

Article

Quantitative Mutation Analysis of Genes and Proteins of Major SARS-CoV-2 Variants of Concern and Interest

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Abstract: Of various SARS-CoV-2 variants, some have drawn special concern or interest because of their heightened disease threat. The mutability of individual SARS-CoV-2 genes/proteins presumably varies. The present study quantified gene/protein mutations in 13 major SARS-CoV-2 variants of concern/interest, and analyzed viral protein antigenicity using bioinformatics. The results from 187 carefully perused genome clones showed significantly higher mean percent mutations in the spike, ORF8, nucleocapsid, and NSP6 than in other viral proteins. The ORF8 and spike proteins also tolerated higher maximal percent mutations. The omicron variant presented more percent mutations in the NSP6 and structural proteins, whereas the delta featured more in the ORF7a. Omicron subvariant BA.2 exhibited more mutations in ORF6, and omicron BA.4 had more in NSP1, ORF6, and ORF7b, relative to omicron BA.1. Delta subvariants AY.4 and AY.5 bore more mutations in ORF7b and ORF8 than delta B.1.617.2. Predicted antigen ratios of SARS-CoV-2 proteins significantly vary (range: 38–88%). To overcome SARS-CoV-2 immune evasion, the relatively conserved, potentially immunogenic NSP4, NSP13, NSP14, membrane, and ORF3a viral proteins may serve as more suitable targets for molecular vaccines or therapeutics than the mutation-prone NSP6, spike, ORF8, or nucleocapsid protein. Further investigation into distinct mutations of the variants/subvariants may help understand SARS-CoV-2 pathogenesis.

Keywords: severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2); coronavirus disease 2019 (COVID-19); mutations; variant; viral proteins; antigenicity



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1. Introduction

As the causative pathogen for coronavirus disease 2019 (COVID-19), severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) undergoes constant mutations, resulting in the emergence of various lineages or variants of the virus since the COVID-19 outbreak [1–3]. The rapid evolution of the SARS-CoV-2 virus has caused new problems like repeated infections, evasion of immune protection, and lost or weakened efficacy of vaccines, therapeutics, or diagnostics [4]. The status of SARS-CoV-2 mutations is closely monitored through genomic sequencing of virus samples from infected individuals. Various large-scale analyses of SARS-CoV-2 mutations have been conducted, some focusing on specific genes/proteins of the virus, and others mainly dealing with evolutions, transmissibility, infectivity, or virulence of the variants [5–10].

SARS-CoV-2 accumulates replication errors along the course of its spread, infection, and proliferation. The variants of concern/interest of SARS-CoV-2 refer to the mutants of the virus that harbor specific combinations of viral genome mutations and have the potential of heightened disease threat due to enhanced transmission, infection, virulence, or immune escape [1,11]. Thus, among the numerous hitherto identified SARS-CoV-2 lineages, the variants of concern/interest are more clinically relevant. Epidemiologically, much has also been learned about these SARS-CoV-2 variants [1–3,12].

The SARS-CoV-2 genome comprises approximately 30,000 nucleotides with 12 canonical genes encoding non-structural, structural, or accessory viral proteins of which functions

Quantitative Analysis Of Disease Associated Mutations And Sequence Variants Pb 2001

**Peter R. Durie, Markus M. Lerch, Albert
B. Lowenfels, Patrick
Maisonneuve, Charles D. Ulrich**

Quantitative Analysis Of Disease Abociated Mutations And Sequence Variants Pb 2001:

Medical Retina Frank G. Holz,Richard F. Spaide,2007-07-30 The specialty of medical retina remains one of the most challenging fields in ophthalmology Written by world renowned experts this authoritative work on medical retina is both comprehensive and practical and will serve the need of all ophthalmologists as well as optometrists and ophthalmic nurses to keep up to date with new developments in the important field of medical retina It encompasses the application of confocal scanning laser ophthalmoscopy including fundus autofluorescence imaging as well as the mapping of central visual function by microperimetry It also covers anti VEGF therapy that has revolutionized the treatment of neovascular age related macular degeneration

Quantitative Analysis of Disease Associated Mutations and Sequence Variants Charlotta Olsson,2001 *Index Medicus* ,2004 Vols for 1963 include as pt 2 of the Jan issue Medical subject headings *The Genetic Basis of Common Diseases* Richard A. King,Jerome I. Rotter,Arno G. Motulsky,2002-10-17 Since the first edition of this highly acclaimed text was published in 1992 much new knowledge has been gained about the role of genetic factors in common adult diseases and we now have a better understanding of the molecular processes involved in genetic susceptibility and diseases mechanisms The second edition fully incorporates these advances The entire book has been updated and twelve new chapters have been added Most of these chapters deal with diseases such as gallstones osteoporosis osteoarthritis skin cancer other common skin diseases prostate cancer and migraine headaches that are seen by all physicians Others address the genetic and molecular basis of spondylarthropathies lupus hemochromatosis IgA deficiency mental retardation hearing loss and the role of mitochondrial variation in adult diseases Chapters on the evolution of human genetic disease and on animal models add important background on the omplexities of these diseases Unique clinical applications of genetics to common diseases are covered in the additional new chapters on genetic counseling pharmacogenetics and the genetic consequences of modern therapeutics *Henry's Clinical Diagnosis and Management by Laboratory Methods E-Book* Richard A. McPherson,Matthew R. Pincus,2021-06-09 For more than 100 years Henry s Clinical Diagnosis and Management by Laboratory Methods has been recognized as the premier text in clinical laboratory medicine widely used by both clinical pathologists and laboratory technicians Leading experts in each testing discipline clearly explain procedures and how they are used both to formulate clinical diagnoses and to plan patient medical care and long term management Employing a multidisciplinary approach it provides cutting edge coverage of automation informatics molecular diagnostics proteomics laboratory management and quality control emphasizing new testing methodologies throughout Remains the most comprehensive and authoritative text on every aspect of the clinical laboratory and the scientific foundation and clinical application of today s complete range of laboratory tests Updates include current hot topics and advances in clinical laboratory practices including new and extended applications to diagnosis and management New content covers next generation mass spectroscopy MS coagulation testing next generation sequencing NGS transfusion medicine genetics and

cell free DNA therapeutic antibodies targeted to tumors and new regulations such as ICD 10 coding for billing and reimbursement Emphasizes the clinical interpretation of laboratory data to assist the clinician in patient management Organizes chapters by organ system for quick access and highlights information with full color illustrations tables and diagrams Provides guidance on error detection correction and prevention as well as cost effective test selection Includes a chapter on Toxicology and Therapeutic Drug Monitoring that discusses the necessity of testing for therapeutic drugs that are more frequently being abused by users Enhanced eBook version included with purchase Your enhanced eBook allows you to access all of the text figures and references from the book on a variety of devices *High-Throughput Phenotyping in the*

Genomic Improvement of Livestock Fabyano Fonseca Silva,Guilherme J. M. Rosa,Gota Morota,2021-08-03 **Russell & Rubinstein's Pathology of Tumors of the Nervous System 7Ed** Roger McLendon,Marc Rosenblum,Darell

Bigner,2006-07-28 This is the leading international professional reference text that also serves as a bench book describing all aspects of the pathology of brain tumours genetics molecular biology epidemiology morphology immunohistochemistry diagnostic criteria and prognosis Beautifully illustrated in colour throughout and comprehensively referenc *Behavioral*

Neurogenetics John F. Cryan,Andreas Reif,2012-05-04 This book covers a wide array of topics relevant to behavioral genetics from both a preclinical and clinical standpoint Indeed in juxtaposing both areas of research the reader will appreciate the true translational nature of the field Topics covered range from technical advances in genetic analysis in humans and animals to specific descriptions of advances in schizophrenia attention disorders depression and anxiety disorders autism aggression neurodegeneration and neurodevelopmental disorders The importance of gene environment interactions is emphasised and the role of neuroimaging in unravelling the functional consequences of genetic variability described This volume will be valued by both the basic scientist and clinician alike who may use it as a detailed reference book It will also be of use to the novice to the field to whom it will serve as an in depth introduction to this exciting area of research Neurodegeneration:

From Genetics to Molecules Victoria Campos-Peña,Marco Antonio Meraz-Ríos,Rosalinda Guevara-Guzmán,Karla Guadalupe Carvajal,2016-11-15 Chronic degenerative diseases are one of the major public health problems particularly those affecting the nervous system They are characterized by the degeneration of specific cell populations that include several pathologies which contribute significantly to morbidity and mortality in the elderly population Therefore in recent years the study of neuroscience has gained significant importance Most of these neurodegenerative disorders are the result of a complex interaction between genetic and environmental factors that generate progression and can even determine its severity The presence of mutations in genes as LRRK2 SNCA PARK7 PARK2 or PINK1 is associated with Parkinson s disease Mutations in genes such as APP PS1 and PS2 are associated with familial Alzheimer s disease while HTT gene mutations are the cause of Huntington s disease In most cases this condition is inherited in an autosomal dominant pattern which means one copy of the altered gene in each cell is sufficient to cause the disorder It is known that these mutations can also alter the proteins

function however it has not yet been possible to fully understand how some genetic changes cause the disease or influence the risk of developing these disorders Most symptoms seen in these conditions occurs when specific nerve cells are damaged or die generating a loss in brain communication Also many of these mutations generate aggregation of intracellular or extracellular proteins affecting cell function and eventually causing neuronal death It is unclear whether the presence of these aggregates play an important role in nerve cell death during the development of neurodegenerative diseases or if they are simply part of the response of cells to the disease Other mutations affect the mitochondrial function generating alterations in energy production and promoting the formation of unstable molecules such as free radicals Under normal conditions the harmful effects caused by free radicals are offset within the cell However in pathological conditions the presence of mutations can alter this process by allowing the accumulation of radicals and damaging or killing cells On the other hand we also know that these diseases may not have a direct genetic component thus the study of sporadic type neurodegenerative diseases is much more complex Histopathological lesions as well as the cellular and molecular alterations are generally indistinguishable from familial cases For this reason it is important to understand the genetic and molecular mechanisms associated with this type of pathologies In this sense this issue aims to understand the molecular processes that occur in the brain and how these are influenced by the environment genetics and behavior

Neonatal Neurology

,2019-07-17 Neonatal Neurology Volume 162 in the Handbook of Clinical Neurology series updates the reader on the latest advances in the study of neurological diseases diagnosed in the fetal and neonatal periods With recent advances in magnetic resonance imaging digital electroencephalography recording and genetic testing and diagnosis there is expanding awareness relating to early onset neurological conditions and how their early diagnosis can improve prediction of outcome and subsequent neurodevelopmental outcome This new volume covers diagnosis and management of congenital conditions including brain malformations neuromuscular conditions and genetic epilepsies as well as acquired injury related to peripartum events prematurity critical illness and systemic diseases Provides an in depth understanding of the basic scientific research translational research and clinical consensus across neonatal and fetal medicine Explores how early neurological diagnosis can improve prediction of outcome and how management can improve subsequent neurodevelopmental outcome Features chapters co authored by two experts combining expertise in both neonatal and fetal neurology

Diabetes Mellitus

Derek LeRoith,Simeon I. Taylor,Jerrold M. Olefsky,2004 Thoroughly revised and updated this Third Edition encompasses the most recent advances in molecular and cellular research and describes the newest therapeutic modalities for type 1 and type 2 diabetes mellitus Chapters by leading experts integrate the latest basic science and clinical research on diabetes mellitus and its complications The text is divided into ten major sections including extensive sections on therapeutics diabetes during pregnancy and complications New chapters cover stem cell therapy for type 1 diabetes genetics and treatment of obesity new therapies to promote insulin action vasculopathy islet cell protocols triglycerides in muscle hypoglycemia in the adult

and the Diabetes Prevention Program *Atherothrombosis and Coronary Artery Disease* Valentin Fuster, Eric J. Topol, Elizabeth G. Nabel, 2005 Written by the world's foremost authorities this volume provides comprehensive coverage of current approaches to the prevention diagnosis and management of atherothrombosis and its coronary and noncoronary complications This edition has been thoroughly updated sharply focused on clinical information and trimmed to one manageable volume Coverage begins with a review of risk factors and prevention emphasizing lipid abnormalities hypertension smoking diabetes and obesity Subsequent sections examine the pathogenesis of atherosclerosis markers and imaging acute coronary syndromes chronic stable angina and noncoronary atherothrombosis Clinical presentations medical management and the latest interventional strategies are included **Clinical Image-Based Procedures. Translational Research in Medical Imaging** Marius Erdt, Marius George Linguraru, Cristina Oyarzun Laura, Raj Shekhar, Stefan Wesarg, Miguel Angel González Ballester, Klaus Drechsler, 2014-03-28 This book constitutes revised selected papers from the International Workshop on Clinical Image Based Procedures CLIP 2013 held in conjunction with MICCAI 2012 in Nagoya Japan in September 2013 The 19 papers presented in this volume were carefully reviewed and selected from 26 submissions The workshop was a productive and exciting forum for the discussion and dissemination of clinically tested state of the art methods for image based planning monitoring and evaluation of medical procedures **Greenfield's Neuropathology - Two Volume Set** Seth Love, Arie Perry, James Ironside, Herbert Budka, 2018-10-08 Greenfield's Neuropathology the world's leading neuropathology reference provides a comprehensive account of the pathological findings in neurological disease their biological basis and their clinical manifestations The book's detailed advice on pathological assessment and interpretation is based on clear descriptions of molecular and cellular processes and reactions that are relevant to the development of the nervous system as well as its normal and abnormal functioning The information is presented in an accessible way to readers working within a range of disciplines in the clinical neurosciences and neuropathological findings are placed within the context of a broader diagnostic process New for the Ninth Edition Features online and downloadable digital formats with rapid search functions annotation and bookmarking facilities image collections and live reference links Contains many color illustrations and high quality clinical photographs to help with interpretation and understanding Includes more than 1000 new photographs and drawings Incorporates new design elements such as alternate colour coding of chapters for easier navigation Known for its thorough yet practical approach Greenfield's continues to provide trusted information to all neuropathologists and those in related specialties including neurologists neurosurgeons general pathologists neuroradiologists and clinical neuroscientists **Genetic Disorders of the Exocrine Pancreas** Peter R. Durie, Markus M. Lerch, Albert B. Lowenfels, Patrick Maisonneuve, Charles D. Ulrich, 2002-01-01 This publication summarizes important new scientific information and provides guidelines for genetic testing for hereditary pancreatitis as well as guidelines for the prevention screening and treatment of pancreatic cancer in hereditary pancreatitis It also includes chapters on neonatal

screening for cystic fibrosis gene mutations in idiopathic pancreatitis and clinical phenotypes of Shwachman Diamond Syndrome This book is required reading for all individuals with an interest in pancreatic disease **Celebrating 5 Years of Avian Physiology in Frontiers in Physiology** Colin G. Scanes, Sandra G. Velleman, 2022-09-27 The avian physiology section is now five years old This special e book is to commemorate this event For this highlights issue celebrating the first five years of the Avian Physiology section it was decided to focus on the top papers reviews published Table 1 lists the top fifteen papers reviews based on either views or down loads as a pdf There is some agreement between the two lists What is compelling is that of the top papers all except one encompasses research conducted in domesticated birds predominantly with chickens with one focused on turkeys It is perhaps not unexpected that research on chickens dominates the top papers because of the following Chickens are commercially important being the number one meat animal globally Chickens are used as the model species for birds Other possibilities that could be the case include the following There are more researchers working on chickens compared to other commercial or wild species There are other avenues to publish wild bird research Lack of funding for open access article processing charges The exceptions to the chicken papers reviews is a paper on a passerine bird the migratory blackheaded bunting *Emberiza melanocephala* Singh et al 2018 and a review paper focused on turkey satellite cell proliferation and differentiation Velleman and Song 2017 Of the top papers reviews six were related to muscle physiology Bottje et al 2017 Greene et al 2019 Lassiter et al 2019 Lin et al 2017 Piekarski et al 2020 Velleman and Song 2017 These papers address different aspects of the physiology of muscle functioning and development in chickens or turkeys specifically the following Small RNAs from the transcribed from mitochondrial genome in muscle Bottje et al 2017 Leptin induced autophagy of muscle cells Piekarski et al 2020 Proliferation and differentiation of myoblasts influence of syndecan 4 and glypican 1 Velleman and Song 2017 Myostatin signaling and muscle growth Lassiter et al 2019 The role of growth factors and signal transduction pathways in myoblast proliferation Lin et al 2017 Muscle pathology specifically woody breast myopathy Greene et al 2019 There are also among the top papers reviews on multiple diverse other organs and systems namely the following adipose tissue Abdalla et al 2018 bone Adhikari et al 2019 feathering Chen et al 2019 gastro intestinal functioning microbiome Li et al 2018 Kraimi et al 2018 Rodrigues et al 2020 immune functioning Bi et al 2018 Wei et al 2018 kidneys Li et al 2018 liver Flees et al 2017 Singh et al 2018 endogenous opioids Scanes and Pierzchala Koziec 2018 photoperiodism Hanlon et al 2020 pituitary gland Zhang et al 2021 and reproduction Eusemann et al 2018 Li et al 2018 The geographical distribution of the top papers is interesting as summarized in Table 2 The United States of America and the People s Republic of China were the country of origin of most of the papers In addition there were papers reviews from Europe France Germany and a collaborative paper between researchers in the USA and Poland and India Of the top papers reviews from the USA six come from a single department namely the Department of Poultry Science Center of Excellence for Poultry Science University of Arkansas Bottje et al 2017 Flees et al 2017 Green et al 2019 Lassiter et al 2019 Piekarski et al

2020 Rodrigues **Rheumatology E-Book** Marc C. Hochberg, Alan J. Silman, Josef S. Smolen, Michael E. Weinblatt, Michael H. Weisman, 2014-06-16 Stay current in the ever changing discipline of rheumatology with clear reliable guidance from Hochberg's Rheumatology one of the most respected and trusted sources in the field Designed to meet the needs of the practicing clinician this medical reference book provides extensive authoritative coverage of rheumatic diseases from basic scientific principles to practical points of clinical management in a lucid logical user friendly manner Track disease progression and treat patients more effectively with the information on genetic findings imaging outcomes cell and biologic therapies rheumatoid arthritis and SLE Incorporate recent findings about pathogenesis of disease imaging outcomes for specific diseases like RA osteoarthritis and spondyloarthropathies cell and biologic therapies and other timely topics Remain up to date on the latest information in rheumatology through 13 brand new chapters covering biomedical and translation science disease and outcome assessment new imaging modalities early emerging disease clinical therapeutics patient management and rehabilitation Take advantage of expanded coverage of small molecule treatment biologics biomarkers epigenetics biosimilars and cell based therapies Focus on the core knowledge needed for successful results with each chapter co authored by an internationally renowned specialist in the field Easily find the information you need thanks to a consistent user friendly format with templated content and large scale images **Cancer Research** ,2006-08 *Recent Advances in Immunosuppression-Related Swine Diseases* Gang Wang, Leyi Wang , Taofeng Du, 2024-07-25 Pigs are important agricultural animals with ancient domestication history and economic value and have become important sources of protein for humans Infectious diseases affect the health of pigs and the stability and productivity of the global swine industry The emergence and reemergence of several contagious swine diseases in recent years have posed a severe threat to pig production globally Increasing concern has been raised about the immunosuppressive effect caused by immunosuppressive swine pathogens in recent years such as porcine reproductive and respiratory syndrome virus PRRSV porcine circovirus PCV African swine fever virus ASFV classical swine fever virus CSFV pseudorabies virus PRV among others Infection with variant strains of PRRSV PRV and the low virulence strains of ASFV increase the pathogenicity of opportunistic infectious agents causing secondary disease challenges which can result in more complicated clinical symptoms and severe diseases These diseases lead to increased treatment expenses reduced swine herd growth rate and feed conversion rate However with the ongoing viral evolution and the emergence of novel variants current research into the mechanisms underlying immunosuppression remains inadequate highlighting the urgent need for further investigation [An A-Z of Genetic Factors in Autism](#) Kenneth Aitken, 2011-04-15 This volume explains the biology and genetics of ASD and provides clinicians and researchers with a comprehensive summary of each genetic factor including the research that links it to ASD diagnosis and treatment issues and related animal models as well as detailing relevant professional organisations and avenues for further research

Quantitative Analysis Of Disease Abociated Mutations And Sequence Variants Pb 2001: Bestsellers in 2023 The year 2023 has witnessed a noteworthy surge in literary brilliance, with numerous engrossing novels captivating the hearts of readers worldwide. Lets delve into the realm of bestselling books, exploring the captivating narratives that have captivated audiences this year. Quantitative Analysis Of Disease Abociated Mutations And Sequence Variants Pb 2001 : Colleen Hoovers "It Ends with Us" This heartfelt tale of love, loss, and resilience has captivated readers with its raw and emotional exploration of domestic abuse. Hoover skillfully weaves a story of hope and healing, reminding us that even in the darkest of times, the human spirit can succeed. Quantitative Analysis Of Disease Abociated Mutations And Sequence Variants Pb 2001 : Taylor Jenkins Reids "The Seven Husbands of Evelyn Hugo" This captivating historical fiction novel unravels the life of Evelyn Hugo, a Hollywood icon who defies expectations and societal norms to pursue her dreams. Reids captivating storytelling and compelling characters transport readers to a bygone era, immersing them in a world of glamour, ambition, and self-discovery. Quantitative Analysis Of Disease Abociated Mutations And Sequence Variants Pb 2001 : Delia Owens "Where the Crawdads Sing" This mesmerizing coming-of-age story follows Kya Clark, a young woman who grows up alone in the marshes of North Carolina. Owens crafts a tale of resilience, survival, and the transformative power of nature, entrancing readers with its evocative prose and mesmerizing setting. These popular novels represent just a fraction of the literary treasures that have emerged in 2023. Whether you seek tales of romance, adventure, or personal growth, the world of literature offers an abundance of captivating stories waiting to be discovered. The novel begins with Richard Papen, a bright but troubled young man, arriving at Hampden College. Richard is immediately drawn to the group of students who call themselves the Classics Club. The club is led by Henry Winter, a brilliant and charismatic young man. Henry is obsessed with Greek mythology and philosophy, and he quickly draws Richard into his world. The other members of the Classics Club are equally as fascinating. Bunny Corcoran is a wealthy and spoiled young man who is always looking for a good time. Charles Tavis is a quiet and reserved young man who is deeply in love with Henry. Camilla Macaulay is a beautiful and intelligent young woman who is drawn to the power and danger of the Classics Club. The students are all deeply in love with Morrow, and they are willing to do anything to please him. Morrow is a complex and mysterious figure, and he seems to be manipulating the students for his own purposes. As the students become more involved with Morrow, they begin to commit increasingly dangerous acts. The Secret History is a brilliant and suspenseful novel that will keep you wondering until the very end. The novel is a warning tale about the dangers of obsession and the power of evil.

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