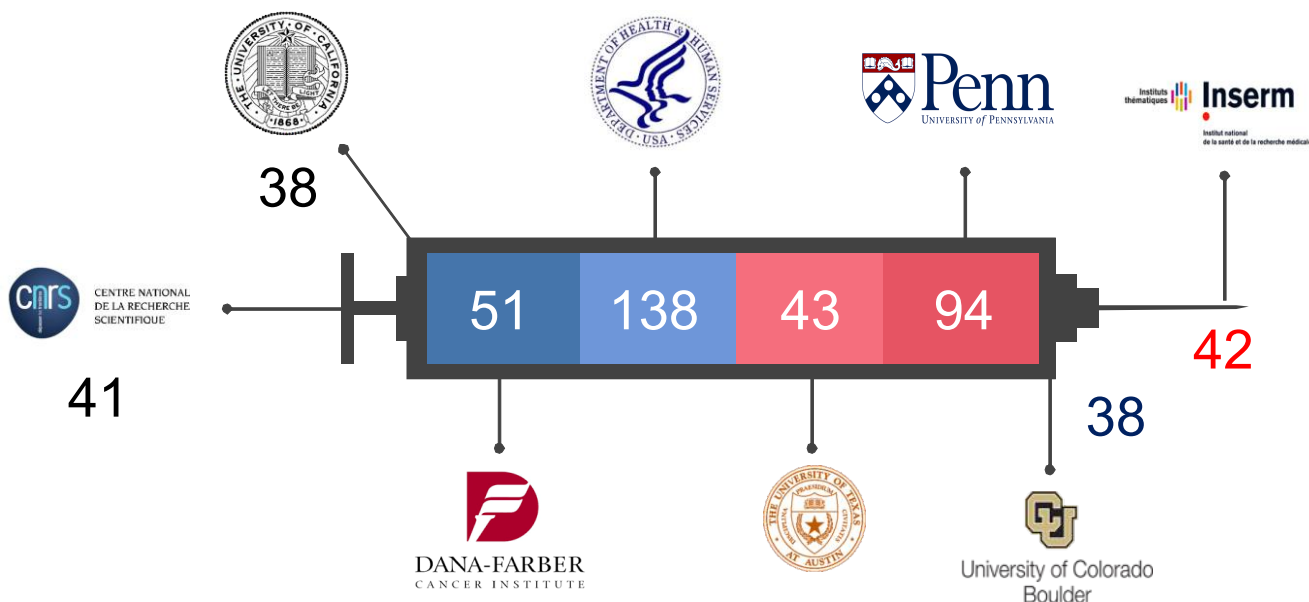
Top Players

Figure represents the top players in terms of cumulative patent filing trends. Novartis appears to dominate with over 121 patents filed followed by Pfizer, Incyte, GSK, Astra Zeneca Medimmune, Merck, Vertex, Wyeth, Zoetis.



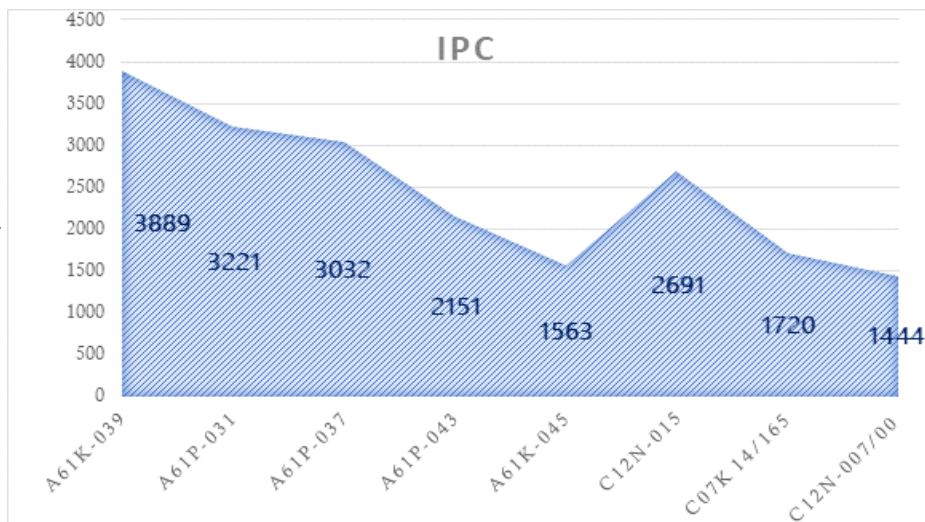
Top University

Figure represents the top R&D Institutes in terms of cumulative patent filing trends. US Department of Health & Human Services appears to dominate with over 138 patents filed followed by University of Pennsylvania, Dana Farber Cancer Institute, University of Texas, INSERM, CNRS, University of Colorado, University of California.

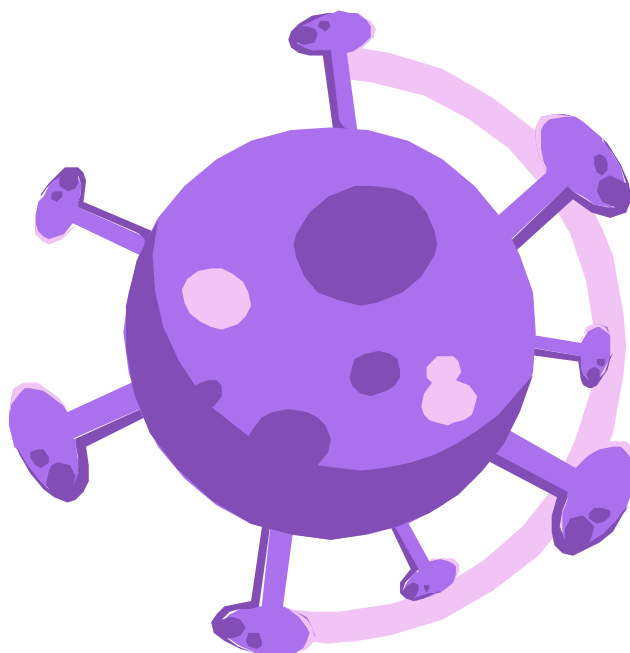
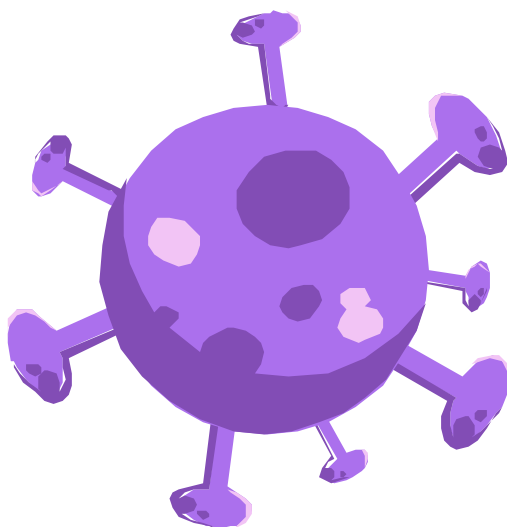
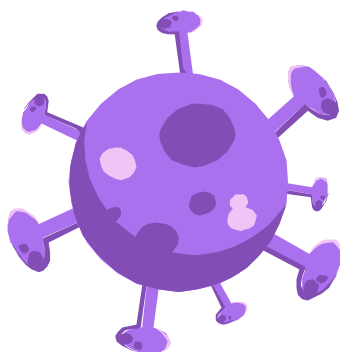


IPC Classifications

IPC classification provides a hierarchical system for the classification of patents and utility models according to the different areas of technology to which they pertain. The graph shows that the top IPC classification deals with the pharmaceutical companies who prepare the compounds effective for the microorganisms.



IPC	Description
A61K-039/12	Medicinal preparations containing antigens or antibodies (Lipids; Lipoproteins)
C12N-007/00	Viruses; Bacteriophages; Compositions thereof; Preparation or purification thereof
A61P-031	Antiinfectives, i.e. antibiotics, antiseptics, chemotherapeutics for Antivirals and RNA Virus
A61P-037	Drugs for immunological or allergic disorders
A61P-043	Drugs for specific purposes, not provided for in groups
C12N-015	Mutation or genetic engineering; DNA or RNA concerning genetic engineering, vectors; Recombinant DNA -technology; Introduction of foreign genetic material using vectors; Vectors; Use of hosts therefor; Regulation of expression; Vectors or expression systems specially adapted for eukaryotic hosts; for animal cells; Viral vectors
C07K 14/165	Peptides having more than 20 amino acids; Coronaviridae
A61K-045	Medicinal preparations containing active ingredients not provided for in groups



Selected Patents Associated with Potential Drugs for COVID-19

Table represents selected patents associated with the potential drugs for COVID-19. The selection was based on the presence of important terms in patent documents as well as the presence of the target and the possible mechanism of action for COVID-19.

Patent Application	Priority Date	Title	Assignee
WO 2017/222935 A1	16-06-2017	Small Molecule Therapeutic Inhibitors Against Picornaviruses, Caliciviruses, And Coronaviruses	KANSAS STATE UNIV RESEARCH FOUNDATION; WICHITA STATE UNIV
US 2011/0269834 A1	21-08-2009	Compounds And Methods For Treating Respiratory Diseases	UNIV ILLINOIS;PURDUE RESEARCH FOUNDATION
US 2016/0050590 W	07-09-2016	Nanoparticle Formulations for Treatment Of Middle - east Respiratory Syndrome Coronaviral Infection	SIRNAOMICS INC
JP5971830	28-04-2015	Preparation of polycyclic pyridone derivatives as cap-dependent endonuclease (CEN) inhibitors and prodrugs thereof	Shionogi and Co., Ltd., Japan
WO2009114512	11-03-2008	Preparation of azetidine and cyclobutane derivatives as JAK inhibitors	Incyte Corporation, USA
US20160122374	29-10-2014	Preparation of nucleosides and methods for treating Filoviridae virus infections	Gilead Sciences, Inc., USA
WO2007075145	04-07-2007	Preparation of benzopyranone derivatives as anti- coronaviral agents	Singapore Polytechnic, Singapore; Shanghai Institute of Materia Medica Chinese Academy of Sciences, China
WO2005021518	10-03-2005	Preparation of 3,4-dihydro-2H-1,4-benzoxazine-2-carboxylic acid derivatives as cysLT2 receptor antagonists for treatment of respiratory diseases	Ono Pharmaceutical Co., Ltd., Japan
Wo2018042343	04-07-2007	Preparation of peptides that inhibit 3C and 3CL proteases and methods of use thereof	GlaxoSmithKline, UK
US 2016/0238601 A1	14-10-2013	Methods and Compositions For Coronavirus Diagnostics And Therapeutics	Univ North Carolina Chapel Hill
EP 3188750 B1	03-09-2010	Attenuated Bovine Coronavirus and Related Vaccines	Intervet Int Bv

Selected Drugs for COVID-19

Researchers are finding a way to repurpose existing drugs. Since SARS-CoV-2 genomic sequence is matching with some extent, the scientists are trying to couple the genomic sequence information with protein structure modelling and suggesting the list of existing drugs with therapeutic potential for COVID-19.

Drug	Target	Possible Mechanism	Indication
baricitinib	JAK kinase	a JAK inhibitor that may interfere with the inflammatory processes	approved drug for rheumatoid arthritis
lopinavir	viral proteases: 3CLpro or PLpro	protease inhibitors that may inhibit the viral proteases: 3CLpro or PLpro	lopinavir and ritonavir are approved drug combination for HIV infection
ritonavir	viral proteases: 3CLpro or PLpro	protease inhibitors that may inhibit the viral proteases: 3CLpro or PLpro	lopinavir and ritonavir are approved drug combination for HIV infection
darunavir	viral proteases: 3CLpro or PLpro	protease inhibitors that may inhibit the viral proteases: 3CLpro or PLpro	approved drug for HIV infection
favipiravir	RdRp	a purine nucleoside that acts as an alternate substrate leading to inaccurate viral RNA synthesis	viral infections
remdesivir	NA	a nucleotide analogue that may block viral nucleotide synthesis to stop viral replication	Ebola virus infection
Ribavirin	NA	NA	RSV infection, hepatitis C, some viral hemorrhagic fevers
galidesivir	NA	NA	hepatitis C, Ebola virus, Marburg virus
BCX-4430 (salt form of galidesivir)	NA	NA	hepatitis C, Ebola virus, Marburg virus
Arbidol	S protein/ ACE2d	an inhibitor that may disrupt the binding of viral envelope protein to host cells and prevent viral entry to the target	influenza antiviral drug
chloroquine	endosome/ ACE2	a drug that can elevate endosomal pH and interfere with ACE2 glycosylation	malarial parasite infection
nitazoxanide		a drug that may inhibit viral protein expression	various helminthic, protozoal, and viral infection-caused diarrhoea

Vaccine under Trial

According to WHO report, currently 2 candidate vaccines are in clinical evaluation whereas 60 candidate vaccines are in pre-clinical evaluation.

Platform	Type of candidate vaccine	Developer	Coronavirus target	Current stage of clinical evaluation/regulatory status- Coronavirus candidate
Non-Replicating Viral Vector	Adenovirus Type 5 Vector	CanSino Biological Inc./Beijing Institute of Biotechnology	COVID-19	Phase 1
RNA	LNP-encapsulated mRNA	Moderna/NIAID	COVID-19	Phase 1

Conclusion

Human civilization has learnt many lessons from such outbreaks and accordingly the global scientific research and development has been focused to counter these pandemics with innovations. This report provides an overview of published information of COVID-19 profile and the mechanism of action with a focus on worldwide innovation status of possible effective inventions on RNA viruses.

The information provided in this report provides an intellectual groundwork for support of ongoing research and development for discovery and development of therapeutic agents and vaccines for treatment of COVID-19 and coronavirus-related diseases.

References:

- Chen Y, Liu Q, Guo D. Emerging coronaviruses: genome structure, replication, and pathogenesis. *J Med Virol* 2020;92:418–23.
- Li X, Geng M, Peng Y, Meng L, Lu S. Molecular immune pathogenesis and diagnosis of COVID-19. *J Pharm Analysis* 2020.
- Yildiz H, Neste EVD, Defour JP, Danse E, Yombi JC. Adult haemophagocytic lymphohistiocytosis: a review. *Qjm Mon J Assoc Physicians* 2020.
- Ramos-Casals M, Brito-Zeron P, Lopez-Guillermo A, Khamashta MA, Bosch X. Adult haemophagocytic syndrome. *Lancet* 2013;383:1503–16.
- Seguin A, Galicier L, Boutboul D, Lemiale V, Azoulay E. Pulmonary involvement in patients with hemophagocytic lymphohistiocytosis. *Chest* 2016;149:1294–301.
- Wan S, Yi Q, Fan S, Lv J, Zhang X, Guo L, et
<https://pubs.acs.org/doi/10.1021/acscentsci.0c00272>
- World Health Organization



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