Claims

1. An artificial nucleic acid molecule comprising

a. at least one open reading frame (ORF); and

b. at least one 3'-untranslated region element (3'-UTR element), which comprises or consists of a nucleic acid sequence, which is derived from the 3'-UTR of PSMB3,

wherein the at least one open reading frame is heterologous to the at least one 3'-UTR element.

2. The artificial nucleic acid molecule of claim 1, wherein said artificial nucleic acid molecule is characterized by high translation efficiency, wherein the high translation efficiency is provided by the at least one 3'-untranslated region element (3'-UTR element),

wherein the translation efficiency of the artificial nucleic acid molecule is compared to the translation efficiency of a reference nucleic acid molecule,

wherein the reference nucleic acid molecule comprises at least one open reading frame (ORF), which is identical to the at least one ORF of the artificial nucleic acid molecule; and wherein the reference nucleic acid molecule does not comprise the 3'-untranslated region element (3'-UTR element) of the artificial nucleic acid molecule,
wherein the translation efficiency of the artificial nucleic acid molecule and the translation efficiency of the reference nucleic acid molecule are compared by a method comprising the steps:
(i) transfecting mammalian cells with the artificial nucleic acid molecule and measuring expressed amounts of the protein encoded by the ORF of the artificial nucleic acid molecule at a certain point in time after transfection ,
(ii) transfecting mammalian cells with the reference nucleic acid molecule and measuring expressed amounts of the protein encoded by the ORF of the reference nucleic acid molecule at the same point in time after transfection,
(iii) calculating the ratio of the amount of protein expressed from the artificial nucleic acid molecule to the amount of protein expressed from the reference nucleic acid molecule,
wherein the ratio calculated in (iii) is ≥ 1.

3. The artificial nucleic acid molecule of claim 2, wherein the reference nucleic acid molecule comprises a 3'-UTR element which is not present in the artificial nucleic acid molecule.

4. The artificial nucleic acid molecule of claim 3, wherein the reference nucleic acid molecule comprises a 3'-UTR element which is derived from a 3'-UTR of an albumin gene.

5. The artificial nucleic acid molecule of claim 2, wherein the reference nucleic acid molecule does not comprise any 3'-untranslated region element (3'-UTR element).

6. The artificial nucleic acid molecule according to claim 1, wherein the open reading frame is derived from a gene, which is distinct from a gene from which the at least one 3'-UTR element is derived.

7. The artificial nucleic acid molecule according to claim 1, comprising at least one 5'-UTR element.

8. The artificial nucleic acid molecule according to claim 1, wherein the open reading frame of the artificial nucleic acid molecule does not code for a reporter protein.

9. The artificial nucleic acid molecule according to claim 7, wherein the at least one 3'-UTR element, the at least one 5'-UTR element, or both increases translation efficiency of said artificial nucleic acid molecule at least 1.2 fold compared to the protein production from a reference nucleic acid molecule lacking a 3'-UTR, the at least one 5'-UTR, or both, respectively, or wherein the at least one 3'-UTR element, the at least one 5'-UTR element, or both provides high translation efficiency to said artificial nucleic acid molecule at least 1.5 fold compared to the protein production from a reference nucleic acid molecule lacking a 3'-UTR, the at least one 5'-UTR, or both respectively.

10. The artificial nucleic acid molecule according to claim 7, wherein the at least one 5'-UTR element comprises a nucleic acid sequence which is derived from the 5'-UTR of a transcript of a gene selected from the group consisting of ZNF460-5'-UTR, TGM2-5'-UTR, IL7R-5'-UTR, BGN-5'-UTR, TK1-5'-UTR, RAB3B-5'-UTR, CBX6-5'-UTR, FZD2-5'-UTR, COL8A1-5'-UTR, NDUFS7-5'-UTR, PHGDH-5'-UTR, PLK2-5'-UTR, TSPO-5'-UTR, PTGS1-5'-UTR, FBXO32-5'-UTR, NID2-5'-UTR, ATP5D-5'-UTR, EXOSC4-5'-UTR, NOL9-5'-UTR, UBB4B-5'-UTR, VPS18-5'-UTR, ORMDL2-5'-UTR, FSCN1-5'-UTR, TMEM33-5'-UTR, TUBA4A-5'-UTR, EMP3-5'-UTR, TMEM201-5'-UTR, CRIP2-5'-UTR, BRAT1-5'-UTR, SERPINH1-5'-UTR, CD9-5'-UTR, DPYSL2-5'-UTR, CDK9-5'-UTR, TFRC-5'-UTR, PSMB3 5'-UTR, FASN-5'-UTR, PSMB6-5'-UTR, PRSS56-5'-UTR, KPNA6-5'-UTR, SFT2D2-5'-UTR, PARD6B-5'-UTR, LPP-5'-UTR, SPARC-5'-UTR, SCAND1-5'-UTR, VASN-5'-UTR, SLC26A1-5'-UTR, LCLAT1-5'-UTR, FBXL18-5'-UTR, SLC35F6-5'-UTR, RAB3D-5'-

UTR, MAP1B-5'-UTR, VMA21-5'-UTR, CYBA-5'-UTR, SEZ6L2-5'-UTR, PCOLCE-5'-UTR, VTN-5'-UTR, ALDH16A1-5'-UTR, RAVER1-5'-UTR, KPNA6-5'-UTR, SERINC5-5'-UTR, JUP-5'-UTR, CPN2-5'-UTR, CRIP2-5'-UTR, EPT1-5'-UTR, PNPO-5'-UTR, SSSCA1-5'-UTR, POLR2L-5'-UTR, LIN7C-5'-UTR, UQCR10-5'-UTR, PYCRL-5'-UTR, AMN-5'-UTR, MAP1S-5'-UTR, and Dpysl2-5'-UTR, Ccnd1-5'-UTR, Acox2-5'-UTR, Cbx6-5'-UTR, Ubc-5'-UTR, Ldlr-5'-UTR, Nudt22-5'-UTR, Pcyox1l-5'-UTR, Ankrd1-5'-UTR, Tmem37-5'-UTR, Tspyl4-5'-UTR, Slc7a3-5'-UTR, Cst6-5'-UTR, Aacs-5'-UTR, Nosip-5'-UTR, Itga7-5'-UTR, Ccnd2-5'-UTR, Ebp-5'-UTR, Sf3b5-5'-UTR, Fasn-5'-UTR, Hmgcs1-5'-UTR, Osr1-5'-UTR, Lmnb1-5'-UTR, Vma21-5'-UTR, Kif20a-5'-UTR, Cdca8-5'-UTR, Slc7a1-5'-UTR, Ubqln2-5'-UTR, Prps2-5'-UTR, Shmt2-5'-UTR, Aurkb-5'-UTR, Fignl1-5'-UTR, Cad-5'-UTR, Anln-5'-UTR, Slfn9-5'-UTR, Ncaph-5'-UTR, Pole-5'-UTR, Uhrf1-5'-UTR, Gja1-5'-UTR, Fam64a-5'-UTR, Kif2c-5'-UTR, Tspan10-5'-UTR, Scand1-5'-UTR, Gpr84-5'-UTR, Fads3-5'-UTR, Cers6-5'-UTR, Cxcr4-5'-UTR, Gprc5c-5'-UTR, Fen1-5'-UTR, Cspg4-5'-UTR, Mrpl34-5'-UTR, Comtd1-5'-UTR, Armc6-5'-UTR, Emr4-5'-UTR, Atp5d-5'-UTR, 1110001J03Rik-5'-UTR, Csf2ra-5'-UTR, Aarsd1-5'-UTR, Kif22-5'-UTR, Cth-5'-UTR, Tpgs1-5'-UTR, Ccl17-5'-UTR, Alkbh7-5'-UTR, and Ms4a8a-5'-UTR.

11. The artificial nucleic acid molecule according to claim 1, wherein the at least one 3'-UTR element comprises or consists of a nucleic acid sequence, which has an identity of at least 90% to the nucleic acid sequence according to SEQ ID NO: 164, or wherein the at least one 3'-UTR element comprises or consists of a fragment of a nucleic acid sequence, which has an identity of at least 90% to fragment of the nucleic acid sequence according to SEQ ID NO: 164.

12. The artificial nucleic acid molecule according to claim 7, wherein the at least one 5'-UTR element comprises or consists of a nucleic acid sequence which has an identity of at least 90% to a nucleic acid sequence selected from the group consisting of SEQ ID NOs: 1 to 151 or wherein the at least one 5'-UTR element comprises or consists of a fragment of a nucleic acid sequence which has an identity of at least 90% to a nucleic acid sequence selected from the group consisting of SEQ ID NOs: 1 to 151.

13. The artificial nucleic acid molecule according to any one of claims 1, 2, and 3-12 further comprising

c. a poly(A) sequence and/or a polyadenylation signal.

14. The artificial nucleic acid molecule according to any one of claims 1, 2, and 3-12, further comprising a 5'-cap structure, a poly(C) sequence, a histone stem-loop, and/or an IRES-motif.

15. The artificial nucleic acid molecule according to any one of claims 1, 2, and 3-12, wherein the nucleic acid comprises a 5'-TOP UTR.

16. The artificial nucleic acid molecule according to any one of claims 1, 2, and 3-12, wherein the artificial nucleic acid molecule is at least partially G/C modified, or wherein the open reading frame comprises a codon-optimized region.

17. The artificial nucleic acid molecule according to any one of claims 1, 2, and 3-12, which is an RNA.

18. The artificial nucleic acid molecule according to claim 17, which is an mRNA.

19. A vector comprising an artificial nucleic acid molecule according to any one of claims 1, 2, and 3-12.

20. A cell comprising the artificial nucleic acid molecule according to any one of claims 1, 2, and 3-12.

21. A pharmaceutical composition for use as a vaccine or for use in gene therapy, comprising the artificial nucleic acid molecule according to any one of claims 1, 2, and 3-12.

22. The artificial nucleic acid molecule according to any one of claims 1, 2, and 3-12 for use as a medicament.

23. The vector according to claim 19 for use as a medicament.

24. The cell according to claim 20 for use as a medicament.

25. The pharmaceutical composition according to claim 21 for use as a medicament.

26. The artificial nucleic acid molecule according to any one of claims 1, 2, and 3-12 for use as a vaccine or for use in gene therapy.

27. The vector according to claim 19 for use as a vaccine or for use in gene therapy.

28. The cell according to claim 20 for use as a vaccine or for use in gene therapy.

29. An *in-vitro* method for increasing translation efficiency of an artificial nucleic acid molecule, the method comprising the step of associating an open reading frame with a 3'-UTR element, wherein the 3'-UTR element comprises or consists of a nucleic acid sequence, which is derived from the 3'-UTR of a transcript of PSMB3 and wherein the 3'-UTR element increases translation efficiency from a resulting artificial nucleic acid molecule, to obtain an artificial nucleic acid molecule, according to any of claims 1, 2, and 3-12.

30. A composition for increasing translation efficiency of an artificial nucleic acid molecule, comprising a 3' UTR element, wherein the 3'-UTR element comprises or consists of a nucleic acid sequence which is derived from the 3'-UTR of a transcript of PSMB3.

31. A kit or kit of parts comprising an artificial nucleic acid molecule according to any one of claims 1, 2, and 3-12.