**Ichthyosis Panel**

**Test code: DE0601**

The Blueprint Genetics Ichthyosis Panel is a 19 gene test for genetic diagnostics of patients with clinical suspicion of congenital ichthyosis or lamellar ichthyosis.

Vast majority of ichthyoses are inherited, but this condition may also develop in the setting of malignancy, autoimmune or infectious disease and nutritional deficiency. Generally severe ichthyosis is inherited in autosomal recessive manner and less severe ichthyosis and related disorders have X-linked recessive or autosomal dominant heritance.

**About Ichthyosis**

It is characterized by dry, scaling skin that may be thickened or very thin. The disease onset is usually at birth, or within the first year, and continues to affect the patient throughout their lifetime. Autosomal recessive congenital ichthyosis (ARCI) includes several forms of non-syndromic ichthyosis: lamellar ichthyosis, congenital ichthyosiform erythroderma and harlequin ichthyosis. Although most neonates with ARCI are collodion babies, severity of ARCI vary significantly from harlequin ichthyosis, the most severe and usually fatal form, to lamellar ichthyosis and congenital nonbullous ichthyosiform erythroderma. Infants with harlequin ichthyosis are often born prematurely and are encased in thick, hard, armor-like plates of cornified skin that severely restrict movement. The skin affection may lead to dehydration, infections, chronic blistering, overheating and rapid-calorie loss. Autosomal dominant ichthyosis, also called as bullous congenital ichthyosiform erythroderma or epidermolytic hyperkeratosis, is generally mild, later onset disease (no presentation as collodion baby) restricted to itching and psychological impact of having skin with an unusual appearance. Mutations in TGM1 explain 90% or more of severe lamellar ichthyosis and 34%-55% of all ARCI and ALOX12B and ALOXE3 genes are estimated to be involved in 17% of ARCI cases. Ichthyosis vulgaris (AD) and X-linked ichthyosis are the most common types of ichthyosis, with an estimated incidence of 1:250 births and 1:6,000 male births. ARCI including lamellar ichthyosis, congenital ichthyosiform erythroderma and harlequin ichthyosis has overall incidence of 1:200,000.

**Availability**

Results in 3-4 weeks. We do not offer a maternal cell contamination (MCC) test at the moment. We offer prenatal testing only for cases where the maternal cell contamination studies (MCC) are done by a local genetic laboratory. Read more: http://blueprintgenetics.com/faqs/#prenatal

**Gene set description**

<table>
<thead>
<tr>
<th>Gene</th>
<th>Associated phenotypes</th>
<th>Inheritance</th>
<th>ClinVar</th>
<th>HGMD</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABCA12</td>
<td>Ichthyosis, harlequin, Ichthyosis, lamellar</td>
<td>AR</td>
<td>21</td>
<td>111</td>
</tr>
<tr>
<td>ALG8</td>
<td>Congenital disorder of glycosylation</td>
<td>AR</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>ALOX12B</td>
<td>Ichthyosiform erythroderma, congenital, nonbullous</td>
<td>AR</td>
<td>17</td>
<td>63</td>
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<tr>
<td>ALOXE3</td>
<td>Ichthyosiform erythroderma, congenital, nonbullous</td>
<td>AR</td>
<td>10</td>
<td>21</td>
</tr>
<tr>
<td>CYP4F22</td>
<td>Ichthyosis, congenital</td>
<td>AR</td>
<td>6</td>
<td>20</td>
</tr>
<tr>
<td>EBP</td>
<td>Chondrodysplasia punctata, Male EBP disorder with neurologic defects (MEND)</td>
<td>XL</td>
<td>43</td>
<td>89</td>
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<tr>
<td>ERCC2</td>
<td>Xerodermia pigmentosa, Trichothiodystrophy, photosensitive</td>
<td>AR</td>
<td>18</td>
<td>90</td>
</tr>
<tr>
<td>FLG*</td>
<td>Ichthyosis vulgaris</td>
<td>AD/AR</td>
<td>24</td>
<td>92</td>
</tr>
</tbody>
</table>

https://blueprintgenetics.com/
**GJA1**
Oculodentodigital dysplasia mild type, Oculodentodigital dysplasia severe type, Syndactyly type 3

AD 23 103

**GJB2**
Deafness, Bart-Pumphrey syndrome, Keratoderma, palmoplantar, with deafness, Vohwinkel syndrome, Hystrix-like ichthyosis with deafness, Keratitis-ichthyosis-deafness syndrome

AD/AR/Digenic 96 385

**GJB3**
Deafness

AD/Digenic 8 37

**KRT1**
Palmoplantar keratoderma, nonepidermolytic, Ichthyosis, cyclic, with epidermolytic hyperkeratosis, Epidermolytic hyperkeratosis, Ichthyosis histrrix, Curth-Macklin, Keratosis palmoplantaris striata, Palmoplantar keratoderma, epidermolytic

AD 17 60

**KRT2**
Ichthyosis bullosa of Siemens, Ichthyosis exfoliativa

AD 8 18

**KRT9**
Knuckle pads, Palmoplantar keratoderma, epidermolytic

AD 13 29

**PEX7**
Refsum disease, Rhizomelic CDP type 1

AR 17 51

**PHYH**
Refsum disease

AR 9 36

**STS**
Steroid sulfatase deficiency

XL 7 68

**SUMF1**
Multiple sulfatase deficiency

AR 18 51

**TGM1**
Ichthyosis, congenital

AR 48 180

*Some regions of the gene are duplicated in the genome leading to limited sensitivity within the regions. Thus, low-quality variants are filtered out from the duplicated regions and only high-quality variants confirmed by other methods are reported out.* Read more.

Gene, refers to HGNC approved gene symbol; Inheritance to inheritance patterns such as autosomal dominant (AD), autosomal recessive (AR) and X-linked (XL); ClinVar, refers to a number of variants in the gene classified as pathogenic or likely pathogenic in ClinVar ([http://www.ncbi.nlm.nih.gov/clinvar/](http://www.ncbi.nlm.nih.gov/clinvar/)); HGMD, refers to a number of variants with possible disease association in the gene listed in Human Gene Mutation Database (HGMD, [http://www.hgmd.cf.ac.uk/ac/](http://www.hgmd.cf.ac.uk/ac/)). The list of associated (gene specific) phenotypes are generated from CDG ([http://research.nhgri.nih.gov/CGD/](http://research.nhgri.nih.gov/CGD/)) or Orphanet ([http://www.orpha.net/](http://www.orpha.net/)) databases.

### Non-coding disease causing variants covered by the panel

<table>
<thead>
<tr>
<th>Gene</th>
<th>Genomic location HG19</th>
<th>HGVS</th>
<th>RefSeq</th>
<th>RS-number</th>
</tr>
</thead>
<tbody>
<tr>
<td>GJB2</td>
<td>Chr13:20766921</td>
<td>c.-23+1G&gt;A</td>
<td>NM_004004.5</td>
<td>rs80338940</td>
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<tr>
<td>GJB2</td>
<td>Chr13:20766922</td>
<td>c.-23G&gt;T</td>
<td>NM_004004.5</td>
<td>rs786204734</td>
</tr>
<tr>
<td>GJB2</td>
<td>Chr13:20767159</td>
<td>c.-260C&gt;T</td>
<td>NM_004004.5</td>
<td></td>
</tr>
<tr>
<td>PEX7</td>
<td>Chr6:137143759</td>
<td>c.-45C&gt;T</td>
<td>NM_000288.3</td>
<td>rs267608252</td>
</tr>
</tbody>
</table>

### Test performance

Blueprint Genetics offers a comprehensive Ichthyosis Panel that covers classical genes associated with congenital ichthyosis, lamellar ichthyosis and multiple sulfatase deficiency. The genes are carefully selected based on the existing scientific evidence, our experience and most current mutation databases. Candidate genes are excluded from this first-line diagnostic test. The test does not recognise balanced translocations or complex inversions, and it may not detect low-level mosaicism. The test should not be used for analysis of sequence repeats or for diagnosis of disorders caused by mutations in the mitochondrial DNA.

Analytical validation is a continuous process at Blueprint Genetics. Our mission is to improve the quality of the sequencing.
process and each modification is followed by our standardized validation process. Average sensitivity and specificity in Blueprint NGS Panels is 99.3% and 99.9% for detecting SNPs. Sensitivity to for indels vary depending on the size of the alteration: 1-10bps (96.0%), 11-20 bps (88.4%) and 21-30 bps (66.7%). The longest detected indel was 46 bps by sequence analysis. Detection limit for Del/Dup (CNV) analysis varies through the genome depending on exon size, sequencing coverage and sequence content. The sensitivity is 71.5% for single exon deletions and duplications and 99% for three exons' deletions and duplications. We have validated the assays for different starting materials including EDTA-blood, isolated DNA (no FFPE) and saliva that all provide high-quality results. The diagnostic yield varies substantially depending on the used assay, referring healthcare professional, hospital and country. Blueprint Genetics’ Plus Analysis (Seq+Del/Dup) maximizes the chance to find molecular genetic diagnosis for your patient although Sequence Analysis or Del/Dup Analysis may be cost-effective first line test if your patient’s phenotype is suggestive for a specific mutation profile.

Bioinformatics

The sequencing data generated in our laboratory is analyzed with our proprietary data analysis and annotation pipeline, integrating state-of-the art algorithms and industry-standard software solutions. Incorporation of rigorous quality control steps throughout the workflow of the pipeline ensures the consistency, validity and accuracy of results. The highest relevance in the reported variants is achieved through elimination of false positive findings based on variability data for thousands of publicly available human reference sequences and validation against our in-house curated mutation database as well as the most current and relevant human mutation databases. Reference databases currently used are the 1000 Genomes Project (http://www.1000genomes.org), the NHLBI GO Exome Sequencing Project (ESP; http://evs.gs.washington.edu/EVS), the Exome Aggregation Consortium (ExAC; http://exac.broadinstitute.org), ClinVar database of genotype-phenotype associations (http://www.ncbi.nlm.nih.gov/clinvar) and the Human Gene Mutation Database (http://www.hgmd.cf.ac.uk). The consequence of variants in coding and splice regions are estimated using the following in silico variant prediction tools: SIFT (http://sift.jcvi.org), Polyphen (http://genetics.bwh.harvard.edu/pph2/), and Mutation Taster (http://www.mutationtaster.org).

Through our online ordering and statement reporting system, Nucleus, the customer can access specific details of the analysis of the patient. This includes coverage and quality specifications and other relevant information on the analysis. This represents our mission to build fully transparent diagnostics where the customer gains easy access to crucial details of the analysis process.

Clinical interpretation

In addition to our cutting-edge patented sequencing technology and proprietary bioinformatics pipeline, we also provide the customers with the best-informed clinical report on the market. Clinical interpretation requires fundamental clinical and genetic understanding. At Blueprint Genetics our geneticists and clinicians, who together evaluate the results from the sequence analysis pipeline in the context of phenotype information provided in the requisition form, prepare the clinical statement. Our goal is to provide clinically meaningful statements that are understandable for all medical professionals, even without training in genetics.

Variants reported in the statement are always classified using the Blueprint Genetics Variant Classification Scheme modified from the ACMG guidelines (Richards et al. 2015), which has been developed by evaluating existing literature, databases and with thousands of clinical cases analyzed in our laboratory. Variant classification forms the corner stone of clinical interpretation and following patient management decisions. Our statement also includes allele frequencies in reference populations and in silico predictions. We also provide PubMed IDs to the articles or submission numbers to public databases that have been used in the interpretation of the detected variants. In our conclusion, we summarize all the existing information and provide our rationale for the classification of the variant.

A final component of the analysis is the Sanger confirmation of the variants classified as likely pathogenic or pathogenic. This does not only bring confidence to the results obtained by our NGS solution but establishes the mutation specific test for family members. Sanger sequencing is also used occasionally with other variants reported in the statement. In the case of variant of uncertain significance (VUS) we do not recommend risk stratification based on the genetic finding. Furthermore, in the case VUS we do not recommend use of genetic information in patient management or genetic counseling. For some cases Blueprint Genetics offers a special free of charge service to investigate the role of identified VUS.

We constantly follow genetic literature adapting new relevant information and findings to our diagnostics. Relevant novel discoveries can be rapidly translated and adopted into our diagnostics without delay. These processes ensure that our
diagnostic panels and clinical statements remain the most up-to-date on the market.

**CPT codes**

SEQ 81479
DEL/DUP 81479

**ICD codes**

Commonly used ICD-10 codes when ordering the Ichthyosis Panel

<table>
<thead>
<tr>
<th>ICD-10</th>
<th>Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q80.9</td>
<td>Congenital ichthyosis</td>
</tr>
<tr>
<td>Q80.2</td>
<td>Lamellar ichthyosis</td>
</tr>
</tbody>
</table>

**Accepted sample types**

- EDTA blood, min. 1 ml
- Purified DNA, min. 5μg
- Saliva (Oragene DNA OG-500 kit)

Label the sample tube with your patient's name, date of birth and the date of sample collection.

Note that we do not accept DNA samples isolated from formalin-fixed paraffin-embedded (FFPE) tissue.

**Resources**

- [Foundation for ichthyosis and related skin types](https://www.foundations.org)
- [Ichthyosis Support Group](https://www.chronicks.org)
- [European Network for Ichthyosis](https://www.ichthyosis.org)
- [NORD - Lamellar Ichthyosis](https://www.nord.org)
- [NORD - Ichthyosis](https://www.nord.org)
- [NORD - Multiple Sulfatase Deficiency](https://www.nord.org)
- [Genereviews](https://www.genereviews.org)