CLAIMS

1. A polynucleotide encoding at least one structural protein of SARS-CoV-2 or a variant thereof, wherein the at least one structural protein is the spike (S) protein and wherein the polynucleotide comprises a first sequence region, said first sequence region comprising a nucleic acid sequence having at least 95% identity to a member of the group consisting of SEQ ID NO: 7, 20, 26, 27, and 32.

2. The polynucleotide of claim 1, wherein said first sequence region is at least 95% identical to SEQ ID NO: 7 or at least 99% identical to SEQ ID NO: 7.

3. The polynucleotide of claim 2, wherein said first sequence region consists of SEQ ID NO: 7.

4. The polynucleotide of claim 3, wherein the encoded spike protein has a protein sequence of SEQ ID NO: 2.

5. The polynucleotide of any of claims 1-4, wherein at least 50% of the polynucleotide sequence is codon optimized.

6. The polynucleotide of any of claims 1-5, wherein the polynucleotide is an mRNA.

7. The polynucleotide of claim 6, comprising a 5'UTR and a 3'UTR, wherein said 5'UTR comprises SEQ ID NO: 47 and said 3'UTR comprises SEQ ID NO: 48.

8. The polynucleotide of claim 7, wherein at least one uracil nucleoside is modified to be N1 -methylpseudouridine.

9. The polynucleotide of claim 8, wherein all uracil nucleosides are modified to be N 1 -methylpseudouridine.

10. A nucleic acid vaccine comprising the polynucleotide of any of claims 1-9.

11. The nucleic acid vaccine of claim 10, formulated in lipid nanoparticle (LNP).

12. A pharmaceutical composition comprising the nucleic acid vaccine of claim 10 and a pharmaceutically acceptable excipient.

13. The pharmaceutical composition of claim 12, comprising about 0.2 mg/mL mRNA of claim 6.

14. The pharmaceutical composition of claim 12 or 13 which is suitable for intramuscular (IM) injection.

15. Use of the nucleic acid vaccine of claim 10 or 11 or the pharmaceutical composition of any of claims 12-14 in the manufacture of a medicament for preventing, mitigating or ameliorating COVID-19 in a subject .

16. The use of claim 15, wherein the dose to be administered is:

    i. from about 5 μg to about 100 μg of the mRNA to the subject;
    ii. about 16 μg of the mRNA;
    iii. about 40 μg of the mRNA; or
    iv. about 100 μg of the mRNA.

17. The use of claim 15 or 16, wherein a second dose of the nucleic acid vaccine or pharmaceutical composition is to be administered after between about 1 and about 5 weeks of a first dose or after about 4 weeks of a first dose.

18. The use of any of claims 15-17, wherein:

    i. anti-Spike protein IgG antibodies are to be detected in the subject by day 28 after receiving a first dose of the nucleic acid vaccine or pharmaceutical composition;

    ii. anti-Spike protein IgG antibodies are present in an enhanced amount in the subject by day 42 after receiving a second dose of the nucleic acid vaccine or pharmaceutical composition; and/or

iii. anti-Spike protein IgG antibodies in the subject are greater than 10-fold the values of anti-Spike protein IgG antibodies in serum samples from SARS-CoV-2 convalescent patients.

19. Use of the nucleic acid vaccine of claim 10 or 11 or the pharmaceutical composition of any of claims 12-14 in the manufacture of a medicament for inducing SARS-CoV-2 neutralizing antibody production in a subject .

20. The use of claim 19, wherein:

i. the SARS-CoV-2 neutralizing antibodies can be detected in the subject by day 28 after the medicament has been administered;

ii. the SARS-CoV-2 neutralizing antibody production is enhanced in the subject at day 42 the medicament has been administered; and/or

iii. the level of neutralizing antibodies to SARS-CoV-2 is increased ten-fold by day 42.