PROBLEMS WITH THE IMMUNE SYSTEM

Blood Types, Transplants, Allergies, Autoimmune diseases, Immunodeficiency Diseases
BLOOD GROUPS AND TRANSFUSIONS

- Antigens on red blood cells determine whether a person has type A, B, AB, or O blood.
- Antibodies to nonself blood types exist in the body.
- Transfusion with incompatible blood leads to destruction of the transfused cells.
- If bloods of incompatible types are mixed, recipient’s immune system will attack and destroy donor cells.

<table>
<thead>
<tr>
<th>ABO Blood Groups</th>
<th>Antigen (on RBC)</th>
<th>Antibody (in plasma)</th>
<th>Blood Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Antigen A</td>
<td>Anti-A Antibody</td>
<td>Type A: Cannot have B or AB blood, Can have A or O blood</td>
</tr>
<tr>
<td></td>
<td>Antigen B</td>
<td>Anti-B Antibody</td>
<td>Type B: Cannot have A or AB blood, Can have B or O blood</td>
</tr>
<tr>
<td></td>
<td>Antigens A + B</td>
<td>Neither Antibody</td>
<td>Type AB: Can have any type of blood, Is the universal recipient</td>
</tr>
<tr>
<td></td>
<td>Neither A or B</td>
<td>Both Antibodies</td>
<td>Type O: Can only have O blood, Is the universal donor</td>
</tr>
</tbody>
</table>
**Rh BLOOD TYPE**

- Based on the presence or absence of Rh marker on red cells
- Can cause problems during pregnancy
  - If mother is Rh negative
  - Has previously carried Rh positive child
  - Is carrying fetus that is Rh positive
- Mother’s antibodies can attack fetal cells
1. Rh+ father.
2. Rh− mother carrying her first Rh+ fetus. Rh antigens from the developing fetus can enter the mother’s blood during delivery.
3. In response to the fetal Rh antigens, the mother will produce anti-Rh antibodies.
4. If the woman becomes pregnant with another Rh+ fetus, her anti-Rh antibodies will cross the placenta and damage fetal red blood cells.
• **Major histocompatibility complex (MHC),** group of genes that code for proteins found on the surfaces of cells that help the immune system recognize foreign substances. MHC proteins are found in all higher vertebrates.
  • Britannica/science
TISSUE AND ORGAN TRANSPLANTS

- An infected cell or a phagocytic cell will “present” the antigen on their own cell surface in a MHC molecule to “show” leukocytes what to look for in binding antigens.
TISSUE AND ORGAN TRANSPLANTS

• MHC molecules stimulate rejection of tissue grafts and organ transplants
• Chances of successful transplantation increase if donor and recipient MHC tissue types are well matched
• Immunosuppressive drugs facilitate transplantation
• Lymphocytes in bone marrow transplants may cause a graft versus host reaction in recipients
TISSUE AND ORGAN TRANSPLANTS

Human Skin

Human Kidney
Is this OK?

Corneas: from USD $30,000
Lungs: from USD $150,000
Heart: from USD $130,000
Liver: from USD $98,000
Kidneys: from USD $62,000

Source: Bloody Harvest Matas & Kilgour (2007)

CHOICE CUTS

Researchers are looking to source an increasing variety of living tissues, including solid organs, from pigs. Many are attempting to genetically engineer the animals to reduce the risk of rejection and infection in humans.

CORNEA
Pig corneas were approved for marketing in China in April.

LUNG
A factory farm is being designed to produce 1,000 pig lungs per year.

KIDNEY
A kidney with six genetic modifications supported a baboon’s life for 4 months.

HEART
A genetically modified pig heart implanted in a baboon’s abdomen survived for 2.5 years.

LIVER
Livers could be engineered to produce their own antibodies against primate immune cells.

PANCREAS
Phase III clinical trials of insulin-producing islet cells are under way.
Why do people have seasonal allergies? - Eleanor Nelsen

https://www.youtube.com/watch?v=-q7Fz7NIMWM
ALLERGIES

- Allergies are exaggerated (hypersensitive) responses to antigens called allergens.

- In localized allergies, antibodies produced after first exposure to an allergen attach to receptors on mast cells (a type of WBC).

Asthma  Hives  Food  Eczema
ALLERGIES

- The next time the allergen enters the body, it binds to mast cell (with associated IgE antibodies)
- Mast cells release histamine which causes vascular changes leading to typical allergy symptoms
- An acute allergic response can lead to anaphylactic shock, a life-threatening reaction that can occur within seconds of allergen exposure
Common Allergy Symptoms

- Fatigue
- Frequent Headaches
- Sneezing
- Postnasal Drainage
- Itching of the Nose
- Frequent "Colds"
- Recurrent Ear Infections
- Recurrent Cough or Bronchitis

- Chronic Sinus Infections
- Dizziness
- Dark Circles Under the Eyes
- Itching, Watering, Redness or Swelling of the Eyes
- Tightness in the Chest, Wheezing or Asthma
- Eczema, Skin Rashes, Itching, or Hives

How pollen makes us sneeze and wheeze

1. Pollen enters eyes, nose, lungs, sensitizing the immune system.
2. Specific antibodies to the pollen are produced.
3. Antibodies attach to mast cells found in tissues.
4. Pollen enters the body again, attaches to antibodies, causing histamine and other chemicals to be released from mast cells.
5. Allergic reaction is triggered, resulting in runny eyes and nose, throat and nose itching, sneezing, nose and sinus congestion and asthma symptoms.

Source: American Academy of Allergy, Asthma and Immunology
AUTOIMMUNE DISORDER

• A condition that occurs when the immune system mistakenly attacks and destroys healthy body tissue
  • More than 80 different types!
• The immune system can’t tell the difference between healthy body tissue and antigens
The result is an immune response that destroys normal body tissues.
The response is a hypersensitivity reaction similar to the response in allergic conditions.

Examples of autoimmune (or immune-related) disorders:
- Addison’s disease
- Celiac disease (gluten-sensitive enteropathy)
- Graves disease
- Hashimoto’s thyroiditis
- Multiple sclerosis
- Myasthenia gravis
- Pernicious anemia
- Rheumatoid arthritis
- Systemic lupus erythematous
- Type I diabetes
**AUTOIMMUNE DISORDER**

**Celiac Disease**

A. In a healthy person, nutrients get absorbed by villi in the small intestine and go into the bloodstream.

B. In a person with Celiac Disease, the villi have been damaged by inflammation, so fewer nutrients pass into the bloodstream.

**Multiple Sclerosis**

Normal and Multiple Sclerosis: Damaged Myelin
AUTOIMMUNE DISORDER

Rheumatoid arthritis

Type I Diabetes

Type 1 Diabetes

Healthy

Diabetic

Pancreas produces insulin

Insulin moves glucose to cells

Glucose in the blood

Pancreas cannot produce insulin

Immune cells destroy beta cells in the pancreas

More glucose in the blood
IMMUNODEFICIENCY DISEASES

- Primary immunodeficiency results from hereditary or congenital defects that prevent proper functioning of immune defense
- Secondary (or acquired) immunodeficiency results from exposure to chemical and biological agents
• Prevents your body from fighting infections and diseases. This type of disorder makes it easier for you to catch viruses and bacterial infections.
IMMUNODEFICIENCY DISEASES

Primary Examples
- X-linked agammaglobulinemia (XLA)
- common variable immunodeficiency (CVID)
- severe combined immunodeficiency (SCID), which is known as alymphocytosis or “boy in a bubble” disease

Secondary Examples
- AIDS
- Cancers of the immune system, like leukemia
- Immune-complex diseases, like viral hepatitis
- Multiple myeloma (cancer of the plasma cells, which produce antibodies)