Claims

1. A biosensor for detection and/or quantification of sperm binding function, the biosensor comprising a substrate and a JUNO protein or a fragment thereof, wherein the fragment is capable of binding to a sperm or to IZUMO1, and wherein the JUNO protein or the fragment thereof is immobilized on the substrate, and wherein the biosensor is configured for determining binding of a sperm cell to a protein immobilized on the substrate.

2. The biosensor according to claim 1, further comprising Zona pellucida 1 (ZP1), Zona pellucida 2 (ZP2), Zona pellucida 3 (ZP3) and/or an anti-IZUMO antibody or fragments thereof wherein the fragments are capable of binding to a sperm or to IZUMO1, and wherein the ZP1, ZP2, ZP3, and/or the anti-IZUMO antibody or fragments thereof are immobilized on the substrate.

3. The biosensor according to any one of the preceding claims, wherein at least one of the JUNO protein, ZP1, ZP2, ZP3, and anti-IZUMO antibody is conjugated to an additional moiety selected from the group consists of a peptide and a label.

4. The biosensor according to any one of the preceding claims, wherein the sperm binding function is determined from the binding of at least a portion of the sperm cell to a protein immobilized on the substrate, wherein said protein is selected from the groups consisting of JUNO protein, ZP1, ZP2, ZP3 and/or the anti-IZUMO antibody, or fragments thereof wherein the fragments are capable of binding to a sperm or IZUMO1.

5. The biosensor according to any one of the preceding claims, wherein the substrate is a dish and wherein said dish is configured such that it can be coupled to a microscope or an optical transducer; or
wherein the substrate is microbeads, wherein said microbeads are configured such that they can be coupled to a microscope, an optical transducer or a measurement circuit; or
wherein the substrate is an electrode and wherein said electrode is configured such that it can be coupled to an electrochemical workstation or a measurement circuit; or
wherein the substrate is a chip and wherein said chip is configured such that it can be coupled to a surface plasmon resonance detector.

6. A method for detecting and/or quantifying sperm binding function, wherein the method comprises the steps of:
    a. Providing a semen sample from a subject, wherein said semen sample comprises one or more sperm cells,
    b. Contacting the semen sample with the biosensor according to any one of the preceding claims,
    c. Determining binding of the sperm cells to a protein immobilized on the substrate,

    thereby detecting and/or quantifying the sperm binding function of said sample.

7. A method for diagnosis of male infertility, wherein the method comprises the steps of:
    a. Providing a semen sample from a subject,
    b. Contacting the semen sample with the biosensor according to any one of the preceding claims,
    c. Quantifying the sperm binding function of said sample according to the method of claim 6,
    d. Using the sperm binding function to diagnose if the subject is infertile.

8. The method according to any one of claims 6 and 7, wherein the sperm binding function of said sample is quantified by determining the percentage of bound versus unbound sperm cells by microscopic analysis, electrochemical detection and/or surface plasmon resonance; and/or

    wherein the sperm binding function of said sample is quantified by determining the acrosomal status of the sperm cells in the semen sample by microscopic analysis, electrochemical detection and/or surface plasmon resonance.

9. A method of selecting sperm, said method comprising:
    a. Providing a semen sample from a subject, wherein said semen sample comprises one or more sperm cells,
    b. Contacting the semen sample with the biosensor according to any one of the preceding claims,
    c. Visualizing a sperm cell bound to the biosensor by microscopy, and
    d. Selecting at least one sperm cell bound to the biosensor.

10. A method for manufacturing a biosensor comprising a JUNO protein according to claim 1, the method comprising:
    a. Providing a substrate,
    b. providing the JUNO protein, and
    c. immobilizing the JUNO protein on the substrate,
    d. providing means for determining binding of a sperm cell to a protein immobilized on the substrate,

    thereby manufacturing a biosensor comprising the JUNO protein.

11. The method according to claim 10, wherein the substrate is as defined in any one of the preceding claims.

12. The method according to any one of claims 10 to 11, wherein the method further comprises immobilizing on the substrate one or more of ZP1, ZP2, ZP3 and an anti-IZUMO antibody.

13. The method according to any one claims 10 to 12, wherein the proteins JUNO, ZP1, ZP2, ZP3 and the anti-IZUMO antibody are as defined in any one of the preceding claims.

14. A hand-held device for detection and/or quantification of sperm binding function, the device comprising:
    a. An inlet for a sample;
    b. A biosensor comprising a JUNO protein or a fragment thereof wherein the fragment is capable of binding to a sperm or to IZUMO1, and wherein the JUNO protein is immobilized on the biosensor, wherein the biosensor is configured for determining binding of a sperm cell to a protein immobilized on the substrate, and wherein the inlet is configured to place the sample in contact with the substrate;
    c. A detector configured to receive a signal from the substrate and transform it into a format readable by a user; and
    d. Optionally, means for separating cellular components from the sample.

15. The hand-held device according to claim 14, wherein the biosensor is as defined in any one of the preceding claims.