

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference R2054-7024WO		FOR FURTHER ACTION see Form PCT/ISA/220 as well as, where applicable, item 5 below.	
International application No. PCT/US21/52032	International filing date (<i>day/month/year</i>) 24 September 2021 (24.09.2021)	(Earliest) Priority Date (<i>day/month/year</i>) 24 September 2020 (24.09.2020)	
Applicant RHYTHM PHARMACEUTICALS, INC.			

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 5 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the **language**, the international search was carried out on the basis of:

- ☒ the international application in the language in which it was filed.
☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6bis(a)).

c. ☒ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ Certain claims were found unsearchable (see Box No. II).

3. ☒ **Unity of invention is lacking** (see Box No. III).

4. With regard to the **title**,

- ☒ the text is approved as submitted by the applicant.
☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

- ☒ the text is approved as submitted by the applicant.
☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,

- a. the figure of the **drawings** to be published with the abstract is Figure No. _____
☐ as suggested by the applicant.
☐ as selected by this Authority, because the applicant failed to suggest a figure.
☐ as selected by this Authority, because this figure better characterizes the invention.
b. ☒ none of the figures is to be published with the abstract.

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Box No. I Nucleotide and/or amino acid sequence(s) (Continuation of item 1.c of the first sheet)

1. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international search was carried out on the basis of a sequence listing:

- a. ☐ forming part of the international application as filed:
 ☐ in the form of an Annex C/ST.25 text file.
 ☐ on paper or in the form of an image file.
- b. ☐ furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.
- c. ☒ furnished subsequent to the international filing date for the purposes of international search only:
 ☒ in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).
 ☐ on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).
2. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

3. Additional comments:

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Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
-***-Please See Supplemental Page-***-

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
Groups 1+, Claims 1-44, and ARL6 (MC4R pathway agonizable gene), Bardet-Biedl syndrome (disease), Acc (A1), Cys (A2), Gly (A3), His (A4), D-Phe (A5), Arg (A6), Trp (A7), Gly (A8), Cys (A9), Acc (A10), OH (R1), H (R2), H (R3)

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

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A. CLASSIFICATION OF SUBJECT MATTER
 IPC - A61P 3/04; A61K 38/08; C07K 14/685 (2021.01)
 CPC - A61P 3/04; A61K 38/08; C07K 14/685

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

See Search History document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y --- A	US 2018/0311309 A1 (RHYTHM PHARMACEUTICALS, INC.) 01 November 2018; [0342]-[0343], [0554], [0561], [0583], [0632]-[0633], [0650], [0679]-[0680], [0767], [0770]-[0780], [0791], [0793]-[0794], [0808], [1039]-[1040], [1042], [1044]; claims 251-254	1-6, 10, 13-15, 32-44 --- 21, 23, 25-28
Y --- A	CHEN. "Molecular Analysis of Bardet-Biedl Syndrome Families: Report of 21 Novel Mutations in 10 Genes" 5317-5324. Investigative Ophthalmology & Visual Science. Vol. 52, No. 8. Web. July 2011; abstract; page 5321, first column, second paragraph; DOI: 10.1167/iov.11-7554	1-6, 10, 13-15, 32-44 --- 21, 23, 25-28
Y --- A	PRIYA. "Bardet-Biedl syndrome: Genetics, molecular pathophysiology, and disease management" 620-627. Indian Journal of Ophthalmology.. Web. 2016; page 621, first column, first paragraph; DOI: 10.4103/0301-4738.194328	1-6, 10, 13 --- 21, 23, 25-28
A	WO 2007/008704 A2 (SOCIETE DE CONSEILS DE RECHERCHES ET D'APPLICATIONS SCIENTIFIQUES S.A.S.) 18 January 2007; page 7, second-fifteenth paragraphs; page 8, items IV, VII	21, 23, 25-28
A	GENPEPT. "Hydrogen cyanide synthase subunit HcnC precursor [Planctomycetes bacterium Pan189]" . ACCESSION: QDT39332.1. Web. 31 July 2019; [retrieved 02 February 2022]. Retrieved from the Internet: <URL: https://www.ncbi.nlm.nih.gov/protein/QDT39332.1?report=genbank&log\$=protalign&blast_rank=3&RID=ZP2A4180013 >; pages 1-2	21, 23, 25-28

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"D" document cited by the applicant in the international application	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"E" earlier application or patent but published on or after the international filing date	"&" document member of the same patent family
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

02 February 2022 (02.02.2022)

Date of mailing of the international search report

FEB 23 2022

Name and mailing address of the ISA/US

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-***-Continued From Box No. III: Observations where unity of invention is lacking-***-

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Groups 1+, Claims 1-44, and ARL6 (MC4R pathway agonizable gene), Bardet-Biedl syndrome (disease), Acc (A1), Cys (A2), Gly (A3), His (A4), D-Phe (A5), Arg (A6), Trp (A7), Gly (A8), Cys (A9), Acc (A10), OH (R1), H (R2), H (R3) are directed towards methods of treating a disease, disorder, or condition comprising administering an MC4R agonist.

The methods of Claims 1-6 (each in-part), 10 (in-part), 13-15 (each in-part), 21 (in-part), 23 (in-part), 25-28 (in-part), 32-44 (each in-part) are believed to encompass the first named invention of Groups 1+ and are the claims that will be searched without fee to the extent that they encompass ARL6 (first exemplary MC4R pathway agonizable gene), Bardet-Biedl syndrome (first exemplary disease), Acc (first exemplary A1), Cys (first exemplary A2), Gly (first exemplary A3), His (first exemplary A4), D-Phe (first exemplary A5), Arg (first exemplary A6), Trp (first exemplary A7), Gly (first exemplary A8), Cys (first exemplary A9), Acc (first exemplary A10), OH (first exemplary R1), H (first exemplary R2), H (first exemplary R3).

Applicant is invited to elect additional MC4F pathway agonizable gene(s), disease(s), A1(s), A2(s), A3(s), A4(s), A5(s), A6(s), A7(s), A8(s), A9(s), A10(s), R1(s), R2(s), R3(s) such that each elected species is fully specified (i.e. no optional or variable amino acids, groups, or substituents), and where available as an option within at least one searchable claim, to be searched. Additional MC4F pathway agonizable gene(s), disease(s), A1(s), A2(s), A3(s), A4(s), A5(s), A6(s), A7(s), A8(s), A9(s), A10(s), R1(s), R2(s), R3(s) will be searched upon the payment of additional fees. Applicants must specify the searchable claims that encompass any additionally elected MC4F pathway agonizable gene(s), disease(s), A1(s), A2(s), A3(s), A4(s), A5(s), A6(s), A7(s), A8(s), A9(s), A10(s), R1(s), R2(s), R3(s). Applicants must further indicate, if applicable, the claims which encompass the first named invention, if different than what was indicated above for this group. Failure to clearly identify how any paid additional invention fees are to be applied to the "+" group(s) will result in only the first claimed invention to be searched/examined. Exemplary elections would be RAI1 (MC4F pathway agonizable gene); Alstrom Syndrome (disease); or HN-(CH₂)_m-C(O) where m is 1 (A1), D-Cys (A2), Ala (A3), 2-Pal (A4), Phe (A5), hArg (A6), 1-Nal (A7), D-Ala (A8), D-Cys (A9), HN-(CH₂)_t-C(O) where t is 1 (A10), NH₂ (R1), (C1-C30)alkyl (R2), (C1-C30)alkyl (R3).

Even if Groups 1+ were considered to share the technical features including: a method of treating a disease, disorder, or condition in a subject comprising administering to the subject a melanocortin-4 receptor "MC4R" agonist, wherein the disease, disorder, or condition is related to an MC4R pathway agonizable gene selected from ARL6, RAI1, SRC1, BBS19, BBS21, CEP290, IFT74, LZTFL1, MKS1, TRIM32, WDPCP, RPS6KA3, HTR2C, KSR2, PROK2, RAB23, MRAP2, AFF4, ADCY3, TUB, OTP, GPR101, TBX3, ACBD7, AGRP, CADM1, CADM2, CARTPT, CCDC28B, CCK, CNR1, CREBBP, CREBRF, CUL4B, DYRK1B, ENPP1, EP300, FMR1, FTO, GHRL, GIPR, GIPR, GIPR, INPP5E, INS, INSG2, IRS1, IRS4, KCTD15, KIDINS220, MCHR1, MSRA, NDN, NEGR1, NLGN2, NPY, NR0B2, NTRK2, PCNT, PCSK2, PHF6, PMCH, PPARG, PYY, SDC3, SEC16B, SLC6A4, SNRPN, THRB, TMEM18, TMEM67, TRAPPC9, UCP1, UCP3, VPS13B, NRP1, NRP2, PLXNA1, PLXNA2, PLXNA3, PLXNA4, SEMA3A, SEMA3B, SEMA3D, SEMA3E, SEMA3F, SEMA3G, DNMT3A, RPGRIP1L, ISL1, TRPC5, PHIP, and MeCP2; these shared technical features are previously disclosed by the publication entitled 'Effect of setmelanotide, a melanocortin-4 receptor agonist, on obesity in Bardet-Biedl syndrome' by Haws et al. (hereinafter 'Haws').

Haws discloses a method of treating a disease, disorder, or condition in a subject (a method of treating Bardet-Biedl syndrome in individuals; abstract) comprising administering to the subject a melanocortin-4 receptor "MC4R" agonist (administering setmelanotide which is an MCR4 agonist; abstract; page 2134, first column, third paragraph), wherein the disease, disorder, or condition is related to an MC4R pathway agonizable gene selected from ARL6, RAI1, SRC1, BBS19, BBS21, CEP290, IFT74, LZTFL1, MKS1, TRIM32, WDPCP, RPS6KA3, HTR2C, KSR2, PROK2, RAB23, MRAP2, AFF4, ADCY3, TUB, OTP, GPR101, TBX3, ACBD7, AGRP, CADM1, CADM2, CARTPT, CCDC28B, CCK, CNR1, CREBBP, CREBRF, CUL4B, DYRK1B, ENPP1, EP300, FMR1, FTO, GHRL, GIPR, GIPR, GIPR, INPP5E, INS, INSG2, IRS1, IRS4, KCTD15, KIDINS220, MCHR1, MSRA, NDN, NEGR1, NLGN2, NPY, NR0B2, NTRK2, PCNT, PCSK2, PHF6, PMCH, PPARG, PYY, SDC3, SEC16B, SLC6A4, SNRPN, THRB, TMEM18, TMEM67, TRAPPC9, UCP1, UCP3, VPS13B, NRP1, NRP2, PLXNA1, PLXNA2, PLXNA3, PLXNA4, SEMA3A, SEMA3B, SEMA3D, SEMA3E, SEMA3F, SEMA3G, DNMT3A, RPGRIP1L, ISL1, TRPC5, PHIP, and MeCP2 (the Bardet-Biedl syndrome is related to BBS1-21 (BBS19, BBS21); page 2134, first column, first paragraph).

Since none of the special technical features of the Groups 1+ inventions is found in more than one of the inventions, and since all of the shared technical features are previously disclosed by the Haws reference, unity of invention is lacking.