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(54) Title: IMMUNOGENIC COMPOSITIONS AND THEIR USES

(57) Abstract: This disclosure provides compositions, pharmaceutical preparations, and methods relating to circular polyribonucleotides encoding an immunogen and a multimerization domain useful in the development and production of vaccines.



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# INTERNATIONAL SEARCH REPORT

International application No  
**PCT/US2022/050908**

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> <b>INV.</b> <b>A61K39/145</b> <b>C07K14/01</b> <b>C07K14/11</b> <b>C07K14/165</b> <b>C07K14/47</b> <b>C12N15/62</b> <b>ADD.</b> According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) <b>C12N   C07K   A61K</b>  Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) <b>EPO-Internal</b>		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
<b>X</b>	<b>WO 2021/156267 A1 (CUREVAC AG [DE])</b> <b>12 August 2021 (2021-08-12)</b> <b>claims 1-5 and 48-59, p. 1 lines 5-11, p.</b> <b>55 lines 7-29, p. 60 line 5 - p. 61 line</b> <b>13, claims 48-59, p. 114 lines 20-37, p 30</b> <b>line 29 - p 31 line 19, p. 36 lines 13-15,</b> <b>p. 55 lines 7-29, claim 22, table 1, p.</b> <b>107 lines 5-21, (p 82 l 41 - p 84 line 5,</b> <b>p. 115 lines 13-30, p. 116 lines 39 - p.</b> <b>117 line 3, section "combinations" on p.</b> <b>120 line 19 - p. 121 line 6), (p. 106 line</b> <b>31 - p. 107 line 21, p. 116 lines 15-16,</b> <b>p. 119 lines 7-26, examples 5, 10 and 13,</b> <b>claims 170-176,</b>  <div style="text-align: center;">----- -/--</div>	<b>1-3, 8-26</b>
<div style="display: flex; justify-content: space-between;"> <div> <input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C.         </div> <div> <input checked="" type="checkbox"/> See patent family annex.         </div> </div>		
<div style="display: flex;"> <div style="flex: 1;"> <p>* Special categories of cited documents :</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"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)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="flex: 1;"> <p>"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</p> <p>"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</p> <p>"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</p> <p>"&amp;" document member of the same patent family</p> </div> </div>		
Date of the actual completion of the international search		Date of mailing of the international search report
<b>20 March 2023</b>		<b>31/05/2023</b>
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer  <b>Potthast, Maria</b>

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International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>Qu Liang ET AL: "Abstract", bioRxiv, 16 March 2021 (2021-03-16), page 19, XP055836122, DOI: 10.1101/2021.03.16.435594 Retrieved from the Internet: URL: <a href="https://www.biorxiv.org/content/10.1101/2021.03.16.435594v1.full.pdf">https://www.biorxiv.org/content/10.1101/2021.03.16.435594v1.full.pdf</a> [retrieved on 2021-08-31] Figure 1a, chapter "circRNABD produced functional SARS-CoV-2 RBD antigens" lines 104-116, chapters "SARS-CoV-2 circRNABD vaccine induced sustained humoral immune responses with high level of neutralizing antibodies", "circRNA vaccine elicited potent neutralizing antibodies and Th1-biased immune responses in rhesus macaques" and "CircRNA vaccine protected the rhesus macaques against SARS-CoV-2 infection"</p> <p>-----</p>	<p>1-3, 8-10, 16, 17, 22, 23</p>

## INTERNATIONAL SEARCH REPORT

International application No.

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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.
  - b. ☒ furnished subsequent to the international filing date for the purposes of international search (Rule 13*ter*.1(a)).  
☒ accompanied by a statement to the effect that the sequence listing does not go beyond the disclosure in the international application as filed.
2. ☐ With regard to any nucleotide and/or amino acid sequence disclosed in the international application, this report has been established to the extent that a meaningful search could be carried out without a WIPO Standard ST.26 compliant sequence listing.
3. Additional comments:

# INTERNATIONAL SEARCH REPORT

International application No.  
**PCT/US2022/050908**

## 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:

**see additional sheet**

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 an 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.:  
**3 (completely); 1, 2, 8-26 (partially)**

### 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.

## FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 3(completely); 1, 2, 8-26(partially)

A circular polyribonucleotide comprising an open reading frame comprising a sequence encoding an immunogen and a sequence encoding a multimerization domain.

1.1. claims: 3(completely); 1, 2, 8-26(partially)

A circular polyribonucleotide comprising an open reading frame comprising a sequence encoding an immunogen and a sequence encoding a multimerization domain, wherein the multimerization domain comprises a T4 foldon domain.

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2. claims: 4(completely); 1, 2, 8-26(partially)

A circular polyribonucleotide comprising an open reading frame comprising a sequence encoding an immunogen and a sequence encoding a multimerization domain, wherein the multimerization domain comprises a ferritin domain.

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3. claims: 5(completely); 1, 2, 8-26(partially)

A circular polyribonucleotide comprising an open reading frame comprising a sequence encoding an immunogen and a sequence encoding a multimerization domain, wherein the multimerization domain comprises a b-annulus peptide.

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4. claims: 6(completely); 1, 2, 8-26(partially)

A circular polyribonucleotide comprising an open reading frame comprising a sequence encoding an immunogen and a sequence encoding a multimerization domain, wherein the multimerization domain comprises an AaLS peptide.

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5. claims: 7(completely); 1, 2, 8-26(partially)

A circular polyribonucleotide comprising an open reading frame comprising a sequence encoding an immunogen and a sequence encoding a multimerization domain, wherein the multimerization domain comprises a lumazine synthase domain.

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2021156267 A1	12-08-2021	AU 2021216658 A1	23-06-2022
		BR 112022014627 A2	27-09-2022
		CA 3160511 A1	12-08-2021
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		DE 202021003575 U1	17-01-2022
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		EP 3886897 A1	06-10-2021
		EP 4147717 A1	15-03-2023
		IL 293571 A	01-08-2022
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		KR 20220144416 A	26-10-2022
		TW 202140518 A	01-11-2021
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