Adipose Tissue
Adipose tissue is a source of lipid storage and mobilization, consisting of specialized tissue able to produce heat (brown adipose). Adipose tissue has the intrinsic ability to produce and secrete an extensive number of adipocytokines. These adipocytokines consist of polypeptides, but also non-protein factors which are metabolically active. These factors span different functional categories including immunity (complement factors, haptoglobin), endocrine function (leptin, sex steroids, various growth factors), metabolic function (fatty acids, adiponectin, resistin), and cardiovascular function (angiotensinogen, PAI-1).

The Brain
As stated by Dr. Barry Levin, "the brain maintains a constant dialog with the external environment through in-puts from somatic sensation, taste, smell, sight, and sound and the body by inputs from the viscera. These signals are relayed to a variety of brain areas through hard-wired neural connections and are complemented by metabolic and hormonal inputs that reflect the metabolic status of the body. These metabolic sensing neurons are clustered in sites scattered throughout the brainstem and forebrain and are integrated into a distributed network that links them to afferent and efferent pathways involved in the control of energy homeostasis. These signals can be augmented and influenced by adipocytokines (e.g. leptin) and factors released from the gut and stomach.

The Intestine
The effects of gut-derived hormones on metabolic function and energy homeostasis are becoming increasingly well-characterized. Glucose-dependent insulinotropic polypeptide (GIP), an incretin hormone produced in the intestines, is an inhibitor of gastric acid secretion and a releaser of insulin during hyperglycemia. GIP also promotes energy storage in adipose tissue and plays a key role in high-fat diet (HFD)-induced obesity and insulin resistance. Glucagon-like peptide-1 (GLP-1) is a second incretin hormone produced in the intestines that stimulates insulin release from beta cells in the pancreas. In addition to its involvement with glucose homeostasis, GLP-1 reduces body weight and food intake and slows gastric emptying. PYY, a peptide also produced within the small intestine and rectum by L-cells, inhibits gut motility and is proposed to stimulate a significant central satiety response.

The Stomach
The stomach is responsible for producing ghrelin, the only known circulating orexigenic hormone. Ghrelin is acylated with a medium-chain fatty acid by the enzyme ghrelin O-acetyltransferase (GOAT) and displays a range of activity from central control of food intake to peripheral functions such as gastric emptying and insulin secretion.

The Pancreas
The pancreas may have the most obvious involvement in energy homeostasis. The pancreas is responsible for secretion of insulin and glucagon, two counteregulatory hormones that control systemic concentration of glucose, a metabolic intermediate used by cells as the primary source of energy. The pancreas releases insulin and glucagon directly based on concentration of glucose in the blood. Not only is insulin secretion regulated in this direct fashion, it is also controlled by the previously mentioned incretins (GIP and GLP-1), a group of gastrointestinal hormones that cause an increase in the amount of insulin released from beta cells after eating, even before blood glucose levels become elevated.

The Liver
Pancreatic function is tightly coordinated with liver function as it is responsible for releasing glucagon when blood sugar (glucose) levels fall too low. Glucagon, the counterpart of insulin, prompts the liver to convert stored glycogen into glucose, causing release into the bloodstream.

References
1. Central Regulation of Energy Homeostasis Intelligent Design: How to Build the Perfect Survivor Barry E. Levin*
4. AJP - Endo May 1, 2010 vol. 298 no. 5 E909-E919
Testing Solutions to Measure Energy Homeostasis Biomarkers

Energy homeostasis is a well-regulated process dependent upon the coordination between feeding behavior and energy expenditure. Research around energy homeostasis, including the impact that conditions such as diabetes and obesity have on this complex process, has grown significantly in recent years.

<table>
<thead>
<tr>
<th>Adiponectin</th>
<th>Species</th>
<th>Catalog #</th>
<th>Sample Types</th>
<th>Size</th>
<th>Incubation</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adiponectin ELISA</td>
<td>Rat</td>
<td>22-ADPRT-E01</td>
<td>Plasma, Serum</td>
<td>5 µL</td>
<td>2hr 30min</td>
<td>0.25 - 10 ng/mL</td>
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<tr>
<td>Adiponectin Total ELISA</td>
<td>Mouse</td>
<td>22-ADPM5-E01</td>
<td>Plasma, Serum, Cell Culture</td>
<td>&lt;5 µL</td>
<td>2hr 30min</td>
<td>0.025 – 1 ng/mL</td>
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<td>Adiponectin HMW &amp; Total ELISA</td>
<td>Human</td>
<td>80-ADPHU-E01</td>
<td>Citrate Plasma, EDTA Plasma, Heparin Plasma, Serum</td>
<td>50 µL</td>
<td>2hr 30min- 3hr</td>
<td>0.078 - 5 ng/mL</td>
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<tr>
<th>C-peptide</th>
<th>Species</th>
<th>Catalog #</th>
<th>Sample Types</th>
<th>Size</th>
<th>Incubation</th>
<th>Range</th>
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<tr>
<td>C-peptide ELISA**</td>
<td>Human</td>
<td>80-CPTHU-E01.1</td>
<td>Plasma, Serum</td>
<td>25 µL</td>
<td>2hr</td>
<td>60 - 9,000 pg/mL</td>
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<tr>
<td>C-peptide ELISA</td>
<td>Mouse</td>
<td>80-CPTMS-E01</td>
<td>Serum</td>
<td>10 µL</td>
<td>2hr 15min</td>
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<tr>
<td>C-peptide ELISA</td>
<td>Rat</td>
<td>80-CPTRT-E01</td>
<td>Serum</td>
<td>10 µL</td>
<td>2hr 15min</td>
<td>150 -13,500 pg/mL</td>
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<td>C-peptide Chemiluminescence ELISA*</td>
<td>Human</td>
<td>80-CPTHU-CH01</td>
<td>Plasma, Serum, Cell Culture</td>
<td>50 µL</td>
<td>3hr</td>
<td>4.5 - 12,960 pg/mL</td>
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<th>Ghrelin</th>
<th>Species</th>
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<th>Size</th>
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<th>Range</th>
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</thead>
<tbody>
<tr>
<td>Acylated Ghrelin ELISA</td>
<td>Human</td>
<td>32-5106</td>
<td>Plasma</td>
<td>100 µL</td>
<td>3hr</td>
<td>1.95 - 250 pg/mL</td>
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<tr>
<td>Acylated Ghrelin ELISA</td>
<td>Mouse/Rat</td>
<td>32-5117</td>
<td>Plasma</td>
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<td>3hr</td>
<td>1.95 - 250 pg/mL</td>
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<tr>
<td>Non-Acylated Ghrelin ELISA</td>
<td>Human</td>
<td>32-5119</td>
<td>Plasma</td>
<td>10 µL</td>
<td>3hr</td>
<td>1.95 - 250 pg/mL</td>
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<td>Non-Acylated Ghrelin ELISA</td>
<td>Mouse/Rat</td>
<td>32-5118</td>
<td>Plasma</td>
<td>10 µL</td>
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<table>
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<tr>
<th>GIP</th>
<th>Species</th>
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<th>Sample Types</th>
<th>Size</th>
<th>Incubation</th>
<th>Range</th>
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</thead>
<tbody>
<tr>
<td>Active GIP ELISA</td>
<td>Human</td>
<td>48-AGIPHU-E01</td>
<td>Cell Culture, Plasma</td>
<td>50 µL</td>
<td>3 hr 30 min</td>
<td>3.9 - 250 pg/mL</td>
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<tr>
<td>Active GIP ELISA</td>
<td>Mouse</td>
<td>48-AGIPMS-E01</td>
<td>Cell Culture, Plasma</td>
<td>25 µL</td>
<td>3 hr 30 min</td>
<td>7.8 - 500 pg/mL</td>
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<tr>
<td>Active GIP ELISA</td>
<td>Rat</td>
<td>48-AGIPRT-E01</td>
<td>Cell Culture, Plasma</td>
<td>50 µL</td>
<td>3 hr 30 min</td>
<td>3.9 - 250 pg/mL</td>
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<tr>
<td>Total GIP ELISA</td>
<td>Human</td>
<td>48-GIPHU-E01</td>
<td>Cell Culture, EDTA Plasma</td>
<td>50 µL</td>
<td>3 hr 30 min</td>
<td>3.1 - 200 pM</td>
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<tr>
<td>Total GIP ELISA</td>
<td>Mouse</td>
<td>48-GIPMS-E01</td>
<td>Cell Culture, EDTA Plasma</td>
<td>10 µL</td>
<td>Overnight</td>
<td>2.5 - 600 pM</td>
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<tr>
<td>Total GIP ELISA</td>
<td>Rat</td>
<td>48-GIPRT-E01</td>
<td>Cell Culture, EDTA Plasma</td>
<td>50 µL</td>
<td>3 hr 30 min</td>
<td>3.1 - 200 pM</td>
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<table>
<thead>
<tr>
<th>GLP</th>
<th>Species</th>
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<th>Sample Types</th>
<th>Size</th>
<th>Incubation</th>
<th>Range</th>
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</thead>
<tbody>
<tr>
<td>GLP-1 Active (7-36)</td>
<td>Human/Mouse/Rat</td>
<td>80-GLP1A-CH01</td>
<td>EDTA Plasma</td>
<td>25 µl</td>
<td>&lt;3hr</td>
<td>0.45 - 151.6 pmol/L</td>
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<tr>
<td>GLP-1 Active (7-36) ELISA</td>
<td>Human</td>
<td>43-GP1HU-E01</td>
<td>Plasma</td>
<td>100 µL</td>
<td>Overnight</td>
<td>0.64 - 48 pmol/L</td>
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<tr>
<td>GLP-1 Total (7-36 and 9-36) ELISA</td>
<td>Human</td>
<td>43-GPThU-E01</td>
<td>Plasma</td>
<td>100 µL</td>
<td>Overnight</td>
<td>2.1 - 54 pmol/L</td>
</tr>
</tbody>
</table>

Assays are for Research Use Only unless otherwise noted.
*FDA Class I Exempt Device. For In Vitro Diagnostic Use. +Available in bulk packaging (10 plates/kit)
### GLP-2 ELISA
- **Species:** Human
- **Catalog #:** 48-GP2HU-E01.1
- **Sample Types:** Plasma, Serum
- **Size:** 25 µL
- **Incubation:** Overnight
- **Range:** 0.412 - 100 ng/mL

### GLP-2 ELISA
- **Species:** Mouse
- **Catalog #:** 48-GP2MS-E01
- **Sample Types:** Plasma, Serum
- **Size:** 25 µL
- **Incubation:** Overnight
- **Range:** 0.412 - 100 ng/mL

### GLP-2 ELISA
- **Species:** Rat
- **Catalog #:** 48-GP2RT-E01
- **Sample Types:** Plasma, Serum
- **Size:** 25 µL
- **Incubation:** Overnight
- **Range:** 0.137 - 100 ng/mL

### Glucagon ELISA
- **Species:** Human/Mouse/Rat
- **Catalog #:** 48-GLUHU-E01
- **Sample Types:** Plasma
- **Size:** 100 µL
- **Incubation:** Overnight
- **Range:** 41 - 10,000 pg/mL

### Glucagon Ultrasensitive ELISA
- **Species:** Human/Mouse/Rat
- **Catalog #:** 48-GLUHUU-E01
- **Sample Types:** Plasma, Serum
- **Size:** 10 µL
- **Incubation:** Overnight
- **Range:** 7.8 - 500 pg/mL

### Glucagon RIA*
- **Species:** Human
- **Catalog #:** 38-GLUHU-R100
- **Sample Types:** Plasma
- **Size:** 200 µL
- **Incubation:** Overnight
- **Range:** 4.7 - 150 pmol/L

### Insulin ELISA
- **Species:** Human
- **Catalog #:** 35-INAHU-E01
- **Sample Types:** Serum
- **Size:** 10 µL
- **Incubation:** 1hr
- **Range:** 3 - 300 U/mL

### Insulin Autoantibody ELISA
- **Species:** Human
- **Catalog #:** 21-IAAHU-E01
- **Sample Types:** Serum
- **Size:** 25 µL
- **Incubation:** Overnight
- **Range:** Cut-off

### Insulin ELISA
- **Species:** Bovine
- **Catalog #:** 80-INSBO-E01
- **Sample Types:** Plasma, Serum
- **Size:** 25 µL
- **Incubation:** 2hr 15 min
- **Range:** 0.25 - 6.0 ng/mL

### Insulin ELISA*
- **Species:** Human
- **Catalog #:** 80-INSHU-E01.1
- **Sample Types:** Plasma, Serum
- **Size:** 25 µL
- **Incubation:** 2hr
- **Range:** 3 - 200 µU/mL

### Insulin ELISA+ Mouse
- **Catalog #:** 80-INSMS-E01
- **Sample Types:** Plasma, Serum
- **Size:** 10 µL
- **Incubation:** 2hr
- **Range:** 0.188 - 6.9 ng/mL

### Insulin ELISA Rat
- **Catalog #:** 80-INSRT-E01
- **Sample Types:** Plasma, Serum
- **Size:** 10 µL
- **Incubation:** 2hr
- **Range:** 0.15 - 5.5 ng/mL

### Insulin High Range ELISA+
- **Species:** Mouse
- **Catalog #:** 80-INSMSH-E01
- **Sample Types:** Plasma, Serum
- **Size:** 5 µL
- **Incubation:** 2hr 15 min
- **Range:** 3 - 150 ng/mL

### Insulin High Range ELISA+
- **Species:** Rat
- **Catalog #:** 80-INSRTH-E01
- **Sample Types:** Plasma, Serum
- **Size:** 5 µL
- **Incubation:** 2hr
- **Range:** 3 - 150 ng/mL

### Insulin Ultrasensitive ELISA*
- **Species:** Human
- **Catalog #:** 80-INSHUU-E01.1
- **Sample Types:** Plasma, Serum
- **Size:** 25 µL
- **Incubation:** 2hr 30 min
- **Range:** 0.15 - 20 µU/mL

### Insulin Ultrasensitive ELISA+
- **Species:** Mouse
- **Catalog #:** 80-INSMSU-E01
- **Sample Types:** Plasma, Serum
- **Size:** 5 µL
- **Incubation:** 2hr 30 min
- **Range:** 0.19 - 6.9 OR 0.025 - 1.25 ng/mL

### Insulin Ultrasensitive ELISA+
- **Species:** Rat
- **Catalog #:** 80-INSRTU-E01
- **Sample Types:** Plasma, Serum
- **Size:** 5 µL
- **Incubation:** 2hr 30 min
- **Range:** 0.15 - 5.5 OR 0.02 - 1.0 ng/mL

### Insulin Chemiluminescence ELISA*
- **Species:** Human
- **Catalog #:** 80-INSHU-CH01
- **Sample Types:** Heparin Plasma, Serum, Tissue Culture
- **Size:** 25 µL
- **Incubation:** 1hr 35 min
- **Range:** 5 - 30,000 pg/mL

### Leptin ELISA
- **Species:** Human
- **Catalog #:** 11-LEPHU-E01
- **Sample Types:** Serum
- **Size:** 20 µL
- **Incubation:** 1hr 45 min
- **Range:** 1 - 100 ng/mL

### Leptin ELISA Mouse/Rat
- **Catalog #:** 22-LEPMS-E01
- **Sample Types:** Serum
- **Size:** 5 µL
- **Incubation:** 3hr
- **Range:** 25 - 1600 pg/mL
<table>
<thead>
<tr>
<th>Assay</th>
<th>Species</th>
<th>Catalog #</th>
<th>Sample Types</th>
<th>Size</th>
<th>Incubation</th>
<th>Range</th>
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</thead>
<tbody>
<tr>
<td>Leptin Ultrasensitive ELISA</td>
<td>Human</td>
<td>22-LEPHUU-E01</td>
<td>Biological Fluids, Plasma, Serum</td>
<td>25 µL</td>
<td>1hr 45min</td>
<td>0.05 - 5 ng/mL</td>
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<tr>
<td>Bioactive Leptin ELISA</td>
<td>Human</td>
<td>22-BLEPHU-E01</td>
<td>EDTA Plasma, Heparin Plasma, Serum</td>
<td>15 µL</td>
<td>4hr</td>
<td>0.05 - 6 ng/mL</td>
</tr>
</tbody>
</table>

### Proinsulin

| Proinsulin (Intact) ELISA*    | Human   | 82-PINHUI-E01   | Plasma, Serum                       | 50 µL | 3h 30 min   | 0.3 - 100 pM  |
| Proinsulin (Total) ELISA      | Human   | 82-PINHUT-E01   | Plasma, Serum                       | 50 µL | 3h 15 min   | 0.5 - 250 pM  |
| Proinsulin (Total) Chemiluminescence ELISA* | Human | 80-PINHUT-CH01 | EDTA Plasma, Serum, Tissue Culture  | 50 µL | 2hr 31min   | 5 - 3000 pg/mL|

### PYY

| PYY ELISA                     | Human   | 48-PYYHU-E01.1 | Plasma, Serum                       | 50 µL | Overnight   | 0.082 - 20 ng/mL|
| PYY ELISA Mouse/Rat           | Mouse/Rat | 48-PYYRT-E01.1 | Plasma, Serum                       | 25 µL | Overnight   | 0.15 - 12.5 ng/mL|

### RBP

| RBP ELISA                     | Human   | 30-6110        | Plasma, Serum, Urine                | 20 µL | 2hr 20min   | 1.1 - 33 µg/L |
| RBP 4 ELISA                   | Mouse   | 41-RBPMS-E01   | Plasma, Serum                       | 5 µL  | 1hr 10min   | 0.625 - 20 ng/ml|

### Other

| Adipocyte Fatty Acid Binding Protein ELISA | Human | 32-5181 | Cell Culture, Plasma, Serum | 20 µL | 2hr 30min | 0.5 - 25 ng/mL |
| Islet Cell Antibody ELISA           | Human | 21-ICAHU-E01 | Serum                              | 25 µL | 2hr 30min | Cut-off |
| Intact FGF-21 ELISA                 | Human | 43-FGFHU-E01 | Cell Culture, Plasma, Serum        | 100 µL | 2hr 35min | 32.5 - 2000 pg/mL |
| L-Arginine ELISA                   | Human | 30-7733 | EDTA Plasma                        | 25 µL | Overnight | 12.5 - 300 µmol/L |
| Obestatin ELISA                    | Human | 48-OBEHU-E01 | Plasma, Serum                      | 20 µL | Overnight | 0.231 - 25 ng/mL |
| Obestatin ELISA Mouse/Rat          | Mouse/Rat | 48-OBEMS-E01 | Serum                              | 25 µL | Overnight | 0.082 - 20 ng/mL |
| Pancreatic Polypeptide RIA          | Human | 38-PPTHU-R100 | Serum                              | 100 µL | Overnight | 6.25 - 200 pmol/L |
| Resistin ELISA                    | Rat    | 32-5179      | Cell Culture                        | 10 µL | 2hr 30min | 0.25 - 20 ng/mL |
| Resistin Ultrasensitive ELISA      | Human | 22-RESHUU-E01 | Cell Culture, Plasma, Serum        | 20 µL | 4hr        | 20 - 1000 pg/mL |
| Somatostatin RIA                   | Human | 38-RB 306RUO | Plasma                             | 1 mL  | Overnight  | 0 - 125 pmol/L |
| Total 25-OH Vitamin D ELISA*       | Human | 38-25DHU-E01 | Serum                              | 50 µL | 2 hr 45 min | 10-180 ng/mL |
| 25-OH Vitamin D ELISA             | Rat    | 38-25DRT-E01 | Serum                              | 50 µL | 2 hr 45 min | 5.3-133.0 ng/mL |

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