A Comparison of the Frequency Distribution of Blood Types on Parvus to Frequency Distributions of Blood Types on Nearby Islands
Blood

• Type of connective tissue
• Five liters in the body
• Product of bone marrow
• Mixture of cells
  • Plasma: 55%
  • Platelets: <1%
  • White Blood Cells (WBCs): <1%
  • Red Blood Cells (RBCs): 45%
Plasma

- Straw-colored fluid
- Water accounts for 90%
- Proteins make up 8%
- Enzymes make up 2%
- Carbohydrates and nutrients transported
Platelets

• Are small, irregular-shaped fragments of cells
• Can circulate through the blood for up to 9 days
• Can be activated to form a blood clot
White Blood Cells

• Vary in shape, size, and function
• Have a nucleus
• Are pale in color
• Have short lifespans (a few hours to a few days)
Red Blood Cells

• Are biconcave disks without nuclei
• Circulate for about 120 days
• Produce 2-3 million per second
• Fit through any blood vessel
• Are red in color
Purpose of Blood

• Part of the Circulatory System
  • Transport oxygen, nutrients and waste
  • Regulates blood pressure, body heat, and pH levels
  • Protects body by forming clots

• Part of the Immune System
  • Transports WBCs
  • Regulates WBCs production
  • Protects body by immune responses
Immune System

• Defense against pathogens

• Two ways to fight pathogens
  • Innate Immunity
    • Immediate reaction
    • Barrier defenses
  • Acquired Immunity
    • Delayed reaction
    • Uses WBC
    • Remembers previous exposure
Antigens and Immunity

- Molecules attached to cell membranes
- Two types of antigens
  - Self-Antigens
  - Foreign Antigens
Antigens in the Blood

• Self-Antigens
  • Hereditary
  • Located on RBC membranes
  • Give different blood types

• Foreign Antigens
  • Enter body various ways, ie. virus, bacteria, pregnancy, transplants and transfusions
  • Causes antibody response
Antibodies and Immunity

• Y-shaped proteins
• Produced by WBCs
• Patrol body in the plasma
• Mark foreign antigens for destruction

1. Antibodies coat free virus particles. The virus envelope cannot fuse with the host cell membrane.
2. The antibody-coated virus is recognized and phagocytosed by a macrophage.
Blood Transfusions

- Blood loss, i.e. injury or surgery
- Donor- gives blood
- Recipient- receives blood
- Blood must be compatible for a successful transfusion
Incompatible Blood

• Causes an Immune reaction
  • Donor blood antigens recognized as foreign
  • Donor blood is marked by antibodies and clumps (agglutination)
  • Donor blood is destroyed by WBCs

• Effects of incompatible blood
  • Mild: Chills, fever, shaking, or aching
  • Severe: Kidney failure, shock, circulatory collapse, or death
Causes for Incompatible Blood

• Antigens on RBCs determine blood groups and blood types
• Over 22 known blood groups
  • Genetically-inherited
  • A gene produces each antigen
  • Multiple antigens on RBCs
• ABO and Rh blood groups
  • Tested before transfusion
  • Transfusion reactions
ABO Blood Group

• Two antigens: A or B
• Four possible blood types
  • Type O – No antigens present
  • Type B – B antigen present
  • Type A – A antigen present
  • Type AB – A and B antigens present
Rh Blood Group

• One antigen: Rh D
• Two possible blood types
  • Positive – Rh D antigen present
  • Negative – Rh D antigen absent
Eight ABO/Rh Blood Types

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<th>O-</th>
<th>A-</th>
<th>B-</th>
<th>AB-</th>
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Blood Typing Tests

• Two tests to determine antigens present
• Determine compatible blood types for transfusions
• Compatible blood does not cause an immune reaction
ABO Test

• Determine if A or B antigens are present
• Mix blood with serums containing A and B antibodies
• Watched for immune reactions (agglutination)
• Immune reaction = antigens present
• No immune reaction = no antigens present
Rh D Test

- Determine if Rh D antigens are present
- Mix blood with a serum containing Rh D antibodies
- Watched for immune reactions (agglutination)
- Immune reaction = antigens present
- No immune reaction = no antigens present
Blood Type Compatibility

• Donor blood
  • Have the same antigens
  • Lack antigens
  • Cause no antibody reactions
• O- is the universal donor
• AB+ is the universal recipient
What is Cross-Matching?

- Complete before a transfusion
- Mix donor and recipient blood
- Watch for immune reactions (agglutination)
  - No immune reaction = compatible blood
  - Immune reaction = incompatible blood
- Are over 20 untested blood groups
Frequency Distribution of Blood Types

• Percentage of the population with each blood type
  • Helpful for blood banks
    • Know needs of population
    • Have needed blood in stock
  • Comparisons between populations

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<th>Blood Type</th>
<th>% of population</th>
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<td>A-</td>
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<td>O+</td>
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<td>O-</td>
<td>50</td>
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Similar Frequency Distributions

• Good blood source
• More compatible blood types
• Fewer transfusion reactions
• More efficient and less waste
Island of Parvus

- Isolated island with no medical facilities performing blood transfusions
- High mortality rates after disasters
- Need for a blood bank for transfusions
- Blood type frequency distribution of the islanders is unknown
Accola and Geminus Archipelagos

- Islands able to donate blood
  - Accola Archipelago – Bella and Cristo Islands
  - Geminus Archipelago – Magnus, Fugo, Lea, and Rea Islands

- Known blood frequency distributions
  - Accola Archipelago – high percentage of O blood types
  - Geminus Archipelago – high percentage of B blood types
Purpose

• Find the frequency distribution of blood types on Parvus
• Compare this frequency distribution to the known frequency distributions of other islands
• Find a suitable blood source for Parvus
Accola Archipelago Hypotheses

- Parvus x Bella
- Parvus x Cristo
Hypotheses: Bella

• $H_0$: There will be no significant difference in the frequency distributions of blood types between Bella and Parvus.

• $H_1$: There will be a significant difference in the frequency distributions of blood types between Bella and Parvus.
Hypotheses: Cristo

- $H_0$: There will be no significant difference in the frequency distributions of blood types between Cristo and Parvus.
- $H_1$: There will be a significant difference in the frequency distributions of blood types between Cristo and Parvus.
Geminus Archipelago Hypotheses

- Parvus x Magnus
- Parvus x Fugo
- Parvus x Lea
- Parvus x Rea
Hypotheses: Magnus

• $H_0$: There will be no significant difference in the frequency distributions of blood types between Magnus and Parvus.

• $H_1$: There will be a significant difference in the frequency distributions of blood types between Magnus and Parvus.
Hypotheses: Fugo

• $H_0$: There will be no significant difference in the frequency distributions of blood types between Fugo and Parvus.

• $H_1$: There will be a significant difference in the frequency distributions of blood types between Fugo and Parvus.
Hypotheses: Lea

\( H_0 \): There will be no significant difference in the frequency distributions of blood types between Lea and Parvus.

\( H_1 \): There will be a significant difference in the frequency distributions of blood types between Lea and Parvus.
Hypotheses: Rea

• \( H_0 \): There will be no significant difference in the frequency distributions of blood types between Rea and Parvus.

• \( H_1 \): There will be a significant difference in the frequency distributions of blood types between Rea and Parvus.
Study Site

• Study Site: Island of Parvus
• Research Lab: Compton Science Center
• Location: Frostburg State University
• Research Team: 17 students
• Data Collection: June 28, 2016
Blood Samples

- Sampled 60 individuals
- Typed each sample twice
- Divide up the samples – 15 per group
Blood Typing Procedure

- Placed 2 drops of blood in all 3 wells
- Placed 1 drop of anti-serums A, B, and Rh D in corresponding wells
- Mixed each well with a separate plastic toothpick
- Mixed for 30 seconds
Determined Blood Types

- Agglutination = antigen present
- No agglutination = antigen not present
- Antigens present = blood type
  - A- : Agglutination in A well only
  - A+ : Agglutination in A and Rh wells
  - O- : Agglutination in no wells
Determined the Frequency Distribution

• Counted number of each blood type
• Found the % for each type in the sample
• Made a frequency distribution table
Compared Parvus to Each Island

• Created graphs using frequency distribution tables
• Conducted Chi-Square test
• Compared to the critical $x^2 = 14.07$ ($df=7, \alpha=0.05$)
  • If calculated $x^2 \leq 14.07 = \text{no significant difference}$
  • If calculated $x^2 > 14.07 = \text{significant difference}$
Frequency Distribution of Blood at Parvus

- Most frequent blood types:
  - O-: 33%
  - O+: 48%

- Least frequent blood types:
  - There were no B+ types
  - All A, B, and AB types were 7% or less

<table>
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<th>Parvus Blood Frequency Distribution</th>
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<tr>
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Parvus Compared to the Accola Archipelago

• Parvus is similar to the Accola Archipelago
  • Both have higher O blood types
  • Low A, B, and AB blood types
• No significant difference
• All calculated $x^2 < 14.07$ (critical $x^2$)
  • Parvus x Bella, $x^2 = 4.39$
  • Parvus x Cristo, $x^2 = 7.65$
Parvus Compared to the Geminus Archipelago

• Parvus is not similar to the Geminus Archipelago
  • Parvus has low B blood types
  • Parvus has high O blood types

• Significant difference

• All calculated $x^2 > 14.07$ (critical $x^2$)
  • Parvus x Magnus, $x^2 = 3324.36$
  • Parvus x Fugo, $x^2 = 2171.28$
  • Parvus x Lea, $x^2 = 3324.96$
  • Parvus x Rea, $x^2 = 2172.90$
Hypotheses: Bella (Accola Archipelago)

- Accepted
  - $H_0$: There will be no significant difference in the frequency distributions of blood types between Bella and Parvus.

- Rejected
  - $H_1$: There will be a significant difference in the frequency distributions of blood types between Bella and Parvus.
Hypotheses: Cristo (Accola Archipelago)

• Accepted
  • $H_0$: There will be no significant difference in the frequency distributions of blood types between Cristo and Parvus.

• Rejected
  • $H_1$: There will be a significant difference in the frequency distributions of blood types between Cristo and Parvus.
Parvus x Bella, $x^2 = 4.39$
Parvus x Cristo, $x^2 = 7.65$
Hypotheses: Magnus (Geminus Archipelago)

• Rejected
  • $H_0$: There will be no significant difference in the frequency distributions of blood types between Magnus and Parvus.

• Accepted
  • $H_1$: There will be a significant difference in the frequency distributions of blood types between Magnus and Parvus.
Hypotheses: Fugo (Geminus Archipelago)

• Rejected
  • $H_0$: There will be no significant difference in the frequency distributions of blood types between Fugo and Parvus.

• Accepted
  • $H_1$: There will be a significant difference in the frequency distributions of blood types between Fugo and Parvus.
Hypotheses: Lea (Geminus Archipelago)

• Rejected
  • $H_0$: There will be no significant difference in the frequency distributions of blood types between Lea and Parvus.

• Accepted
  • $H_1$: There will be a significant difference in the frequency distributions of blood types between Lea and Parvus.
Hypotheses: Rea (Geminus Archipelago)

• Rejected
  • $H_0$: There will be no significant difference in the frequency distributions of blood types between Rea and Parvus.

• Accepted
  • $H_1$: There will be a significant difference in the frequency distributions of blood types between Rea and Parvus.
Parvus x Magnus, $x^2 = 3324.36$
Parvus x Fugo, $x^2 = 2171.28$
Parvus x Lea, $x^2 = 3324.96$
Parvus x Rea, $x^2 = 2172.90$
Suitable Blood Source for Parvus

- Use Accola Archipelago
  - Bella Island
  - Cristo Island
- Similar frequency distributions
- Not statistically different
- Low percentage of B blood types
- High percentage of O blood types
Limitations of Blood Supply

- Did not have blood from Geminus or Accola Archipelagos
- Could not cross match
- Could contain other blood groups
- Could cause incompatible transfusions
- Should obtain blood from all islands
Limitations of Research Experience

• Had two practice sessions
• Had little experience with syringes
• Had different cleaning efforts between samples
• Had possible cross-contamination
• Should establish rules for more practice and clean-up
Limitations of Blood Typing Technique

- Blood typing plates used
- Plates hand-washed
- Blood splattered
- Blood typed incorrectly
- Other blood typing techniques
Future Research: Find the Origins of Parvus Islanders

- Parvus and Accola Archipelago have similar frequency distributions of blood types
- Ancestry/Genetics may be similar
- Blood antigens are inherited
- Hardy-Weinberg Law of Genetics
  - Genetics should not change much between related populations
  - Parvus and Accola islanders could be genetically-related
Location of Parvus

- Accola islanders could travel by sea to Parvus
- Circular ocean current around Accola Archipelago
- Current also passes Parvus
Benefits of Being Related

• Less transfusion complications – other similar blood group antigens
• Better understanding of medical issues facing Parvus
  • Other inherited diseases may be similar: cancer, diabetes, sickle cell
  • Inherited disease resistance may be similar: malaria resistance in certain blood types
  • Similar drug treatments may be used for Parvus
Research Recommendations

• Genetics testing comparing Parvus to Accola Archipelago