

FCR 18

Office of the President
February 18, 2022

Members, Board of Trustees:

PATENT ASSIGNMENT REPORT

Recommendation: that the Board of Trustees accept the patent assignment report for the period October 1, 2021 to December 31, 2021.

Background: At its March 1997 meeting, the Board of Trustees authorized the University of Kentucky Research Foundation to conduct all future copyright and patent filings and prosecutions. Quarterly reports on patent and copyright applications are to be submitted to the Finance Committee of the Board.

Action taken: Approved Disapproved Other _____

PATENT ASSIGNMENTS
FOR THE PERIOD October 1, 2021 TO December 31, 2021

Patents

The following assignments on behalf of the Board of Trustees of the University of Kentucky Research Foundation have been executed:

- 1. U.S. Patent Application Number:** 17/492,299
UKRFID: 2536
Filed: October 1, 2021
Title: POLYPEPTIDE DIRECTED AGAINST PROTEIN TYROSINE PHOSPHATASE 4A PROTEINS, AND COMPOSITIONS AND METHODS FOR USE THEREOF
Inventors: Jessica Blackburn and Caroline Smith (College of Medicine)
Description and Application: This is a novel amino acid sequence that binds to the tyrosine phosphate 4A (PTP4A or PRL) family of proteins. PTP4A proteins are dual specificity phosphatases that act as oncogenes in multiple cancer types. These novel amino acids may be tagged with a compound for degrading targeted PRL protein. In this manner, the novel amino acid can act as the targeting system for a compound that can affect the cancer cell. The global market for cancer therapeutics is approximately \$98.9 billion with an expected compound annual growth rate (CAGR) of 7.7%.
License: N/A
- 2. U.S. Patent Application Number:** 17/604,557
UKRFID: 2623
Filed: October 18, 2021
Title: COMPOSITIONS COMPRISING A TWEAK LIGAND AND METHODS OF USING THE SAME
Inventors: Kim Serogy (University of Cincinnati), David Yurek (College of Medicine), and Assen Galal Ziady (Cincinnati Children's Hospital)
Description and Application: This is a novel nanoparticle composition used to target cancer cells. The nanoparticles may take a variety of forms, including non-viral, viral, and lipid nanoparticles, and may utilize a tumor necrosis factor (TNF) receptor superfamily member 12A (TWEAKR) binding region of the TWEAK protein to target nanoparticles to tissues expressing TWEAKR. The novel nanoparticle

is designed to specifically target glioblastoma (GBM), which accounts for approximately 40% of primary brain tumors, is the most malignant form of astrocytoma and is synonymous with a grade IV glioma. The global market for brain cancer therapeutics is approximately \$2.5 billion with an expected CAGR of 9.8%.

License: N/A

3. U.S. Patent Application Number: 17/605,506

UKRFID: 2183

Filed: October 21, 2021

Title: bZIP TRANSCRIPTION FACTORS REGULATE CONVERSION OF NICOTINE TO NORNICOTINE AND REDUCE LEVELS OF TOBACCO SPECIFIC (TSNA) PRECURSORS

Inventors: Ling Yuan, Sanjay Singh, Sitakanta Pattanaik (College of Agriculture, Food and Environment) and Darlene Lawson (R.J. Reynolds Tobacco Company)

Description and Application: The invention is a method of decreasing conversion of nicotine to nornicotine. Nornicotine is a precursor to *N*-nitrosornicotine (NNN), which is produced during the curing and processing of tobaccos materials. Specifically, during post-harvest processing, nornicotine chemically reacts with nitrosating agents to form NNN. As NNNs belong to a class of smoking-related carcinogens called tobacco specific nitrosamines (TSNA), it is highly desirable to reduce TSNA in tobacco products. The method involves administering a basic region/leucine zipper (bZIP) type transcription factor inhibitor to an organism. The method also includes mutating a bZIP type transcription factor binding site on a promoter of a nicotine N-demethylase (NND). In other methods, the plant genome may be mutated to knock out at least one bZIP type transcription factor. The global tobacco market is expected to reach \$1.1 trillion by 2027 with an expected growth of 3.1%.

License: N/A

- 4. U.S. Patent Application Number:** 17/521,788
UKRFID: 2392
Filed: November 8, 2021
Title: METHOD FOR DETECTION AND QUANTIFICATION OF CLN3 PROTEIN
Inventors: Qingjun Wang (College of Medicine) and Beatrix Ueberheide (New York University)
Description and Application: This is a method for detecting and quantifying CLN3 proteins. CLN3 is a gene that is mutated in juvenile neuronal ceroid lipofuscinosis (JNCL), known as juvenile Batten disease. There is no cure for the disease, nor is there a working method of CLN3 protein detection and quantification. The novel method includes a heavy isotope labeled CLN3 proteotypic peptide. After peptide selection, a stable isotope labeled standard is generated. A sample is then spiked with known amounts of the isotope labeled standard. Then the retention times and calibration curves are determined. The global market was \$35 million in 2017 and is expected to grow at a CAGR of 2.8% until 2023.
License: N/A

- 5. U.S. Patent Application Number:** 17/521,586
UKRFID: 2466
Filed: November 8, 2021
Title: METHOD FOR SYNTHESIZING A HYDROPHOBIC DEEP EUTECTIC SOLVENT
Inventors: Jian Shi, Jameson Hunter, Yuxuan Zhang, (College of Engineering) and Wenqi Li (formerly College of Engineering)
Description and Application: This is a method for synthesizing a hydrophobic deep eutectic solvent (DES) using one or more lignin-derived compounds. The accumulation of microplastics and nanoplastics in the environment is of increasing concern as their small size makes remediation difficult using traditional methods. Hydrophobic DESs are useful in extracting plastics contaminants from water supplies. The novel method includes mixing a lignin-derived compound with another lignin-derived compound to create a mixture. The mixture is then heated and stirred to form a DES. The global water treatment market is approximately \$283 billion with an expected CAGR of more than 7%.
License: N/A

- 6. U.S. Patent Application Number:** 17/522,619
UKRFID: 2404
Filed: November 9, 2021
Title: IN VITRO EQUINE MODEL SYSTEMS AND THEIR INTEGRATION INTO HORSE-ON-A-CHIP PLATFORM
Inventors: Carrie Shaffer (College of Agriculture, Food and Environment)
Description and Application: This is a novel method of culturing cells to obtain equine organoids using microfluidic cells. This method may be used to develop *in vitro* equine organ model systems including monolayer of differentiated cell types derived from three-dimensional organs prepared using equine tissue. The organ-on-chip global market was \$5 million in 2016 and is expected to reach \$170 million by 2023.
License: N/A
- 7. U.S. Patent Application Number:** 17/530,029
UKRFID: 2538
Filed: November 18, 2021
Title: ELECTROCHEMICAL APPARATUS FOR ACID GAS REMOVAL AND HYDROGEN GENERATION
Inventors: Kunlei Liu, Xin Gao, Ayokunle Omosebi, and Reynolds Frimpong (Center for Applied Energy Research)
Description and Application: This is a novel device for removing an acid gas from a feed gas stream while generating hydrogen gas. The device uses an absorber to separate the acid gas using lean carbon capture. An electrochemical regenerator is connected to the absorber and used to release acid gas from a carbon-rich capture fluid and regenerate the solvent. The global carbon capture market is expected to reach \$4.9 billion by 2026.
License: N/A
- 8. U.S. Patent Application Number:** 17/538,442
UKRFID: 2122
Filed: November 30, 2021
Title: PROSTAGLANDIN E SYNTHASE INHIBITORS AND METHODS FOR UTILIZING THE SAME
Inventors: Chang-Guo Zhan, Fang Zheng, Ziyuan Zhou, (College of Pharmacy) and Kai Ding (College of Arts and Sciences)
Description and Application: This invention includes novel microsomal prostaglandin E synthase (mPGES-1) inhibitors and their

use in treating inflammatory disorders. Currently available non-steroidal anti-inflammatory drugs (NSAIDs) inhibit either cyclooxygenase (COX)-1 or COX-2 or both. These inhibitors have several deleterious side effects including ulcers, bleeding in the gastrointestinal tract, or increased risk of cardiovascular events. Current studies indicate that the novel compounds have no similar side effects. The global market for anti-inflammatory therapeutics is expected to reach \$125 billion by 2028.

License: N/A

9. U.S. Patent Application Number: 17/618,952

UKRFID: 2341

Filed: December 14, 2021

Title: PHARMACEUTICALLY ACTIVE PYRAZOLO-PYRIDONE MODULATORS OF DCN1/2-MEDIATED CULLIN NEDDYLYATION

Inventors: Rodney Kip Guy (College of Pharmacy), Jared Hammill, Hoshin Kim (formerly College of Pharmacy), Bhuvanesh Singh (Memorial Sloan Kettering Cancer Center), Daniel Scott (St. Jude's Children's Research Hospital), and Brenda Schulman (formerly St. Jude's Children's Research Hospital)

Description and Application: The invention includes novel compounds exhibiting reversible inhibition of neddylation. Inhibition of neddylation has several potential disease applications, including antiviral, oncology, and Alzheimer's disease. Current FDA-approved drugs that target this pathway have a high level of *in vivo* toxicity due to irreversible inhibition of neddylation. The combined markets for oncology, antiviral drugs and Alzheimer's disease is \$123 billion with growth over 6% annually.

License: Licensed to Cinsano Pharma, Inc.

10. U.S. Patent Application Number: 17/622,408

UKRFID: 2375

Filed: December 23, 2021

Title: BONE BIOPSY SYSTEM AND METHOD

Inventors: Madhumathi Rao, Clay Larkin and Florence Lima (College of Medicine)

Description and Application: The invention is a novel bone biopsy needle designed to sample bone with minimal damage to microarchitecture and surrounding tissue. The novel needle is used in conjunction with a power tool to minimize the force required during the

procedure. The global osteoporosis diagnostic market is approximately \$455 million with an expected CAGR of 4.1%.

License: N/A

11. International Application Number: PCT/US2021/64647

UKRFID: 2517

Filed: December 21, 2021

Title: STRUCTURE-BASED DESIGN AND DISCOVERY OF LONG-ACTING COCAINE HYDROLASE MUTANTS WITH IMPROVED BINDING AFFINITY TO NEONATAL FC RECEPTOR FOR TREATMENT OF SUBSTANCE USE DISORDERS AND ORGANOPHOSPHORUS TOXICITY

Inventors: Chang-Guo Zhan and Fang Zheng (College of Pharmacy)

Description and Application: This is a method of treating cocaine use disorder in a patient by administering butyrylcholinesterase (BChE) fusion protein. The BChE fusion protein includes a BChE protein and an Fc polypeptide mutant with one or more substitutions. The global drug addiction treatment market is expected to reach \$33 billion by 2028.

License: Optioned to Clear Scientific, Inc.

12. Foreign Application Number: P00202110520

UKRFID: 2183

Filed: November 23, 2021

Title: bZIP TRANSCRIPTION FACTORS REGULATE CONVERSION OF NICOTINE TO NORNICOTINE AND REDUCE LEVELS OF TOBACCO SPECIFIC (TSNA) PRECURSORS

Inventors: Ling Yuan, Sanjay Singh, Sitakanta Pattanaik, (College of Agriculture, Food and Environment) and Darlene Lawson (R.J. Reynolds Tobacco Company)

Description and Application: The invention is a method of decreasing conversion of nicotine to nornicotine. Nornicotine is a precursor to *N*-nitrosonornicotine (NNN), which is produced during the curing and processing of tobaccos materials. Specifically, during post-harvest processing, nornicotine chemically reacts with nitrosating agents to form NNN. As NNNs belong to a class of smoking-related carcinogens called tobacco specific nitrosamines (TSNA), it is highly desirable to reduce TSNA in tobacco products. The method involves administering a basic region/leucine zipper (bZIP) type transcription factor inhibitor to an organism. The method also includes mutating a

bZIP type transcription factor binding site on a promoter of a nicotine N-demethylase (NND). In other methods, the plant genome may be mutated to knock out at least one bZIP type transcription factor. The global tobacco market is expected to reach \$1.1 trillion by 2027 with an expected growth of 3.1%.

License: N/A

13. Foreign Application Number: CN2021122201247090

UKRFID: 2183

Filed: December 3, 2021

Title: BZIP TRANSCRIPTION FACTORS REGULATE CONVERSION OF NICOTINE TO NORNICOTINE AND REDUCE LEVELS OF TOBACCO SPECIFIC (TSNA) PRECURSORS

Inventors: Ling Yuan, Sanjay Singh, Sitakanta Pattanaik (College of Agriculture, Food and Environment) and Darlene Lawson (R.J. Reynolds Tobacco Company)

Description and Application: The invention is a method of decreasing conversion of nicotine to nornicotine. Nornicotine is a precursor to *N*-nitrosornicotine (NNN), which is produced during the curing and processing of tobaccos materials. Specifically, during post-harvest processing, nornicotine chemically reacts with nitrosating agents to form NNN. As NNNs belong to a class of smoking-related carcinogens called tobacco specific nitrosamines (TSNA), it is highly desirable to reduce TSNA in tobacco products. The method involves administering a basic region/leucine zipper (bZIP) type transcription factor inhibitor to an organism. The method also includes mutating a bZIP type transcription factor binding site on a promoter of a nicotine N-demethylase (NND). In other methods, the plant genome may be mutated to knock out at least one bZIP type transcription factor. The global tobacco market is expected to reach \$1.1 trillion by 2027 with an expected growth of 3.1%.

License: N/A

14. Foreign Application Number: KR1020217039728

UKRFID: 1935

Filed: December 3, 2021

Title: COMPOSITION AND METHODS FOR TREATING RETINAL DEGRADATION

Inventors: Benjamin Fowler, Jayakrishna Ambati, and Kameshwari Ambati (formerly College of Medicine)

Description and Application: These are methods to treat degradation of the retinal pigment epithelium (RPE) by administering compositions with a nucleoside and/or a nucleoside reverse transcriptase inhibitor (NRTI). Geographic atrophy, an advanced form of age-related macular degeneration, causes blindness in millions of people worldwide. There are no approved treatments, and it results from death of RPE cells. The inventive treatment to reduce RPE cell death includes: 1) inhibiting inflammasome activation, 2) reducing permeability of a cell, 3) reducing the amount of mitochondrial reactive oxygen species in the cell, and/or 4) inhibiting activation of at least one inflammasome in a subject's eye. The global pharmaceutical market for age-related macular degeneration was \$8.6 billion in 2018 and is expected to reach \$18.7 billion in 2028.

License: Exclusive license with Inflammasome Therapeutics, Inc.

Patent Activities
Fiscal Year to Date as of December 31, 2021

Total FY2021-22					
	FY22Q1	FY22Q2	FY22Q3	FY22Q4	Total FY22
Invention Disclosures ⁱ	13	20	0	0	33
Full Patent Applications ⁱⁱ	22	14	0	0	36
Provisional Patent Applications ⁱⁱⁱ	18	21	0	0	39
Patents Issued	9	12	0	0	21
License Income ^{iv}	\$925,684.76	\$73,397.91	\$0	\$0	\$999,082.67
New Licenses & Options Executed	8	2	0	0	10
New UK Startups Formed	0	1	0	0	1

Patent Activities
FY2020-21 as of June 30, 2021

Total FY2020-21					
	FY21Q1	FY21Q2	FY21Q3	FY21Q4	Total FY21
Invention Disclosures ⁱ	26	28	25	30	99
Full Patent Applications ⁱⁱ	23	16	22	16	77
Provisional Patent Applications ⁱⁱⁱ	26	17	19	18	80
Patents Issued	8	8	4	2	22
License Income ^v	\$810,900.86	\$209,591.78	\$1,250,404.62	\$81,934.69	\$2,352,831.95
New Licenses & Options Executed	6	3	11	7	27
New UK Startups Formed	0	0	5	1	6

Patent Application Summary Table

Inventors	College(s)	Title	Brief description
Biomedical			
Jessica Blackburn and Caroline Smith	College of Medicine	Polypeptide directed against protein tyrosine phosphatase 4A proteins, and compositions and methods for use thereof	This is a novel amino acid sequence to bind to the tyrosine phosphate 4A (PTP4A or PRL) family of proteins. PTP4A proteins are dual specificity phosphatases that act as oncogenes in multiple cancer types
Kim Serogy, David Yurek, and Assen Galal Ziady	College of Medicine	Compositions comprising a tweak ligand and methods of using the same	This is a novel nanoparticle composition to target cancer cells.
Qingjun Wang and Beatrix Ueberheide	College of Medicine	Method for detection and quantification of CLN3 protein	This is a method for detecting and quantifying CLN3 proteins.
Chang-Guo Zhan, Fang Zheng, Ziyuan Zhou, and Kai Ding	College of Pharmacy College of Arts and Sciences	Prostaglandin E synthase inhibitors and methods for utilizing the same	This invention includes novel microsomal prostaglandin E synthase (mPGES-1) inhibitors and their use in treating inflammatory disorders.

Inventors	College(s)	Title	Brief description
Rodney Kip Guy (College of Pharmacy), Jared Hammill, Hoshin Kim, Bhuvanesh Singh, Daniel Scott, and Brenda Schulman	College of Pharmacy	Pharmaceutically active pyrazolo-pyridone modulators of DCN1/2-mediated cullin neddylation	The invention includes novel compounds exhibiting reversible inhibition of neddylation, useful for antiviral, oncology, and Alzheimer's disease applications.
Madhumathi Rao, Clay Larkin, and Florence Lima	College of Medicine	Bone biopsy system and method	The invention is a novel bone biopsy needle designed to sample bone with minimal damage to microarchitecture and surrounding tissue.
Chang-Guo Zhan and Fang Zheng	College of Pharmacy	Structure-based design and discovery of long-acting cocaine hydrolase mutants with improved binding affinity to neonatal FC receptor for treatment of substance use disorders and organophosphorus toxicity	This is a method of treating cocaine use disorder in a patient by administering butyrylcholinesterase (BChE) fusion protein.

Inventors	College(s)	Title	Brief description
Benjamin Fowler, Jayakrishna Ambati, and Kameshwari Ambati	College of Medicine	Composition and methods for treating retinal degradation	These are methods to treat degradation of the retinal pigment epithelium (RPE) by administering compositions with a nucleoside and/or a nucleoside reverse transcriptase inhibitor (NRTI).
Engineering			
Jian Shi, Jameson Hunter, Yuxuan Zhang, and Wenqi Li	College of Engineering	Method for synthesizing a hydrophobic deep eutectic solvent	This is a method to synthesize a hydrophobic deep eutectic solvent (DES) using one or more lignin-derived compounds.
Kunlei Liu, Xin Gao, Ayokunle Omosebi, and Reynolds Frimpong	CAER	Electrochemical apparatus for acid gas removal and hydrogen generation	This is a novel device to remove an acid gas from a feed gas stream and simultaneously generate hydrogen gas.
Agriculture, Food and Environment			
Ling Yuan, Sanjay Singh, Sitakanta Pattanaik, and Darlene Lawson	College of Agriculture, Food, and Environment	bZip transcription factors regulate conversion of nicotine to nornicotine and reduce levels of tobacco specific (TSNA) precursors	The invention is a method of decreasing conversion of nicotine to nornicotine in tobacco plants.

Inventors	College(s)	Title	Brief description
Carrie Shaffer	College of Agriculture, Food, and Environment	In vitro equine model systems and their integration into horse-on-a-chip platform	This is a novel method of culturing cells to obtain equine organoids using microfluidic cells.
Ling Yuan, Sanjay Singh, Sitakanta Pattanaik, and Darlene Lawson	College of Agriculture, Food and Environment	bZip transcription factors regulate conversion of nicotine to nornicotine and reduce levels of tobacco specific (TSNA) precursors	The invention is a method of decreasing conversion of nicotine to nornicotine.
Ling Yuan, Sanjay Singh, Sitakanta Pattanaik, and Darlene Lawson	College of Agriculture, Food and Environment	bZip transcription factors regulate conversion of nicotine to nornicotine and reduce levels of tobacco specific (TSNA) precursors	The invention is a method of decreasing conversion of nicotine to nornicotine.

ⁱ Invention disclosures include new technologies and intellectual property disclosed to the Office of Technology Commercialization (OTC) that do not fall under an existing technology number. This number captures the potential new intellectual property disclosed to OTC.

ⁱⁱ Full patent applications, as used by OTC, include nonprovisional patent application filings at the United States Patent and Trademark Office (USPTO), Patent Cooperation Treaty filings, and foreign patent application filings. These are technologies that are assigned to the University of Kentucky that OTC has identified to invest further into in an effort to obtain patent protection and are described in more detail in the patent assignment section above.

ⁱⁱⁱ Provisional patent applications are legal documents filed at the USPTO that establish a filing date and protect the owner from anticipated publication of the technology, but do not mature into an issued patent unless the applicant files a full patent application within one year. Although owned by the University of

Kentucky, the provisional patent applications are not included in the patent assignment descriptions as they will not mature into full patent applications without further action and investment.

^{iv} In Q1 an additional \$200,000.00 and in Q2 an additional \$300,000.00 was received from a license to 22nd Century managed by the College of Agriculture, Food and Environment on behalf of the Office of Technology Commercialization.

^v In Q2 an additional \$300,000.00 was received from a license to 22nd Century managed by the College of Agriculture, Food and Environment on behalf of the Office of Technology Commercialization.