

## INFORMED CONSENT FOR PREIMPLANTATION GENETIC TESTING FOR ANEUPLOIDIES (PGT-A), FOR CARRIERS OF STRUCTURAL REARRANGEMENTS (PGT-SR) AND FOR MITOSCORE

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### DESCRIPTION, PURPOSE AND ADVANTAGES OF PERFORMING THE ANALYSIS

Preimplantation Genetic Testing for Aneuploidies (PGT-A) is used in combination with in vitro fertilisation (IVF) treatment to detect chromosomal abnormalities in embryos before their transfer. Chromosomal abnormalities are often seen in embryos and frequently result in abnormal pregnancies, miscarriages and failed implantation. The information obtained from PGT-A helps clinicians and patients decide which embryos to transfer in IVF treatment.

Almost every cell in the body has chromosomes, which are organized structures containing DNA and proteins. This information contained within the chromosomes is necessary for growth and development. There are 24 different types of chromosomes in humans, numbered from 1 to 22, plus the sex chromosomes X and Y. Most human cells contain a total of 46 chromosomes: 22 pairs and an XX pair for a biological female, and an XY pair for a biological male. Both the sperm and the egg must have 23 chromosomes each to produce an embryo with the correct number of chromosomes, meaning that, when a sperm fertilizes an egg, the resulting embryo has 46 chromosomes in total.

Any biological female can produce chromosomally abnormal eggs and any biological male chromosomally abnormal sperm. If an egg with 24 chromosomes is fertilized by a sperm with 23 chromosomes, the resulting embryo has 47 chromosomes (one extra). A common example of a chromosomal abnormality is Down syndrome, which is caused by the presence of three copies instead of two of chromosome 21. Embryo aneuploidy (extra or missing chromosomes) may develop as a result of an abnormal egg (risk groups include women over the age of 38), an abnormal sperm (severe male factor), individuals with balanced structural rearrangements (translocations and inversions), or due to a subsequent error during cell division. Chromosomal abnormalities can give rise to reproductive failure or prevent assisted reproductive treatment from resulting in pregnancy. They can also be responsible for miscarriages in the first trimester, foetal death, or newborns with chromosomal abnormalities.

Most abnormal embryos are not distinguishable from normal embryos when assessed using a microscope in the IVF clinic. Therefore, assessment of embryo morphology cannot be used to detect the presence of chromosomal abnormalities.

PGT-A detects extra or missing copies of the 24 chromosomes or large chromosomal imbalances, and embryos with chromosomal abnormalities will not be recommended for transfer. The potential benefits of PGT-A include the reduction of the risk of miscarriages, the increase in implantation rate and decreased time to pregnancy. Not all pregnancies with chromosomal abnormalities lead to implantation failure or miscarriage; some of these chromosomal alterations can result in the birth of a baby with serious abnormalities. These conditions can be detected during the pregnancy via other types of invasive tests such as chorionic villus biopsy and amniocentesis. However, these procedures involve a risk of miscarriage and cannot be performed until after the pregnancy is achieved.

In addition, the MitoScore test can be performed, which measures the mitochondrial DNA. The results obtained from this test allow us to identify which of the chromosomally normal (euploid) embryos of a patient might have a greater chance of implantation. An increase in the mitochondrial DNA (mtDNA) in euploid embryos was shown in some studies to be associated with a lower implantation potential and can be indicative of a reduced energetic capability during the maturation of oocytes. MitoScore is a value which shows the standard amount of mtDNA in euploid embryos and indicates the total amount of mtDNA in the sample (Diez-Juan A, Rubio C et al. 2015).

Selecting chromosomally normal embryos with a lower MitoScore value can potentially increase the likelihood of implantation.

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### PROCEDURES, RISKS AND LIMITATIONS

The PGT-A process consists of several phases. The first three phases are carried out at your IVF clinic: the in vitro fertilization, embryo biopsy and cell preparation. The biopsied cells are then transferred to Igenomix for subsequent analysis.

#### **In vitro fertilization (IVF):**

PGT-A analyses cells taken (i.e., biopsied) from an embryo. Therefore, an IVF cycle is required regardless of your fertility history. Your IVF clinic will advise you on this process and may require additional consent. An ICSI (intracytoplasmic sperm injection) is recommended to reduce the risk of errors in the test due to contamination. Abstaining from sexual relations for at least two weeks before egg collection and for the time leading up to the pregnancy test is also recommended. We know that sperm can survive several days in the body of a female and that not all the eggs are removed during the collection process in the IVF cycle. A spontaneous pregnancy may give an incorrect diagnosis.

#### **Embryo biopsy, cell preparation and transport:**

The embryo biopsy is carried out on day 5-7 of embryonic development when the embryo is at the blastocyst stage (trophectoderm biopsy). In the trophectoderm biopsy, several cells are removed from each blastocyst for PGT-A analysis. After the biopsy, the embryos will remain at the IVF clinic and will be frozen by a process known as vitrification.

After performing the biopsy, the cells obtained are "cleaned" by the embryologist to eliminate any potential source of contamination and are then transferred to a small tube supplied by Igenomix.

These tubes containing the cells are then safely packaged into an Igenomix cooler and sent by courier to the laboratory. Depending on the location of the IVF clinic, the samples will take 1-7 days in transit to arrive to the laboratory.

**Analysis and reporting of the results:**

Once the laboratory receives the samples, the genetic content (DNA) of the cells is amplified to increase the amount of genetic material present for evaluation. This sample is then prepared and analysed using Next Generation Sequencing. If the sample contains excess or missing genetic material for one chromosome (i.e., an aneuploidy in one chromosome), the embryo is classified as "aneuploid"; if aneuploidy is detected in 2-5 chromosomes, the embryo is classified as "complex abnormal"; embryos with aneuploidies in more than 5 chromosomes are classified as "chaotic". Embryos with abnormalities of any kind are NOT recommended for transfer. The results are sent directly to the IVF clinic and your clinician will indicate which embryo(s) to transfer based on this information.

**Mosaicism:**

Depending on the sequencing data obtained, the embryos are classified as either euploid (normal), mosaic or aneuploid (abnormal). Mosaicism is defined as the presence of more than one type of chromosomally different cell in an embryo. A mosaic embryo contains a combination of chromosomally normal cells and cells with aneuploidies. Mosaicism occurs randomly and spontaneously during embryonic development. During the process of cell division, the chromosomes may not be distributed equally, giving rise to cells with an abnormal number of chromosomes. An embryo will be considered mosaic when the level of aneuploidies detected in the biopsy is between 30% and 70%, based on our internal validation of PGT-A using NGS. Embryos will be considered to have "low-level mosaicism" if the level of aneuploidy in the biopsy is between 30% and 50%; and "high-level mosaicism" if the level of aneuploidy in the biopsy is between 50% and 70%. Embryos with aneuploidy levels above 70% will be reported as "aneuploid", and embryos with aneuploidy levels below 30% will be reported as "euploid". Embryos that have another uniform aneuploid chromosome will not be reported as mosaic, but as "complex abnormal".

Published data indicate that mosaic embryos may have a lower potential for implantation, final development and healthy birth compared to chromosomally normal embryos (PMID: 33685629). However, mosaic embryos have a greater potential to lead to a healthy pregnancy compared to embryos that are diagnosed as entirely aneuploid. The non-selection study conducted by Igenomix has shown that they have similar clinical outcomes compared to euploid embryos (PMID: 34798051). Concordance studies have shown that biopsies with a low mosaic result most likely have a euploid inner cell mass (ICM), the part of the embryo that will become the fetus (PMID: 34798051). The PGDIS Position Statement on the Transfer of Mosaic Embryos states that mosaic embryos should not be disregarded in terms of suitability for transfer (<https://pgdis.org/docs/PositionStatement.pdf>). The risk for mosaicism to persist throughout pregnancy or until birth is thought to be low. Embryos reported to have high-level mosaicism in certain chromosomes may have some reproductive potential but with lower implantation rates and a higher risk of miscarriage compared to euploid and "low-level mosaic" embryos (PMID: 33685629; PGDIS Position Statement on the Transfer of Mosaic Embryos 2021). Concordance studies show that biopsies with a high mosaic result are most likely to be concordant with an aneuploid ICM (PMID: 34798051). Clinical outcome data from transfer of embryos with high-level mosaicism is still emerging. There are no non-selection studies for the transfer of "high-level mosaic" embryos, therefore their reproductive potential cannot be assessed at this time.

A "euploid" result suggests that no mosaicism was detected in the biopsied sample, or any aneuploidy that was detected was at a level below 30%; the PGT-A test cannot rule out the presence of mosaicism in the whole embryo. An embryo diagnosed as normal may have chromosomal abnormalities in other cells that were not biopsied, which may lead to a diagnostic error.

The decision on which embryos to transfer is made by the patient and health care professional. The patient must talk to their clinician/genetic counsellor if they wish for a mosaic embryo to be transferred.

References: PMID: 33685629. Viotti M, Victor AR, Barnes FL, Zouves CG, Besser AG, Grifo JA, Cheng EH, Lee MS, Horcajadas JA, Corti L, Fiorentino F, Spinella F, Minasi MG, Greco E, Munné S. Using outcome data from one thousand mosaic embryo transfers to formulate an embryo ranking system for clinical use. *Fertil Steril.* 2021 May;115(5):1212-1224. doi: 10.1016/j.fertnstert.2020.11.041. Epub 2021 Mar 6. PMID: 34798051. Capalbo A, Poli M, Rienzi L, Girardi L, Patassini C, Fabiani M, Cimadomo D, Benini F, Farcomeni A, Cuzzi J, Rubio C, Albani E, Sacchi L, Vaiarelli A, Figliuzzi M, Findikli N, Coban O, Boynukalin FK, Vogel I, Hoffmann E, Livi C, Levi-Setti PE, Ubaldi FM, Simón C. Mosaic human preimplantation embryos and their developmental potential in a prospective, non-selection clinical trial. *Am J Hum Genet.* 2021 Dec 2;108(12):2238-2247. doi: 10.1016/j.ajhg.2021.11.002. Epub 2021 Nov 18; PMID: 34798051. PGDIS Position Statement on the Transfer of Mosaic Embryos 2021. <https://pgdis.org/docs/PositionStatement.pdf>

**MitoScore:**

The MitoScore test can also be performed on the DNA obtained from the same biopsy to identify which embryos could have a greater capacity and suitability for achieving pregnancy. The level of mitochondrial DNA (MitoScore) is obtained using NGS, which offers information on both the nuclear and mitochondrial DNA.

**Clinic-determined reporting options:** IVF clinics/Test requesters might not request all information that can be obtained from PGT-A analysis to be reported as it may not influence embryo transfer or decision making. Information about MitoScore and some categories of mosaicism can be masked at the request of the requester (e.g., mosaicism for all chromosomes may be masked and reported as aneuploid at the request or low mosaicism for the chromosomes associated with non-viable aneuploidies i.e., 13, 18, 21, X and Y may be masked and reported as euploid at the request of the clinic).

Given the complexity of the genetic tests and the significant implications of the test results, the results obtained must be interpreted in conjunction with other clinical data, within the general context of a medical practice run by healthcare professionals. The result reports are strictly confidential. The test result will be available within 10 working days following receipt of the sample at Igenomix. A small percentage of samples may be delayed due to unforeseeable circumstances. Should this occur, the corresponding requesting clinic will be notified.

To process the sample, the test request form will need to be correctly filled out. If this is not the case, the analysis may be suspended until the information required has been provided to the laboratory.

**Risks and limitations:**

PGT-A does not eliminate the risk of an offspring developing a disorder and it cannot guarantee a healthy pregnancy or eliminate the risk of miscarriage, death or the birth of a child with abnormalities. The main risks and limitations associated with PGT-A and MitoScore are:

### 1. Risks During Embryo Biopsy:

It is possible that the implantation capacity of a normal biopsied embryo is slightly reduced compared to a normal embryo which has not been biopsied.

It is possible that the embryo may become damaged during the biopsy and will stop developing or not be suitable for transfer. However, when handled by skilled embryologists, the risk of damage to the embryo is very low. Igenomix is not responsible for any potential damage to the embryo.

### 2. Preparation of cells:

Once the cells are removed from the embryo, they are transferred to a small tube. Occasionally, the cells may not be successfully transferred to the tube, in which case there would be no cellular material to perform genetic analysis on. It is also possible that the genetic material is degraded (poor quality), in which case it would not be successfully amplified. In either of these cases, results from PGT-A will not be obtained for the embryo. Igenomix is not responsible in the event that cells are not present in the tube or if the DNA is of poor quality.

### 3. Transport:

The cells are sent via courier to Igenomix for analysis. Certain adverse conditions during transportation may cause a delay in receiving the sample or, on rare occasions, cause damage to the sample(s). Although highly unlikely, a sample(s) could also be lost. Igenomix is not responsible for any loss or damage to a sample during transport.

### 4. Limits in detection:

PGT-A is a test designed to detect aneuploidies (losses or gains of whole chromosomes) and it can also detect partial aneuploidies, including deletions, duplications and unbalanced structural rearrangements, depending on the segment size of the affected chromosome. PGT-A does not allow us to detect gains or losses in chromosome segments smaller than 10 Mb (Megabases). These abnormalities are rare unless there is a family history of them.

### 5. Test limitations of PGT-A

**Accuracy:** The accuracy of this test is higher than 98%. The risk of birth defects is between 3 and 5% in the general population and may be due to other genetic or non-genetic causes, which are not necessarily due to alterations in the number of chromosomes.

**Balanced structural rearrangements:** PGT-A does not allow us to detect balanced structural rearrangements (such as balanced translocations and inversions). In other words, abnormalities in the structure of the chromosomes which do not result in gains or losses in chromosomal material will not be detected by PGT-A.

**Genetic mutations:** Not all genetic abnormalities are due to chromosomal abnormalities. For example, to detect the presence of alterations in individual genes, such as cystic fibrosis, sickle cell anaemia or haemophilia, tests must be performed to detect the particular change in the familial gene (mutation). Any known familial genetic alteration should be discussed with your clinician.

**Uniparental disomy (UPD):** This is the presence of two copies of a chromosome from one partner, which is associated with genetic syndromes with clinical manifestation or cognitive deficits, related to the chromosome in which the UPD presents. Igenomix cannot detect UPD using PGT-A.

**Ploidy:** PGT-A cannot detect haploidy, triploidy or tetraploidy, which are alterations of the entire set of chromosomes, with the presence of one, three or four copies of each and every one of the chromosomes contained in a cell respectively. These types of chromosomal alterations, which we would not be able to identify, would lead to miscarriages and partial molar pregnancies, but their incidence in human preimplantation embryos is less than 1%.

In addition, physical birth defects may appear, such as heart alterations, which are not related to chromosomal alterations. Some illnesses are multifactorial, which means that they occur due to a combination of genetic and environmental influences. Currently, studies on embryos or on fetuses during pregnancy are not possible for the majority of these conditions as the exact cause is unknown. Some examples of these conditions are autism, schizophrenia and diabetes.

For these reasons, ultrasound monitoring is recommended if pregnancy is achieved.

### 6. Error in diagnosis:

PGT-A has a 1 to 2% chance of error. One possibility is a 'false positive'. This means that normal embryos are diagnosed as abnormal. Conversely, there is the possibility of a 'false negative', meaning that abnormal embryos are diagnosed as normal. False negatives may be due to the presence of mosaicism, as explained above, with the biopsy analysed not always being representative of the whole embryo.

The embryo biopsy and all the laboratory procedures are carried out under sterile conditions to avoid contamination or the presence of genetic material which does not come from the embryo and may lead to incorrect results.

**8. No diagnosis due to the absence of DNA:**

It may not be possible to obtain results from an embryo biopsy. The likelihood of not getting results is less than 4%. The most common reasons for this are the absence of cells in the test tube or poor-quality genetic material (common in cells damaged during the biopsy process). Some couples choose to transfer embryos with a result of "No DNA detected". When transferring embryos without a diagnosis, the benefits associated with the PGT-A do not apply.

**9. Non-informative results:**

When the quality of the sample is insufficient, the algorithmic model used to determine the chromosome complement does not allow for a conclusive result. In this case the diagnosis will appear on the report as "non-informative". Some couples choose to transfer embryos with a "non-informative" result. When transferring these embryos, the benefits associated with the PGT-A do not apply.

**10. Absence of embryos for transfer:**

In some cases, all the embryos are diagnosed as abnormal, and no embryo is recommended for transfer.

**11. ICSI:**

The recommended laboratory technique for the fertilization of eggs to undergo PGT is ICSI, but this is not required by some IVF clinics. If ICSI is not performed, the risk of an incorrect result increases due to possible contamination of the biopsy sample with sperm or granulosa cells adhering to the external surface of the embryo.

**12. MitoScore:**

High MitoScore values could indicate that the implantation potential of the embryo is low, but do not suggest abnormalities in the embryo. MitoScore does not provide information on the health of the embryo, and all the embryos diagnosed as chromosomally normal are considered potential candidates for transfer, regardless of their MitoScore value.

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## ADDITIONAL INFORMATION CONCERNING PGT-SR FOR STRUCTURAL REARRANGEMENTS

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**DESCRIPTION, PURPOSE AND ADVANTAGES OF PERFORMING THE ANALYSIS**

Preimplantation Genetic Testing for Structural Rearrangements (PGT-SR) is offered to patients who, before IVF treatment discover that one of the partners is a carrier of a balanced structural rearrangement, such as a translocation or inversion. The information regarding aneuploidies described for PGT-A also applies for PGT-SR (please see above sections), with the following modifications:

Translocations and inversions are the most common types of structural chromosome rearrangements:

- An individual with an inversion has a segment of a chromosome which has changed position within that chromosome.
- A translocation is caused by the transfer of genetic material between chromosomes.

Individuals that are carriers of balanced structural rearrangements present abnormalities in the structure of the chromosomes, without gains or losses in chromosomal material.

The risk factors of being a carrier of a balanced translocation or inversion include unexplained male infertility (low sperm count), implantation failure, recurring miscarriages, and family history of having offspring born with abnormalities.

In carriers of balanced structural rearrangements, there is a risk of producing eggs and sperm with unbalanced chromosomal alterations which could be transmitted to the offspring. In general, a carrier of a balanced structural rearrangement does not have health problems, although in some cases they may have difficulty conceiving. The embryos of carriers of balanced structural rearrangements may present unbalanced structural rearrangements (gain or loss of a chromosome segment), which may lead to implantation failure, miscarriage, or children born with mental and/or physical problems. If the children inherit the balanced structural rearrangement, they should not have health problems, just like their carrier parent(s).

The identification of embryos which have inherited an unbalanced structural rearrangement may help patients and clinicians to decide which embryos to transfer.

**PROCEDURES, RISKS AND LIMITATIONS**

The PGT-SR process using NGS is carried out in a similar manner to PGT-A (see previous sections), using the same biological sample. For the detection of these chromosomal imbalances, an optimised NGS platform is used to detect imbalances greater than 6 Mb. The unbalanced structural rearrangement is identified as gains and/or losses of segments of the ends of the chromosomes involved in the structural rearrangement.

Before planning a PGT-SR cycle, the couple must provide their referring clinician with a karyotype report of the carrier of the balanced structural rearrangement so that it can be subsequently reviewed by Igenomix scientists, who will then advise on the appropriate protocol and/or request additional tests if necessary.

The risks and limitations described above for PGT-A also apply to PGT-SR. However, there are additional specific limitations of PGT-SR set out below:

1. PGT-SR using NGS does not allow us to detect chromosomal imbalances below 6 Mb.

2. PGT-SR does not allow us to differentiate between completely normal embryos and carrier embryos having a balanced structural rearrangement (same as the carrier parent(s)).

The turn-around-time for PGT-SR is the same as PGT-A which is 10 working days.

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## DATA PRIVACY, STORAGE AND RESEARCH USE OF SAMPLES

Your privacy is a priority for the Igenomix Group ("Igenomix"). Your identity and all data referring to your personal information will be confidential and only Igenomix personnel will be permitted access to this information, along with the relevant authorities when required by the laws of the applicable jurisdiction. You will find further information on the Igenomix Privacy Policy, along with all your rights at [www.igenomix.com](http://www.igenomix.com), or this information may be provided to you upon request by sending an email to [privacy@igenomix.com](mailto:privacy@igenomix.com).

We would like to inform you that your personal data will only be processed to: (1) Fulfil the obligations arising from the provision of the services contracted by you; (2) Check and guarantee the quality of the services provided (internal audits, quality controls, laboratory validation studies); (3) For educational purposes, provided that it remains anonymous throughout and you cannot be identified during the analysis of the data, which will not be linked to your personal data; (4) For research purposes, scientific publications and presentations, provided that it remains anonymous throughout and you cannot be identified during the analysis of the data, which will not be linked to your personal data; and (5) Personally address any doubts or suggestions made by the patient during the process and monitor the proper performance and resolution of the test, including the indefinite retention of your data, except where local laws of the applicable jurisdiction state otherwise.

You also declare that you understand and accept that you will not obtain, either now or in the future, any economic benefit for any research carried out, and that there is no intention to compensate you for the products developed from any research.

The sample will be analysed by Igenomix or an associated group selected by Igenomix on an international level. Igenomix reserves the right to carry out part or all of the analyses included in the test through third party laboratories accredited to recognised international quality standards, or failing this, they will be periodically assessed by Igenomix. Any results obtained in this way will be inspected by Igenomix and this circumstance will be indicated in the final report issued.

The samples and data associated with the same shall be held by the laboratory in accordance with Igenomix's sample retention policy which meets all legal requirements.

Pursuant to the laws on the Protection of Personal Data<sup>1</sup>, the requesting party must have the patient's consent to perform the diagnostic tests requested and to process their data. You may, at any time, exercise your rights regarding access, rectification, opposition, erasure, automated decisions, limitation, portability, by sending an email to [privacy@igenomix.com](mailto:privacy@igenomix.com), providing proof of the requesting party's identity.

<sup>1</sup>**For patients residing outside of the United States:** under certain jurisdictions, clients residing outside the United States may at any time request to have their personal information deleted from our active databases, subject to the applicable laws and regulations in each jurisdiction. Although we can delete your personal information from our active databases, part or all of your personal information shall remain stored in back-up files for the purpose of complying with legal, regulatory or other requirements. Information that has already been coded and/or anonymised may not be recoverable or traceable for destruction, deletion or modification. If you wish to have your personal information removed from our active databases, please contact us at [privacy@igenomix.com](mailto:privacy@igenomix.com).

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## HAVING READ AND UNDERSTOOD THE FOREGOING, I AM AWARE OF:

The indications, procedure, success rate, risks and complications of the proposed treatment, as well as the financial cost of said test(s).

The fact that medical staff are at my disposal to expand on any aspect of the information that is not sufficiently clear to me.

I have understood the explanations given to me in clear and simple language, and the clinician who saw me allowed me to make comments, clarifying any issues I raised and informing me that I may freely withdraw my consent at any time.

I am satisfied with the information received and I freely consent to an embryo biopsy being performed (PGT-A or PGT-SR) and to a blood sample being taken if required (PGT-SR), for the purpose of sending these samples to the Igenomix facilities so that the analysis can be performed.

I also accept that the results of the test(s) may be passed on to my clinician, so that they can advise me correspondingly on the suitable treatment to follow.

**Patient consent**

By signing this requisition form, I voluntarily request Igenomix to carry out the test indicated above. I have read and received a copy of the informed consent, included in the previous pages. The risks, benefits and limitations of this test have been explained to me.

Patient's full name \_\_\_\_\_

Patient's signature \_\_\_\_\_ Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

**Partner consent (when applicable)**

By signing this requisition form, I voluntarily request Igenomix to carry out the test indicated above. I have read and received a copy of the informed consent, included in the previous pages. The risks, benefits and limitations of this test have been explained to me.

Partner's full name \_\_\_\_\_

Partner's signature \_\_\_\_\_ Date: \_\_\_\_/\_\_\_\_/\_\_\_\_