TRANSFORMING GENETIC DATA into actionable PATIENT CARE

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Fulgent Genetics
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Mission

Developing flexible and affordable genetic testing that improves the everyday lives of those around us. Founded in 2011, Fulgent began with two simple ideas; flexibility and affordability. Today, we strive to create the most effective and wide ranging genetic tests on the market.
<table>
<thead>
<tr>
<th><strong>Fulgent Genetics</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Website</strong></td>
</tr>
<tr>
<td><strong>Year Founded</strong></td>
</tr>
<tr>
<td><strong>Headquarters</strong></td>
</tr>
<tr>
<td><strong>Company Type</strong></td>
</tr>
<tr>
<td><strong>NASDAQ</strong></td>
</tr>
<tr>
<td><strong>Company Size</strong></td>
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</tbody>
</table>
Who is Fulgent?

New approach in the genetic testing market

- Computer Science methodology of analysis and data management
- Experienced process engineering and qualitative business intelligence
- Experienced genetic diagnostic reporting and quality focused patient care
- Laboratory research grade pursuit for innovation and discovery
Who is Fulgent?
Over 100 hospitals from all over the world
## What We Do

| **SINGLE MUTATION** | • Single Mutation – detection status  
• Familial Known Mutation – requires proband/family information |
|---------------------|---------------------------------------------------------------|
| **SINGLE GENE**     | • 18,000+ orderable genes, sequencing and del/dup  
• 100% guaranteed coverage at 20x w/ fill-in |
| **PANELS**          | • 800+ preset panels  
• >96% guaranteed coverage at 20x |
| **EXOMES**          | • Clinical, reflex All-in-One: 4,500+ genes (“OMIM-ome”)  
• Whole, reflex Whole-in-One: 18,000+ genes |
| **HEREDITARY CANCER** | • Focus – 29 genes  
• Comprehensive – 123 genes |
| **CARRIER SCREENING** | • NGS w/ del/dup + RP-PCR for Fragile X  
• Three tiers: Focus, Extended, Comprehensive |
| **NEWBORN GENETIC ANALYSIS** | • 255 gene panel to complement standard newborn screening |
| **MITOCHONDRIAL GENOME** | • Entire mtDNA genome: 16,569 nucleotides, Mean Coverage: 10,000x  
• Minimum @ 1000x |
| **REPEAT EXPANSION** | • C9orf72, HTT, FMR1, DMPK, CNBP  
• Ataxia Repeat Expansion Analysis (15 genes) |
| **WHOLE GENOME**    | • High volume, research use  
• CLIA / CAP Validated |
| **SOMATIC CANCER**  | • Solid Tumor Molecular Profile – 170 genes; DNA and RNA assessment |
Main Components of the Human Genome

- LTR retrotransposons 8%
- DNA transposons 3%
- SINEs 13%
- simple sequence repeats 3%
- segmental duplications 5%
- miscellaneous heterochromatin 8%
- miscellaneous unique sequences 12%
- introns 26%
- LINEs 20%
- protein coding genes 1.5%
Inheritance

**Autosomal Dominant**
- A single mutation is sufficient to cause disease.
- Each child typically has a 50% chance of inheriting disease predisposition.

**Autosomal Recessive**
- An affected individual carries two mutations, one inherited from each parent.
- Carriers of a single recessive mutation are typically not affected.
- If both parents are carriers, each child has a 25% chance of being affected.

**X-Linked**
- Women carriers can pass on the mutation to their children, both male and female.
  - 50% of male offspring will be affected.
  - 50% of female offspring will be carriers.
Molecular Diagnostics in the 21st Century

- Drop in sequencing costs
- Explosion of gene discovery
- More patients can benefit from DNA testing
Next Generation Sequencing (Illumina)

“Solexa” (2006)
~1 Gb/wk

NovaSeq 6000 (2018)
8 Tb/40 hours
Sequencing Platforms

<table>
<thead>
<tr>
<th></th>
<th>3 NovaSeq</th>
<th>3 HiseqX</th>
<th>HiSeq4000</th>
<th>2 NextSeq</th>
<th>2 Miseq</th>
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</thead>
<tbody>
<tr>
<td>Total Reads PF</td>
<td>110-140B</td>
<td>36B-42B</td>
<td>11-12B</td>
<td>800-900M</td>
<td>40-54M</td>
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<tr>
<td>Total Data</td>
<td>24 Tb</td>
<td>6 Tb</td>
<td>1.6 Tb</td>
<td>300 GB</td>
<td>20 Gb</td>
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<tr>
<td>Weekly output (H27 panel samples)</td>
<td>240,000</td>
<td>n/a</td>
<td>8,000</td>
<td>3,000</td>
<td>n/a</td>
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</tbody>
</table>
Laboratory Processing Overview
<table>
<thead>
<tr>
<th>Focus</th>
<th>Gene Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Custom Comprehensive Cancer</td>
<td>up to 123</td>
</tr>
<tr>
<td>Breast and Ovarian Cancer Comprehensive</td>
<td>24</td>
</tr>
<tr>
<td>Colorectal Cancer Comprehensive</td>
<td>20</td>
</tr>
<tr>
<td>Endometrial Cancer Comprehensive</td>
<td>10</td>
</tr>
<tr>
<td>Fanconi Anemia Comprehensive</td>
<td>17</td>
</tr>
<tr>
<td>Gastric Cancer Comprehensive</td>
<td>14</td>
</tr>
<tr>
<td>Hematologic Malignancy Comprehensive</td>
<td>16</td>
</tr>
<tr>
<td>Melanoma Comprehensive</td>
<td>9</td>
</tr>
<tr>
<td>Nervous System / Brain Cancer Comprehensive</td>
<td>26</td>
</tr>
<tr>
<td>Full Comprehensive Cancer</td>
<td>123</td>
</tr>
<tr>
<td>Ovarian Cancer Comprehensive</td>
<td>18</td>
</tr>
<tr>
<td>Pancreatic Cancer Comprehensive</td>
<td>22</td>
</tr>
<tr>
<td>Paraganglioma-Pheochromocytoma Comprehensive</td>
<td>11</td>
</tr>
<tr>
<td>Prostate Cancer Comprehensive</td>
<td>12</td>
</tr>
<tr>
<td>Renal / Urinary Cancer Comprehensive</td>
<td>27</td>
</tr>
<tr>
<td>Sarcoma Comprehensive</td>
<td>26</td>
</tr>
<tr>
<td>Thyroid Cancer Comprehensive</td>
<td>7</td>
</tr>
</tbody>
</table>
The image shows a scatter plot with the Y-axis representing the probability of cure (%) and the X-axis representing the percentage of all cancers. Different cancer types are plotted, such as Testis, Thyroid, Melanoma, Bladder, Prostate, Breast, Kidney, Oral, Cervix/Uteri, Colon/rectum, Ovary, NHL, Nasopharynx, CNS, Brain, Leukemia, Myeloma, Esophagus, Pancreas, Liver, and Lung. The source of the information is stated as WHO.
Oncology Discovery
Ovarian Cancer

Deadly
- 204,449 New cases annually; 124,860 deaths

Incurable
- Less than 40% are cured

Difficult Dx
- Patients present with a suspicious/palpable mass

Early Dx is Key
- Five year survival is good if diagnosed early, but most patients are diagnosed late stage

Illumina Solution
- Develop a diagnostic assay which will diagnose ovarian cancer at an early stage
Personalized Cancer Therapy

1. Molecular Profiling

2. Prognostic Markers
   - Markers predictive of drug sensitivity/resistance
   - Markers predictive of adverse events

[Image showing silhouettes of people in different colors, indicating a process flow from molecular profiling to prognostic markers, followed by selection of appropriate treatments.]
# Classification of Tumors

<table>
<thead>
<tr>
<th>Tissue or origin</th>
<th>Benign</th>
<th>Malignant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epithelial tumours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Squamous epithelium</td>
<td>Squamous cell papilloma</td>
<td>Squamous cell carcinoma</td>
</tr>
<tr>
<td>2. Transitional epithelium</td>
<td>Transitional cell papilloma</td>
<td>Transitional cell carcinoma</td>
</tr>
<tr>
<td>3. Glandular epithelium</td>
<td>Adenoma</td>
<td>Adenocarcinoma</td>
</tr>
<tr>
<td>4. Basal cell layer skin</td>
<td>--</td>
<td>Basal cell carcinoma</td>
</tr>
<tr>
<td>5. Neuroectoderm</td>
<td>Naevus</td>
<td>Melanoma (melanocarcinoma)</td>
</tr>
<tr>
<td>6. Hepatocytes</td>
<td>Liver cell adenoma</td>
<td>Hepatoma (Hepatocellular carcinoma)</td>
</tr>
<tr>
<td>7. Placenta (chorionic epithelium)</td>
<td>Hydatidiform mole</td>
<td>Choriocarcinoma</td>
</tr>
</tbody>
</table>
Tumor Grading

Grading is based on

1. the degree of anaplasia
2. the rate of growth

- Grade-I: Well-differentiated (less than 25% anaplastic cells)
- Grade-II: Moderately-differentiated (25-50% anaplastic cells)
- Grade-III: Moderately-differentiated (50-75% anaplastic cells)
- Grade-IV: Poorly-differentiated or anaplastic (more than 75% anaplastic cells)
Tumor Molecular Profile

**Crizotinib or second generation ALK inhibitors**

**Dabrafenib, trametinib, vemurafenib**

**Erlotinib, gefitinib, afatinib, osimertinib**

**KRAS**

**None**

**Numerous clinical trials using inhibitors of MEK and other pathways in combination**

**Chemotherapy or immunotherapy**
Oncogenic Driver Mutations Impact Anticancer Therapy in Humans

**Lung Cancer**
- **EGFR mutation positive**
  - Gefitinib RR 71%
  - Mok et al. 2009
- **EGFR mutation negative**
  - Gefitinib RR 1%

**Melanoma**
- **BRAF**^{V600E}_+ melanoma patients treated with PLX4032 ≥ 240 mg BID
  - 6-month progression-free survival
  - Ph II Trial PLX-4032 PASCO ’09

*Images of chest X-rays from February 6, 2002 and February 11, 2002.*
Melanoma with BRAF Mutation Treated with PLX4032
Solid Tumor Molecular Profile

- 170 cancer genes
- DNA + RNA
- DNA mutations
- Gene amplifications
- Gene fusions
- Tumor mutation burden
Comprehensive Cardio Panels

ARRHYTHMIA

Comprehensive Arrhythmia
> Gene Count: 76

Arrhythmogenic Right Ventricular Cardiomyopathy
> Gene Count: 46

Catecholaminergic Polymorphic Ventricular Tachycardia
> Gene Count: 9

Long QT/Brugada Syndrome
> Gene Count: 34

Short QT Syndrome
> Gene Count: 6
HCM SCD in Athletes
Case Presentation

Autopsy
- Cardiac gross exam: asymmetric septal LVH
- Cardiac tissue histology: myofiber disarray

Normal: 
Deceased: 

Normal / Deceased
Personal Genomic Profile

5-7% people are positive for a clinically actionable DNA change

- **Cancer**: 60 genes
- **Cardio**: 77 genes
- **Carrier**: 30 genes
Personal Genomic Profile

65 Treatable Disorders

Cancer Syndromes
- Breast cancer
- Colorectal cancer
- Endometrial cancer
- Melanoma
- Ovarian cancer
- Pancreatic cancer
- Prostate cancer
- Thyroid cancer

Cardiovascular-Related Disorders
- Arrhythmia
- Cardiomyopathy
- Fabry disease
- Hypercholesterolemia
- Marfan/Loeys-Dietz syndrome
Beacon Carrier Screening Suite

>320 genes validated

“Test the highest number of relevant conditions with the best possible detection rate and turnaround time with competitive pricing.”
Carrier Screening Test Comparison

# of genes with highest reported detection rate

- BioReference Inerigen
- Counsyl FamilyPrepScreen
- Counsyl Forsight
- Fulgent Beacon Expanded
- LabCorp InherTest
- Natera Horizon 2.74
- Recombine CarrierMap
- SEMA4
Newborn Genetic Analysis

“Newborn screening saves or improves the lives of more than 12,000 infants in the United States each year.”
- Health Resources and Services Administration

This test is designed to:

- Evaluate sequencing variants and whole gene deletion/duplication
- Screen for conditions beyond standard newborn testing
- Only report diagnostic findings that are clinically actionable
- Serve as confirmatory/follow-up testing for an abnormal or inconclusive newborn screening result

Early diagnosis and intervention are key in preventing or reducing severe complications
### Newborn Genetic Analysis

Newborn Genetic Analysis covers conditions beyond standard newborn screening

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Example of Conditions</th>
<th>Treatment Options</th>
<th># of Genes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metabolic Disorders</td>
<td>Propionic acidemia, Carnitine palmitoyltransferase II (CPT II) deficiency, PKU, Congenital hypothyroidism</td>
<td>Dietary modifications, hormone replacement therapy, surgery</td>
<td>145</td>
</tr>
<tr>
<td>Blood Disorders</td>
<td>Thrombocytopenia, Spherocytosis, Hereditary hemorrhagic telangiectasia</td>
<td>Surveillance, transfusions</td>
<td>12</td>
</tr>
<tr>
<td>Hearing Loss</td>
<td>Connexin-related hearing loss, Pendred syndrome</td>
<td>Hearing aids and devices</td>
<td>18</td>
</tr>
<tr>
<td>Heart Conditions</td>
<td>Heart defects/malformations, Marfan syndrome</td>
<td>Surgery, increased surveillance</td>
<td>8</td>
</tr>
<tr>
<td>Immunodeficiency Disorders (SCID)</td>
<td>Agammaglobulinemia, Chronic granulomatous disease, Omenn syndrome</td>
<td>Prophylactic administration of antibiotics, bone marrow transplantation</td>
<td>22</td>
</tr>
<tr>
<td>Pediatric Cancers</td>
<td>Hemangioblastomas, Neurofibromatosis, Retinoblastoma, Xeroderma pigmentosum</td>
<td>Increased surveillance and screening</td>
<td>13</td>
</tr>
<tr>
<td>Epilepsy</td>
<td>Seizures, Encephalopathy</td>
<td>Routine monitoring, anti-epileptic medication</td>
<td>10</td>
</tr>
<tr>
<td>Vision Loss</td>
<td>Oculocutaneous albinism, Optic atrophy</td>
<td>Dietary management, vision aids, reduced sun exposure</td>
<td>4</td>
</tr>
<tr>
<td>Others</td>
<td>Cystic Fibrosis, Polycystic kidney disease, Spinal muscular atrophy, Usher syndrome</td>
<td>Surveillance, medication, transplantation</td>
<td>23</td>
</tr>
</tbody>
</table>
The Story of Nic Volker and the Dawn of Genomic Medicine

- Nic Volker a 6-year-old boy
  - Wounds in the intestine
  - 100 surgeries starting at age 4

- Undiagnosed and misdiagnosed for years

- Exome sequencing revealed mutation in the \textit{XIAP} gene

- Cord blood transplant saved the boy
Epigenetic regulation of development

Development & Lineage-Specification

Cell Type-Specific Gene Expression Programs

Cell Type A

Gene X

Gene Y

Gene Z

Gene AA

Gene ZZ

Cell Type B

Chromatin Structure & the Epigenome
Gut Microbiome
The Forgotten Endocrine Organ

- Trains Immune System
- Suppresses Pathogens
- Synthesizes Vitamins (K)
- Maintains Gut Barrier
- Regulates Brain and Gut Development (gene pool)
All these diseases have evidence for a role of the gut microbiota.

- Asthma/Eczema
- Inflammatory bowel disease
- Colon Cancer
- Heart disease
- Depression
- Non-alcoholic fatty liver disease
- Obesity
- Diabetes
The Future of Medicine
What about the future?

Present

5 Hours into Future
P4 MEDICINE:

**PREDICTIVE**
Genetic risks for many diseases are identified. Signs of illness are recognized, before it manifests. The effects of disease are known and planned for in advance.

**PERSONALIZED**
The focus of care is on the individual and how to optimize wellness by predicting disease and personalized treatments to prevent it.

**PREVENTIVE**
Individuals are given the tools to recognize the earliest signs of disease, when it’s most reversible.

**PARTICIPATORY**
Individuals are well informed about their health and better prepared to make their own health care decisions. This makes medicine far more efficient.
1990–2003
Human Genome Project

2004–2010

2011–2020

Beyond 2020

Understanding the structure of genomes
Understanding the biology of genomes
Understanding the biology of disease
Advancing the science of medicine
Improving the effectiveness of healthcare

Fulgent Genetics

Every gene tells a different story.

We believe that patients deserve customized testing for their individual clinical needs.

Our mission is to provide flexible and affordable testing options for personalized medicine.
Thank you.
Supporting Slides
Let’s change the world together.
Sequencing Applications

Integrative-Omics
Fulgent offers next generation sequencing for genomes, epigenomes, transcriptomes, metagenomes and microbiomes. By integrating multi-layers of omics, you discover novel insights into identification, characterization and progression wide-ranging biological conditions.

Population Genetics
Our understanding of genetic diversity has been significantly enhanced by high throughput NGS, which is advancing our understanding of genetic variation, epigenetic variation and metagenomic variation between different groups and ethnicities.
Sequencing Service Applications

Clinical Trials
NGS is becoming a powerful tool in initiatives to eradicate disease, and is unlocking new ways to look at data in clinical trials. Fulgent offers great clinical trials support through extensive expertise in developing and validating clinical assays, and through our ability to sequence large sample volumes at unbeatable turnaround times.

Biomarker Discover
Next generation sequencing allows for discovery of novel genes and transcripts that can serve as new targets for drug discovery and development. Fulgent combines high-throughput and high-resolution NGS services with extensive clinical expertise to provide solutions for biomarker discovery and validation.

Companion Diagnostics
Personalized medicine is advancing, and companion diagnostics are essential for the adoption of many new targeted therapies. At Fulgent, we can leverage the power of NGS and bioinformatics to develop and validate a new wave of powerful companion diagnostics solutions.
Locations

Los Angeles
Headquarters/Lab

Los Angeles
Bioinformatics

Atlanta
Curation

Texas
Backup Systems

UAE
Customer Service

Canada
Customer Service

Australia
Customer Service

Kingdom of Saudi Arabia
Customer Service

Belgium
Customer Service

China
Lab/Office