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Supplementary information

Ebola as a case study for the patent landscape of medical countermeasures for emerging infectious diseases

In the format provided by the authors and unedited

Online Methods

Dataset Preparation

The first step towards the preparation of the PLR was taken by the construction of a dataset. Patent information was retrieved from the Lens patent database (https://www.lens.org) becauseof free availability, the ability to export up to 50000 records, and the inclusion of the number of family members in exported search results. Any patent document that contained the term Ebola virus, EBOV, or EVD in its title, abstract, or claims and was published before January 2020 was included in search results. Search results were exported to a CSV file format (provided in supplementary data) and were imported into R statistical package[1] for modification and analysis (referred to as the dataset, hereafter) mainly by using tools, provided in packages including readr [2], plyr[3], dplyr[4], and tidyr[5]. All graphs were generated using the ggplot2 package[6]. To avoid more than one record for each invention, one patent document was chosen to represent each patent family. The representative patent document for each family was chosen to be the one with the earliest application date among those with the same priority number (referred to as "family" hereafter).

Dates

The application year of the representative patent for each family was used in all graphs. The application date column in the dataset was split to day, month, and year, and the year column was used for all graphs.

Jurisdictions

The patent office that each family was filed in, was chosen as the jurisdiction in all graphs.

Applicants

Two different approaches were used to prepare patent family applicant data for further analysis. In the first approach, the column of applicants in the dataset was split in a way that if a family had more than one applicant, each applicant had a dedicated column. The resulting columns were combined and unique applicants were extracted and counted. This approach was used in figure 4 and figure 6C to get applicants with the most patent applications. On the second approach, the intact applicant column was used to obtain a word cloud for the applicants and also to determine types of applicants. To generate a word cloud from the applicants column of the dataset, the tm package was used to create a bag of words, remove English stop words, and create a word matrix by counting the number of word occurrences[7–9]. The resulting matrix turned to a word cloud, using the wordcloud package[10,11]. The intact applicant column was also used to distinguish between applicant types, and a set of keywords was assembled for each applicant type, which all are presented in table S1.

Classifications

International Patent Classifications (IPC) were used to acquire technological areas of patent families. Each IPC consists of two segments. A segment before the forward-slash ('/') identified as ipc1 hereafter, and a segment after the forward-slash identified as ipc2 henceforth. Patent families were grouped and analyzed using the first part of the classifications because this action allowed for the formation of larger groups and more generalized analysis. The number of family members in each group was then graphed either alone or versus application year or applicants with the most applications.

Network Analysis

When a patent family is classified in two or more different IPCs, those IPCs can be assumed to be linked by that patent family. These links can be analyzed by network diagrams. To draw a

network diagram of the links, ipc1 was used to allow for more inclusive communities. Every ipc1 pair was extracted, sorted and redundant pairs were removed using basic R functions. The linkcomm package[12] was used for the analysis and visualization of the network. Communities generated by the "getLinkCommunities()" function, with "mcquitty" as the clustering method. This function organizes the provided database as nodes (ipc1 segments) and edges (co-occurrence of two ipc1 segments in one patent family). The generated communities were then visualized by the "spencer.circle" layout. Moreover, the generated communities were clustered again based on their common nodes with the "getClusterRelatedness()" function.

References

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Table S1. Search keywords used to distinguish between applicant types.

Applicant type	Search terms
Academic	univ, college, acad, inst, inst, school, foun, center, hospital, center, res
Commercial	inc, Ltd, corp, llc, gmbh, as, ag, res & dev, company, lab, ag, bv, pharma , pharmaceuticals , ink , co, sa, therapeutics , pty , limited, limited , plc, sdn, bhd, s a s, biotechnologies, pharma, aio, org, tech
Governmental	gov ,army ,minister, armed forces, federalnoe, federal, fed, agency, government, control & prevention, nat
Individual	Lack of all above keyboards in the applicant field

Table S2. Patent families with equal to or more than 20 family members

Title	Publication Number	Applicants	Simple Family Size
Methods For Treating Filoviridae Virus Infections	US 9724360 B2	GILEAD SCIENCES INC	98
Methods For The Preparation Of Ribosides	TW 201630925 A	GILEAD SCIENCES INC	98
Use Of A Peptide As A Therapeutic Agent	WO 2009/040019 A2	MONDOBIOTECH LAB AG;;BEVEC DORIAN;;CAVALLI FABIO;;CAVALLI VERA;;BACHER GERALD	90
Use Of A Peptide As A Therapeutic Agent	WO 2009/040018 A2	MONDOBIOTECH LAB AG;;BEVEC DORIAN;;CAVALLI FABIO;;CAVALLI VERA;;BACHER GERALD	84
Peptides And Related Molecules That Bind To Tall-1	WO 2002/092620 A2	AMGEN INC	76
Method Of Preventing Virus:cell Fusion By Inhibiting The Function Of The Fusion Initiation Region In Rna Viruses Having Class I Membrane Fusogenic Envelope Proteins	EP 2261380 B1	UNIV TULANE;;AUTOIMMUNE TECHNOLOGIES LLC	70
Method And Apparatus For Minimizing Redundant Enhanced Uplink Allocation Requests And Fault-isolating Enhanced Uplink Transmission Failures.	AU 2008/207587 B2	INTERDIGITAL TECH CORP	69
Phosphonate Compounds	US 7452898 B2	UNIV CALIFORNIA	67
Phosphonate Compounds	EP 1233770 B1	UNIV CALIFORNIA AT SAN DIEGO	67
Pharmaceutical Composition Containing A Stabilised Mrna Optimised For Translation In Its Coding Regions	US 2016/0136259 A1	CUREVAC AG	62
Use Of Cell-permeable Peptide Inhibitors Of The Jnk Signal Transduction Pathway For The Treatment Of Various Diseases	WO 2009/143865 A1	XIGEN SA;;BONNY CHRISTOPHE	62
Hybrid And Tandem Expression Of Neisserial Proteins	AU 2002/339217 B2	NOVARTIS VACCINES AND DIAGNOSTICS S R L	60
Pyrrolopyrimidine Derivatives For Use In The Inhibition Of Polymerase	EP 3345605 B1	BIOCRYST PHARM INC	58
Methods And Compositions For Inhibition Of Polymerase	US 9492452 B2	BIOCRYST PHARM INC	58
Peptide	WO 2006/018652 A2	NOVABIOTICS LTD;;O'NEIL DEBORAH	58
Lentiviral Vectors Pseudotyped With A Sindbis Virus Envelope Glycoprotein	EP 2456786 B2	IMMUNE DESIGN CORP	57
Recombinant Hcmv And Rhcmv Vectors And Uses Thereof	EP 2772265 B1	UNIV OREGON HEALTH & SCIENCE	55
Recombinant Hcmv And Rhcmv Vectors And Uses Thereof	WO 2011/143650 A2	UNIV OREGON HEALTH & SCIENCE;;PICKER LOUIS;;NELSON JAY A;;FRUEH KLAUS;;JARVIS MICHAEL A;;HANSEN SCOTT G	55
Immunopotentiative Composition	US 2009/0297518 A1	HONJO TASUKU;;MINATO NAGAHIRO;;IWAI YOSHIKO;;SHIBAYAMA SHIRO	54
Gla Domains As Targeting Agents	US 2016/0008482 A1	BAYER HEALTHCARE LLC	53
Targeted Gene Delivery For Dendritic Cell Vaccination	AU 2007/275010 B2	CALIFORNIA INST OF TECHN	53
Targeted Gene Delivery For Dendritic Cell Vaccination	EP 2048955 B1	CALIFORNIA INST OF TECHN	53
Gla Domains As Targeting Agents	WO 2014/151683 A1	BAYER HEALTHCARE LLC	53
Chimpanzee Adenovirus Vaccine Carriers	EP 1711518 B1	ANGELETTI P IST RICHERCHE BIO	52
Compositions And Methods For Sirna Inhibition Of Angiogenesis	US 2004/0018176 A1	UNIV PENNSYLVANIA	52
Compositions And Methods For Sirna Inhibition Of Angiogenesis	WO 2004/009769 A2	UNIV PENNSYLVANIA;;TOLENTINO MICHAEL J;;REICH SAMUEL JOTHAM	52
Method And System For Mimo Transmission In A Distributed Transceiver Network	US 9686060 B2	GOLBA LLC	51
Reversal Of Viral-induced Systemic Shock And Respiratory Distress By Blockade Of The Lymphotoxin Beta Pathway	WO 2000/021558 A1	BIOGEN INC;;BROWNING JEFF;;PUGLIELLI MARYANN;;AHMED RAFI	47
Vaccine Nanotechnology	WO 2009/051837 A2	MASSACHUSETTS INST TECHNOLOGY;;VON ANDRIAN ULRICH H;;FAROKHZAD OMID C;;LANGER ROBERT S;;JUNT TOBIAS;;MOSEMAN ASHLEY;;ZHANG LIANGFANG;;BASTO PAMELA;;IANNACONE MATTEO;;ALEXIS FRANK	46
Stimulation Of Host Defense Mechanisms Against Viral Challenges	EP 0956040 B1	PHARMA PACIFIC PTY LTD	45
Multiplex Immuno Screening Assay	AU 2012/350229 A1	PASTEUR INSTITUT	45
Oligonucleotide Chelate Complex Methods	EP 2849760 B1	REPLICOR INC	44
Use Of A Peptide As A Therapeutic Agent	US 2010/0197599 A1	BEVEC DORIAN;;CAVALLI FABIO;;CAVALLI VERA;;BACHER GERALD	43
Methods And Compositions For Inhibition Of Membrane Fusion-associated Events, Including Hiv Transmission	AU 1996/044734 A	UNIV DUKE;;TRIMERIS INC	41

Title	Publication Number	Applicants	Simple Family Size
Steroids Comprising A Spiranic Cycle In Position 17, Preparation Process And Utilization Thereof	AU 604692 B2	ROUSSEL UCLAF	41
Non-sequence Complementary Antiviral Oligonucleotides	AU 2003/267785 C1	REPLICOR INC	40
Non-sequence Complementary Antiviral Oligonucleotides	WO 2004/024919 A1	REPLICOR INC;;VAILLANT ANDREW;;JUTEAU JEAN-MARC	40
Fusion Polypeptides Com0prising An Ige-binding Domain And A Hsa Component, And Their Diagnostic And Therapeutic Uses	AU 1997/042025 A	NOVARTIS AG	40
Mimo Beamforming-based Single Carrier Frequency Division Multiple Access System	EP 1938543 B1	INTERDIGITAL TECH CORP	39
Nucleic Acids Comprising Formula (nugixmgnnv)a And Derivatives Thereof As An Immunostimulating Agents /adjuvants	EP 2176408 B1	CUREVAC GMBH	38
Virus Like Particle Production In Plants	AU 2011/349031 B2	MEDICAGO INC	37
Method And Apparatus For Processing Feedback In A Wireless Communication System	US 2016/0134340 A1	INTERDIGITAL TECH CORP	37
Vector Comprising Multiple Homologous Nucleotide Sequences	US 2016/0017369 A1	BAVARIAN NORDIC AS	35
Ip-10 Based Immunological Monitoring	EA 020412 B1	HVIDOVRE HOSPITAL	35
Anti-gitr Antibodies And Uses Thereof	EP 2343320 B1	GITR INC	35
Use Of Gelsolin To Treat Infections	US 10022424 B2	STOSSEL THOMAS P;;LEE PO SHUN;;BRIGHAM & WOMENS HOSPITAL INC	35
Phosphonate Ester Derivatives And Methods Of Synthesis Thereof	EP 3020720 B1	CHIMERIX INC	34
Platinum Complexes For The Treatment Of Tumors	EP 1675864 B1	UNIV SOUTH FLORIDA	33
Platinum Complexes For The Treatment Of Tumors	AU 2004/264421 B2	UNIV SOUTH FLORIDA	33
Platinum Complexes And Methods Of Use	US 2005/0080131 A1	KAY HEIDI;;PALMER JAY W.;;STANKO JOSEPH A.	33
Platinum Complexes And Methods Of Use	US 2010/0316704 A1	UNIV SOUTH FLORIDA	33
Method Of Regulating Phosphorylation Of Sr Protein And Antiviral Agents Comprising Sr Protein Activity Regulator As The Active Ingredient	EP 2666481 B1	HAGIWARA MASATOSHI	32
Compositions And Methods Relating To Universal Glycoforms For Enhanced Antibody Efficacy	WO 2015/184009 A1	ACADEMIA SINICA;;WONG CHI-HUEY	32
Compositions And Methods Relating To Universal Glycoforms For Enhanced Antibody Efficacy	AU 2015/267052 A1	ACAD SINICA	32
Compositions And Methods For Inhibiting Expression Of A Gene From The Ebola Virus	US 7759320 B2	ALNYLAM PHARMACEUTICALS INC;;US GOV SEC ARMY	31
Nucleic Acid Comprising Or Coding For A Histone Stem-loop And A Poly (a) Sequence Or A Polyadenylation Signal For Increasing The Expression Of An Encoded Pathogenic Antigen	WO 2013/120499 A1	CUREVAC GMBH;;THESS ANDREAS;;SCHLAKE THOMAS;;PROBST JOCHEN	31
Parainfluenza Virus 5 Based Vaccines	US 9505807 B2	UNIV GEORGIA	31
Parainfluenza Virus 5 Based Vaccines	WO 2013/112720 A1	UNIV GEORGIA;;HE BIAO	31
Parainfluenza Virus 5 Based Vaccines	AU 2013/212097 B2	UNIVERSITY OF GEORGIA RESEARCH FOUNDATION INC	31
Synergistic Attenuation Of Vesicular Stomatitis Virus, Vectors Thereof And Immunogenic Compositions Thereof	EP 1756287 B1	WYETH LLC	30
T Cell Receptor-deficient T Cell Compositions	US 2012/0302466 A1	SENTMAN CHARLES L	30
Adjuvant Compositions For Enhancing Immune Responses To Polynucleotide-based Vaccines	EP 1955709 B1	VICAL INC	30
Complement Receptor 2 Targeted Complement Modulators	AU 2003/298650 A1	MUSC FOUND FOR RES DEV	30
Tunnel Drilling Apparatus And Method To Remove Drill Waste	AU 1990/064314 A	VALTO ILOMAKI	30
Development Of A Preventive Vaccine For Filovirus Infection In Primates	AU 2002/327049 B2	GOVERNMENT OF THE UNITED STATES OF AMERICA AS REPRESENTED BY THE SECRETARY	29
Purification Processes For Isolating Purified Vesicular Stomatitis Virus From Cell Culture	WO 2007/123961 A2	WYETH CORP;;KANG YUN;;CUTLER MARK WILLIAM;;OUATTARA AMADOU AFFREY;;SYVERTSEN KRISTEN ELISSA	29
Rna Containing Composition For Treatment Of Tumor Diseases	US 2016/0331844 A1	CUREVAC AG	29
Variant Rnai	WO 2016/130589 A2	GENZYME CORP	29
Oncolytic Rhabdovirus	WO 2009/016433 A2	OTTAWA HEALTH RESEARCH INST;;STOJDL DAVID;;BROWN CHRISTOPHER;;BELL JOHN	29
Spatial Division Multiple Access Wireless Communication Systems	AU 1993/031454 A	ARRAYCOMM INC	29
Methods For Treating Viral Infection Using Il-28 And Il-29	US 2008/0124299 A1	ZYMOGENETICS INC	28

Title	Publication Number	Applicants	Simple Family Size
Pyrazolo-triazine Derivatives As Selective Cyclin-dependent Kinase Inhibitors	EP 2820020 B1	LEAD DISCOVERY CENTER GMBH	28
Ebola Virion Proteins Expressed From Venezuelan Equine Encephalitis (vee) Virus Replicons	WO 2000/000617 A2	US MED RES INST INFECT DISEASE;;HART MARY KATHERINE;;WILSON JULIE A;;PUSHKO PETER;;SMITH JONATHAN F;;SCHMALJOHN ALAN L	27
Methods For Diagnosing Infectious Diseases Using Adsorption Media	WO 2015/069942 A1	EXTHERA MEDICAL CORP	27
Composition For Inactivating An Enveloped Virus	US 9526700 B2	VIROBLOCK S A;;VIROBLOCK SA	27
Compositions And Methods Of Delivering Treatments For Latent Viral Infections	US 2015/0368670 A1	UNIV LELAND STANFORD JUNIOR	27
Systems And Methods For Detecting Infectious Diseases	US 2015/0072889 A1	THERANOS INC	27
Treatment Or Prevention Of Hemorrhagic Viral Infections With Immunomodulator Compounds	WO 2006/047702 A2	SCICLONE PHARMACEUTICALS INC;;MOSSEL ERIC C;;TUTHILL CYNTHIA W;;RUDOLPH ALFRED R	27
Use Of Immunesuppressant Receptor	US 8945557 B2	ONO PHARMACEUTICAL CO	27
Lentiviral Vector Particles Having Improved Transduction Efficiency For Cells Expressing Dc- Sign	WO 2013/149167 A1	IMMUNE DESIGN CORP;;NICOLAI CHRISTOPHER JAMES;;TAREEN SEMIH U	27
Compositions And Methods Of Delivering Treatments For Latent Viral Infections	WO 2015/184262 A1	UNIV LELAND STANFORD JUNIOR	27
Materials And Methods For Producing Improved Lentiviral Vector Particles	US 2020/0030423 A1	IMMUNE DESIGN CORP	27
Phosphorous Organic Compounds And Their Use	AU 754165 B2	JOMAA PHARMAKA GMBH	27
Single Domain Antibodies Directed Against Ebola Virus	US 2017/0121392 A1	SINGH BIOTECHNOLOGY LLC	26
Compositions And Methods For Inhibiting Viral Polymerase	RU 2654482 C2	BAJOKRIST FARMASYUTIKALZ INK	26
Immunostimulatory Regimen Comprising Administering Type 1 Interferon And Agonistic Anti-cd40 Antibody	US 8137672 B2	KEDL ROSS;;SANCHEZ PHILLIP J;;HALUSZCZAK CATHERINE;;UNIV COLORADO	26
Soluble Fragments Of Influenza Virus Pb2 Protein Capable Of Binding Rna-cap	WO 2009/046983 A1	EUROPEAN MOLECULAR BIOLOGY LAB EMBL;;CUSACK STEPHEN;;GUILLIGAY DELPHINE;;HART DARREN;;TARENDEAU FRANCK	26
Bivalent Bromodomain Inhibtors And Uses Thereof	WO 2017/091673 A2	DANA-FARBER CANCER INST INC;;BRADNER JAMES E	26
Immunoprotective Primary Mesenchymal Stem Cells And Methods	US 2014/0271580 A1	TULANE EDUCATIONAL FUND THE ADMINISTRATORS OF;;UNIV TULANE	25
Methods For Generating Immune Response Using Cationic-liposome-mediated Nucleic Acid Delivery	EP 2175835 B1	UNIV GEORGETOWN	25
Barrier Webs	EP 0826083 B1	NEXTEC APPLICATIONS INC	25
Diagnostic And Therapeutic Uses Of Gelsolin In Renal Failure	WO 2009/094194 A2	GEN HOSPITAL CORP;;BRIGHAM & WOMENS HOSPITAL;;BETH ISRAEL HOSPITAL;;THADHANI RAVI;;STOSSEL THOMAS P;;LEE PO-SHUN;;KARUMANCHI ANANTH	25
Alphavirus Rna Replicon Systems	EP 1012295 B1	UNIV NORTH CAROLINA	25
Organophosphorous Compounds And The Use Thereof	EP 1133500 B1	JOMAA PHARMAKA GMBH	25
Adenovirus Serotype 26 And Serotype 35 Filovirus Vaccines	US 2014/0017278 A1	SULLIVAN NANCY J;;NABEL GARY J;;ASIEDU CLEMENT;;CHENG CHENG;;PAU MARIA GRAZIA;;GOUDSMIT JAAP;;CRUCELL HOLLAND BV	24
Compositions And Methods For Sirna Inhibition Of Hif-1 Alpha	WO 2004/042024 A2	UNIV PENNSYLVANIA;;REICH SAMUEL JOTHAM;;SURACE ENRICO MARIA;;TOLENTINO MICHAEL J	24
Kir-binding Agents And Methods Of Use Thereof	EP 1836225 B1	NOVO NORDISK AS;;INNATE PHARMA	24
Treatment Of Viral Infections By Modulation Of Host Cell Metabolic Pathways	WO 2009/023059 A2	UNIV PRINCETON;;SHENK THOMAS;;RABINOWITZ JOSHUA D;;MUNGER JOSH;;BENNETT BRYSON	24
A Method And Device For Treating Fibre Material	AU 657360 B2	SUNDS DEFIBRATOR IND AB	24
Crystal Of Recombinant Interferon With Altered Spatial Configuration, Three-dimensional Structure And Uses Thereof	US 8846025 B2	WEI GUANGWEN;;WANG DACHENG	23
Systems And Methods For Multi-analysis	US 2015/0368717 A1	THERANOS INC	23
Recombinant Adenoviruses And Use Thereof	EP 2920313 B1	BETH ISRAEL DEACONESS MEDICAL CT INC;;UNIV WASHINGTON	23

Title	Publication Number	Applicants	Simple Family Size
Thiazole Or Imidazole Substituted Pyrimidine, Pyridine And Pyrazine Amide Derivatives And Related Compounds As Abl1, Abl2 And Bcr-abl1 Inhibitors For The Treatment Of Cancer, Specific Viral Infections And Specific Cns Disorders	EP 2900637 B1	NOVARTIS AG	23
Lipids Suitable For Liposomal Delivery Of Protein-coding Rna	AU 2016/201063 A1	NOVARTIS AG	23
Improved Complement Receptor 2 (cr2) Targeting Groups	EP 2569332 B1	UNIV COLORADO REGENTS	23
Use Of Organophosphoric Compounds For The Therapeutic And Preventative Treatment Of Infections	AU 747407 B2	JOMAA PHARMAKA GMBH	23
Compounds And Compositions For Inhibiting The Activity Of Abl1, Abl2 And Bcr-abl1	AU 2013/261129 B2	NOVARTIS AG	23
Combined Preparations For The Treatment Of Cancer Or Infection	WO 2016/110593 A1	IMMUTEP S A S	23
Use Of Organophosphorus Compounds For The Therapeutic And Prophylactic Treatment Of Infections	US 6680308 B1	HASSAN JOMAA	23
Amended Recombinant Cells (arcs) For The Production And Delivery Of Antiviral Agents, Adjuvants And Vaccine Accelerants	WO 2004/087864 A2	DOW AGROSCIENCES LLC;;GAERTNER FRANK H;;LEE STACEY LYNN;;SHUTTER ROBERT W	23
Casein Hydrolyzate And Method For Production Of Such Casein Hydrolyzate	AU 657451 B2	NOVO NORDISK AS	23
Killed Ruminant Mastitis Vaccine	AU 589185 B2	COMMW SCIENT IND RES ORG	23
Human Antibodies To Ebola Virus Glycoprotein	TW 201639883 A	REGENERON PHARMA	22
Human Antibodies To Ebola Virus Glycoprotein	AU 2016/211783 A1	REGENERON PHARMA	22
Human Antibodies To Ebola Virus Glycoprotein	PH 12017501277 A1	REGENERON PHARMA	22
Uses Of Recombinant Super-compound Interferons	WO 2006/134497 A2	WEI GUANGWEN	22
Vaccine Compositions Having Improved Stability And Immunogenicity	WO 2017/041100 A2	NOVAVAX INC	22
Sample Fixation And Stabilisation	US 10393633 B2	RNASSIST LTD	22
Vero Cell Line Adapted To Grow In Suspension	US 2007/0111309 A1	DAELLI MARCELO G	22
Methods For Detection Or Measurement Of Viruses	US 2011/0262892 A1	AOYAGI KATSUMI;;OHUE CHIHARU;;IIDA KUMIKO;;KIMURA TATSUJI;;YAGI SHINTARO	22
Monoclonal Antibody Production By Ebv Transformation Of B Cells	US 2010/0021470 A1	INST RESEARCH IN BIOMEDICINE	22
Method Of Treatment	AU 724689 B2	PHARMA PACIFIC PTY LTD	22
Methods Of Selecting T Cell Line And Donor Thereof For Adoptive Cellular Therapy	WO 2016/073550 A1	SLOAN KETTERING INST CANCER	22
Vaccine Compositions Having Improved Stability And Immunogenicity	AU 2016/315478 A2	NOVAVAX INC	22
Use Of Macrolides For The Treatment Of Cerebral Ischemia	AU 687025 B2	FUJISAWA PHARMACEUTICAL CO	22
Clip-type Article Carrier Packaging Mechanism	WO 1994/006684 A1	RIVERWOOD INT CORP	22
Fungal Stress Proteins	AU 640394 B2	JAMES PETER BURNIE	22
Therapy For Inhibition Of Single-stranded Rna Virus Replication	US 9974800 B2	REDHILL BIOPHARMA LTD	21
Therapy For Inhibition Of Single-stranded Rna Virus Replication	AU 2015/334590 B2	REDHILL BIOPHARMA LTD	21
Therapy For Inhibition Of Single-stranded Rna Virus Replication	WO 2016/063134 A1	REDHILL BIOPHARMA LTD	21
Method And Apparatus For Singular Value Decomposition Of A Channel Matrix	US 2012/0307945 A1	KOO CHANG-SOO;;OLESEN ROBERT LIND;;INTERDIGITAL TECH CORP	21
Use Of Mutant Herpes Simplex Virus-2 For Cancer Therapy	WO 2007/002373 A2	BAYLOR COLLEGE MEDICINE;;ZHANG XIAOLIU;;FU XINPING	21
Modified Small Interfering Rna Molecules And Methods Of Use	US 2005/0058982 A1	CHIRON CORP	21
Antigen Delivery System	WO 2005/014040 A2	ROYAL VETERINARY COLLEGE;;WERLING DIRK	21
Substituted Nucleosides, Nucleotides And Analogs Thereof	WO 2015/200205 A1	ALIOS BIOPHARMA INC	21
Use Of A Peptide As A Therapeutic Agent	WO 2009/046833 A1	MONDOBIOTECH LAB AG;;BEVEC DORIAN;;CAVALLI FABIO;;CAVALLI VERA;;BACHER GERALD	21
Homogeneous Suspension Of Immunopotentiating Compounds And Uses Thereof	WO 2011/084549 A1	NOVARTIS AG;;SKIBINSKI DAVID;;JAIN SIDDHARTHA;;SINGH MANMOHAN;;O'HAGAN DEREK	21
Halogen Treatment Of Heart Attack And Ischemic Injury	US 2020/0016194 A1	HUTCHINSON FRED CANCER RES	21
Substituted Nucleosides, Nucleotides And Analogs Thereof	US 10052342 B2	ALIOS BIOPHARMA INC	21
Multi-dimensional Signal Processing And Display	US 5379268 A	HUTSON; WILLIAM H.	21
Genetically Modified Human Umbilical Cord Perivascular Cells For Prophylaxis Against Or Treatment Of Biological Or Chemical Agents	EP 2288359 B1	TISSUE REGENERATION THERAPEUTICS INC	21
Improved Adenoviral Vectors And Uses Thereof	WO 2006/040330 A2	CRUCELL HOLLAND BV;;BETH ISRAEL HOSPITAL;;HAVENGA MENZO JANS EMCO;;BAROUCH DAN	21

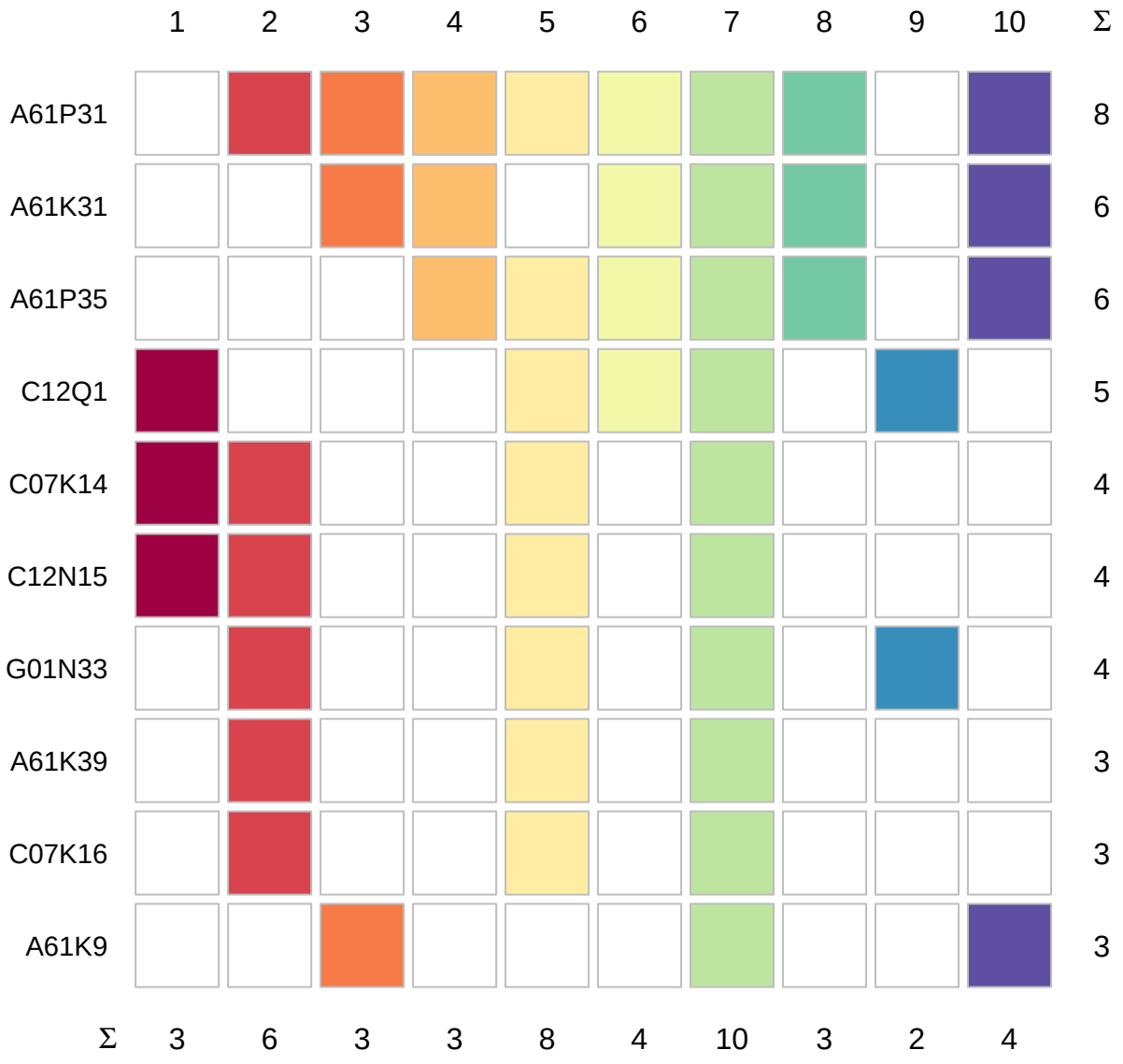
Title	Publication Number	Applicants	Simple Family Size
Primate T-lymphotropic Viruses	EP 1880006 B1	US GOV HEALTH & HUMAN SERV;;UNIV JOHNS HOPKINS	21
Substituted Nucleosides, Nucleotides And Analogs Thereof	AU 2015/280234 A1	ALIOS BIOPHARMA INC	21
Halogen Treatment Of Heart Attack And Ischemic Injury	WO 2015/120458 A1	HUTCHINSON FRED CANCER RES	21
Improved Adenoviral Vectors And Uses Thereof	AU 2005/293568 A1	CRUCELL HOLLAND BV;;BETH ISRAEL HOSPITAL	21
Rna-coded Antibody	EP 2101823 B1	CUREVAC AG	21
Acetamide Thienotriazoldiazepines And Uses Thereof	WO 2017/044792 A1	DANA-FARBER CANCER INST INC;;BRADNER JAMES E;;TANAKA MINORU	21
Compositions And Methods Of Use For Treatment Of Mammalian Diseases	WO 2006/017179 A1	SABIN ROBERT	21
Compositions And Methods Of Use For Treatment Of Mammalian Diseases	AU 2005/271897 A1	SABIN ROBERT	21
Medical Implants And Anti-scarring Agents	WO 2005/049105 A2	ANGIOTECH INT AG;;HUNTER WILLIAM L;;GRAVETT DAVID M;;TOLEIKIS PHILIP M;;MAITI ARPITA;;SIGNORE PIERRE E;;LIGGINS RICHARD T	21
Medical Implants And Anti-scarring Agents	AU 2004/291062 A1	ANGIOTECH INT AG	21
Antisense Antiviral Compounds And Methods For Treating A Filovirus Infection	US 2009/0186847 A1	STEIN DAVID A;;IVERSEN PATRICK L;;BAVARI SINA;;WELLER DWIGHT D	20
Antisense Antiviral Compounds And Methods For Treating A Filovirus Infection	US 7524829 B2	AVI BIOPHARMA INC	20
Antisense Antiviral Compounds And Methods For Treating Filovirus Infection	EP 1814596 B1	AVI BIOPHARMA INC	20
Compositions For The Treatment Of Autodigestion	AU 2015/236283 B2	LEADING BIOSCIENCES INC	20
Anti-inflammatory Agents As Virostatic Compounds	US 8354433 B2	4SC AG;;VITT DANIEL;;GROEPPEL MANFRED;;BAUMGARTNER ROLAND;;LEBAN JOHANN	20
Methods For Delivery Of Exogenous Proteins To The Cytosol	EP 1536828 B1	HARVARD COLLEGE;;GEN HOSPITAL CORP	20
Method For Producing Storage Stable Viruses And Immunogenic Compositions Thereof	US 2008/0206281 A1	WYETH CORP	20
Compositions For The Treatment Of Autodigestion	WO 2015/148474 A1	LEADING BIOSCIENCES INC	20
Compositions And Methods For Sirna Inhibition Of Icam-1	WO 2004/065546 A2	UNIV PENNSYLVANIA;;REICH SAMUEL JOTHAM;;TOLENTINO MICHAEL J	20
Cyanovirin Variant-polymer Conjugates	WO 2004/056852 A2	NEKTAR THERAPEUTICS AL CORP;;US GOV HEALTH & HUMAN SERV;;SNELL M ELIZABETH;;ROBERTS MICHAEL J;;MORI TOSHIYUKI;;O'KEEFE BARRY R;;BOYD MICHAEL R	20
Cyanovirin Variant-polymer Conjugates	US 2004/0258706 A1	SNELL M. ELIZABETH;;ROBERTS MICHAEL J.;;MORI TOSHIYUKI;;O'KEEFE BARRY R.;;BOYD MICHAEL R.	20
Method Of Efficient Extraction Of Protein From Cells	US 9207240 B2	MALICK ADRIEN P;;CREWS VIRGINIA M;;ROSALES JULIE L;;FERGUSON CARRIE S;;BRUTON JEFF H;;BEADENKOPF ROBERT J;;MANTLO JOHN;;ARBOR VITA CORP	20
Targeting Opposite Strand Replication Intermediates Of Single-stranded Viruses By Rnai	WO 2006/036872 A2	NUCLEONICS INC;;MCCALLUS DANIEL E;;GU BAOHUA;;PACHUK CATHERINE J	20
Nampt Inhibitors And Methods	US 10017523 B2	GENZYME CORP	20
Novel Alkyl Phospholipid Derivatives With Reduced Cytotoxicity And Uses Thereof	WO 2007/071658 A2	ZENTARIS GMBH	20
7-benzyl-4-(2-methylbenzyl)-2,4,6,7,8,9-hexahydroimidazo [1,2-a]Pyrido[3,4-e]Pyrimidin-5(1h)-one, Analogs And Salts Thereof And Their Use In Therapy	WO 2016/123571 A1	ONCOCEUTICS INC;;PROVID PHARMACEUTICALS INC	20
Cyano Thienotriazolodiazepines And Uses Thereof	WO 2017/044849 A1	DANA-FARBER CANCER INST INC;;BRADNER JAMES E;;TANAKA MINORU;;BUCKLEY DENNIS	20
7-benzyl-4-(2-methylbenzyl)-2,4,6,7,8,9-hexahydroimidazo [1,2-a]Pyrido[3,4-e]Pyrimidin-5(1h)-one, Analogs And Salts Thereof And Their Use In Therapy	AU 2016/211243 A1	ONCOCEUTICS INC;;PROVID PHARMACEUTICALS INC	20
Peptides And Nanoparticles For Intracellular Delivery Of Molecules	WO 2016/102687 A1	AADIGEN LLC;;DIVITA GILLES;;DESAI NEIL	20
Process And Device For Producing Rolled Wafer Cones Or The Like	AU 1995/026076 A	HAAS FRANZ WAFFELMASCH	20

Table S3 Partial defenition of IPC classifications with the most instances. IPC classifications were split into two parts with the split point being the forward-slash "/". Frequencies were calculated for ipc1 (before "/") and then ipc2 (after "/"). Finally, each group was defined based on ipc1 and ipc2.

Befor slash "/" (IPC1)		After slash (IPC2)											Partial Description
IPC1	occurrence count		1	2	3	4	5	6	7	8	9	10	
A61K39	415	IPC2	"00"	"12"	"395"	"42"	"39"	"21"	"145"	"02"	"29"	"385"	medicinal preparations containing antigens or antibodies materials for immunoassay like viral antigenes and antibodies.
		occurrence count	162	149	92	45	44	34	33	19	19	17	
A61P31	346	IPC2	"12"	"14"	"00"	"18"	"16"	"04"	"22"	"20"	"10"	"06"	antivirals for RNA viruses
		occurrence count	147	139	69	52	47	45	26	24	15	5	
A61K31	336	IPC2	"7088"	"675"	"5377"	"00"	"4439"	"713"	"7068"	"7072"	"506"	"662"	medicinal preparations containing organic active ingredients, like nucleic acids,
		occurrence count	23	22	19	17	15	14	13	13	12	12	
C12N15	300	IPC2	"113"	"86"	"09"	"11"	"00"	"10"	"40"	"85"	"63"	"861"	genetic engineering, like antisense oligonucleotides, viral vectors, recombinant DNA technology...
		occurrence count	51	46	45	38	21	21	21	21	17	16	
C07K14	300	IPC2	"08"	"005"	"16"	"47"	"705"	"00"	"02"	"11"	"15"	"18"	peptides having more than 20 amino acids from viruses
		occurrence count	49	33	26	24	20	15	15	15	12	12	
C12Q1	203	IPC2	"68"	"70"	"02"	"686"	"00"	"04"	"66"	"18"	"37"	"6806"	measuring or testing processes involving enzymes, nucleic acids or microorganisms
		occurrence count	131	97	14	8	5	5	5	4	4	4	
A61K38	191	IPC2	"00"	"17"	"16"	"21"	"19"	"20"	"08"	"10"	"22"	"06"	medicinal preparations containing peptides
		occurrence count	67	40	29	20	9	9	8	7	7	6	
C07K16	183	IPC2	"10"	"28"	"00"	"08"	"12"	"18"	"30"	"24"	"46"	"06"	immunoglobulins, e.g. monoclonal or polyclonal antibodies against material from viruses or cell surface antigens or bacteria
		occurrence count	93	42	26	23	13	10	8	7	6	5	
G01N33	165	IPC2	"569"	"68"	"53"	"50"	"577"	"543"	"574"	"533"	"48"	"58"	immunoassay biospecific binding assay materials
		occurrence count	62	41	32	23	14	12	11	7	6	6	
C12N7	113	IPC2	"00"	"04"	"01"	"02"	"06"	NA	NA	NA	NA	NA	viruses like inactivated viruses, purification of viruses, virus vaccines
		occurrence count	73	35	18	6	5	NA	NA	NA	NA	NA	
A61K9	99	IPC2	"00"	"02"	"04"	NA	NA	NA	NA	NA	NA	NA	medicinal preparations characterised by special physical form
		occurrence count	96	10	6	NA	NA	NA	NA	NA	NA	NA	
A61P35	99	IPC2	"00"	"127"	"107"	"14"	"51"	"08"	"06"	"16"	"50"	"19"	antineoplastic agents
		occurrence count	39	33	10	10	10	8	5	5	5	4	
C12N5	93	IPC2	"10"	"0783"	"00"	"02"	"20"	"071"	"06"	"16"	"18"	"078"	undifferentiated human, animal or plant cells, modified by insertion of foreign genetic material
		occurrence count	39	16	8	7	7	6	4	4	4	3	
A61K48	86	IPC2	00	NA	NA	NA	NA	NA	NA	NA	NA	NA	medicinal preparations containing genetic material which is inserted into cells of the living body to treat genetic diseases gene therapy
		occurrence count	86	NA	NA	NA	NA	NA	NA	NA	NA	NA	
A61K45	71	IPC2	"06"	"00"	"08"	NA	NA	NA	NA	NA	NA	NA	mixtures of active ingredients without chemical characterisation
		occurrence count	58	15	2	NA	NA	NA	NA	NA	NA	NA	
A61K35	66	IPC2	"04"	"00"	"02"	"06"	"08"	NA	NA	NA	NA	NA	medicinal preparations containing materials or reaction products thereof with undetermined constitution
		occurrence count	28	21	11	7	5	NA	NA	NA	NA	NA	
A61P37	66	IPC2	"76"	"17"	"12"	"14"	"00"	"13"	"16"	"763"	"761"	"766"	drugs for immunological or allergic disorders
		occurrence count	24	14	10	7	4	4	4	4	3	3	
A61K47	61	IPC2	"04"	"02"	"00"	NA	NA	NA	NA	NA	NA	NA	medicinal preparations characterised by the non-active ingredients used
		occurrence count	38	19	15	NA	NA	NA	NA	NA	NA	NA	
C07H21	61	IPC2	"48"	"24"	"42"	"04"	"69"	"02"	"26"	"34"	"64"	"68"	nucleic acids
		occurrence count	22	6	6	5	5	4	4	4	4	4	
C12N9	46	IPC2	"22"	"02"	"12"	"10"	"16"	"99"	"00"	"96"	"14"	"64"	enzymes like ribonucleases, oxidoreductases, kinases ...
		occurrence count	15	8	6	5	5	4	3	3	2	2	
C12P21	36	IPC2	"08"	"02"	"06"	"00"	"04"	NA	NA	NA	NA	NA	fermentation or enzyme-using processes to synthesise a desired chemical compound or composition
		occurrence count	19	9	5	4	3	NA	NA	NA	NA	NA	
A61P25	34	IPC2	"28"	"00"	"16"	"04"	"14"	"24"	NA	NA	NA	NA	drugs for disorders of the nervous system
		occurrence count	20	14	5	1	1	1	NA	NA	NA	NA	

Befor slash "/" (IPC1)		After slash (IPC2)											Partial Description
IPC1	occurrence count		1	2	3	4	5	6	7	8	9	10	
C07F9	31	IPC2	"6561"	"40"	"6512"	"38"	"655"	"6571"	"6574"	"02"	"22"	"28"	compounds containing elements of groups 5 or 15 of the periodic system
		occurrence count	14	10	10	9	7	3	3	2	2	2	
C12N1	29	IPC2	"21"	"15"	"19"	"00"	"20"	"02"	"06"	"12"	"04"	"14"	bacteria, fungi, or yeast culture media modified by introduction of foreign genetic material
		occurrence count	12	6	6	4	4	3	2	2	1	1	
A61P33	27	IPC2	"06"	"08"	"00"	"04"	"64"	NA	NA	NA	NA	NA	antiparasitic agents
		occurrence count	12	8	4	4	1	NA	NA	NA	NA	NA	
C07K7	27	IPC2	"00"	"06"	"02"	"12"	NA	NA	NA	NA	NA	NA	peptides having 5 to 20 amino acids
		occurrence count	20	8	7	1	NA	NA	NA	NA	NA	NA	
A61P9	26	IPC2	"00"	"10"	"08"	"02"	"04"	"12"	"14"	NA	NA	NA	drugs for disorders of the cardiovascular system
		occurrence count	14	6	4	1	1	1	1	NA	NA	NA	
C12R1	24	IPC2	"93"	"91"	"19"	"84"	"01"	"04"	"725"	"92"	NA	NA	processes using microorganisms
		occurrence count	10	7	3	2	1	1	1	1	NA	NA	
A61K33	23	IPC2	"00"	"22"	"18"	"10"	"16"	"20"	"24"	"12"	NA	NA	medicinal preparations containing inorganic active ingredients
		occurrence count	10	7	5	2	2	2	2	1	NA	NA	
G06F19	23	IPC2	"00"	"24"	"04"	"34"	"06"	"18"	"30"	"02"	"16"	"26"	digital computing or data processing equipment or methods
		occurrence count	8	6	4	3	2	2	2	1	1	1	

Figure S1: Community membership of nodes. Community membership of each node in Figure 6A, generated with function "plotLinkCommMembers()" from "linkcomm" package



TableS4. Communities visualized in Figure 6 were clustered based on their common nodes (ipc1 segments) by "getClusterRelatedness()" function from "linkcomm" package. These clusters are also visualized in Figure 6B. Nodes that are shared with the communities within the cluster are in bold and their numeration contains a prime. Moreover, the definition of nodes is presented in two separate columns: one for the nodes that are unique in the community, and the other for the nodes that are shared in communities within the cluster.

Commutity Number	Nodes	Defenition of The Nodes Specific To The Community In Order Of Appearance	Defenition of Nodes shared in Community Clusters In Order Of Appearance
1	1-C07K14 2-C12N15 1'-**C12Q1** 3-C40B40	1- peptides having more than 20 amino acids 2- genetic engineering 3- libraries per se , e.g. arrays, mixtures	1'-measuring or testing processes involving enzymes, nucleic acids or microorganisms
9	1-G01N21 1'-**C12Q1** 2-G01N33 3-G06F19	1- investigating or analysing materials by the use of optical means 2- investigating or analysing materials by specific methods not covered by groups g01n1/00 - g01n31/00 3- digital computing or data processing equipment or methods	
2	**1'-A61K39** 1-C07K1 2'-**A61P31** **3'-C07K14** 4'-**C12N15** 5'-**C07K16** 6'-**G01N33**	1- general methods for the preparation of peptides , i.e. processes for the organic chemical preparation of peptides or proteins of any length	1'-medicinal preparations containing antigens or antibodies materials for immunoassay 2'-antiinfectives 3'-peptides having more than 20 amino acids 4'-genetic engineering 5'-immunoglobulins 6'-investigating or analysing materials by specific methods not covered by groups 7'-measuring or testing processes involving enzymes, nucleic acids or microorganisms 8'-undifferentiated human, animal or plant cells 9'-antineoplastic agents 10'-preparation of peptides or proteins single-cell protein 11'-medicinal preparations containing peptides
5	1-C12N1 4'-**C12N15** 7'-**C12Q1** 1'-**A61K39** 3'-**C07K14** 2-C07K19 2'-**A61P31** 8'-**C12N5** 3-C12R1 9'-**A61P35** 5'-**C07K16** 10'-**C12P21** 11'-**A61K38** 6'-**G01N33**	1- microorganisms 2- hybrid peptides 3- processes using microorganisms	
7	1-A61K31 1'-**A61K39** 3'-**C07K14** 11'-**A61K38** 2'-**A61P31** 4'-**C12N15** **5'-C07K16** 2-A61K48 7'-**C12Q1** 3-A61K9 9'-**A61P35** 4-A61K47 5-C07H21 6-A61K35 7-A61K45 8'-**C12N5** 10'-**C12P21** 8-A61P37 9-C12N7 10-C12N9 11-A61P33 12-C07K7 6'-**G01N33**	1- medicinal preparations containing organic active ingredients 2- gene therapy 3- medicinal preparations characterised by special physical form 4- medicinal preparations characterised by the non-active ingredients used 5- nucleic acids 6- medicinal preparations containing materials or reaction products thereof with undetermined constitution 7- medicinal preparations containing active ingredients not provided for in groups 8- drugs for immunological or allergic disorders 9- viruses 10- enzymes 11- antiparasitic agents 12- peptides having 5 to 20 amino acids in a fully defined sequence	

Commutity Number	Nodes	Defenition of The Nodes Specific To The Community In Order Of Appearance	Defenition of Nodes shared in Community Clusters In Order Of Appearance
3	1-A61K33 1'-**A61K31** 2'-**A61K9** 3'-**A61P31**	1-medicinal preparations containing inorganic active ingredients	1'-medicinal preparations containing organic active ingredients 2'-medicinal preparations characterised by special physical form 3'-antiinfectives
10	1'-**A61K31** 1-A61P25 3'-**A61P31** 2-A61P35 3-A61P3 4-A61P29 5-A61K38 6-A61P11 7-A61P37 8-A61P19 9-A61K47 2'-**A61K9** 10-A61P9 11-A61P43 12-A61P7	1-drugs for disorders of the nervous system 2-antineoplastic agents 3-drugs for disorders of the metabolism of the blood or the extracellular fluid 4-non-central analgesic, antipyretic or antiinflammatory agents, e.g antirheumatic agents non-steroidal antiinflammatory drugs (nsaids) 5-medicinal preparations containing peptides 6-drugs for disorders of the respiratory system 7-drugs for immunological or allergic disorders 8-drugs for skeletal disorders 9-medicinal preparations characterised by the non-active ingredients used 10-drugs for disorders of the cardiovascular system 11-drugs for specific purposes, not provided for in groups 12-drugs for disorders of the blood or the extracellular fluid	
4	**1'-A61K31** 2'-**A61P31** 3'-**A61K45** 4'-**A61P35** 1-C07D487	1-heterocyclic compounds containing nitrogen atoms as the only ring hetero atoms in the condensed system, not provided for by groups	
6	**1'-A61K31** 2'-**A61P31** 1-A01N57 3'-**A61K45** 4'-**A61P35** 2-C07F9 3-A61P33 4-A61P9 5-C07H19 6-C12Q1	1-biocides, pest repellants or attractants, or plant growth regulators containing organic phosphorus compounds 2-compounds containing elements of groups 5 or 15 of the periodic system 3-antiparasitic agents 4-drugs for disorders of the cardiovascular system 5-compounds containing a hetero ring sharing one ring hetero atom with a saccharide radical nucleosides mononucleotides anhydro derivatives 6-measuring or testing processes involving enzymes	
8	**1'-A61K31** 1-C07D401 2'-**A61P31** 2-C07D403 3-C07D405 4-C07D409 5-C07D413 4'-**A61P35** 6-C07D239 7-C07D417	1-groups cover compounds containing two or more relevant hetero rings at least two of which are covered by different main groups of groups , neither condensed among themselves nor condensed with a common carbocyclic ring or ring system. 2-heterocyclic compounds containing two or more hetero rings, having nitrogen atoms as the only ring hetero atoms, not provided for by group 3-heterocyclic compounds containing both one or more hetero rings having oxygen atoms as the only ring hetero atoms, and one or more rings having nitrogen as the only ring hetero atom 4-heterocyclic compounds containing two or more hetero rings, at least one ring having sulfur atoms as the only ring hetero atoms 5-heterocyclic compounds containing two or more hetero rings, at least one ring having nitrogen and oxygen atoms as the only ring hetero atoms 6-heterocyclic compounds containing 1,3-diazine or hydrogenated 1,3-diazine rings 7-heterocyclic compounds containing two or more hetero rings, at least one ring having nitrogen and sulfur atoms as the only ring hetero atoms, not provided for by group	1'-medicinal preparations containing organic active ingredients 2'-antiinfectives 3'-medicinal preparations containing active ingredients not provided for in groups 4'-antineoplastic agents