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Sickle Cell Disease and Model

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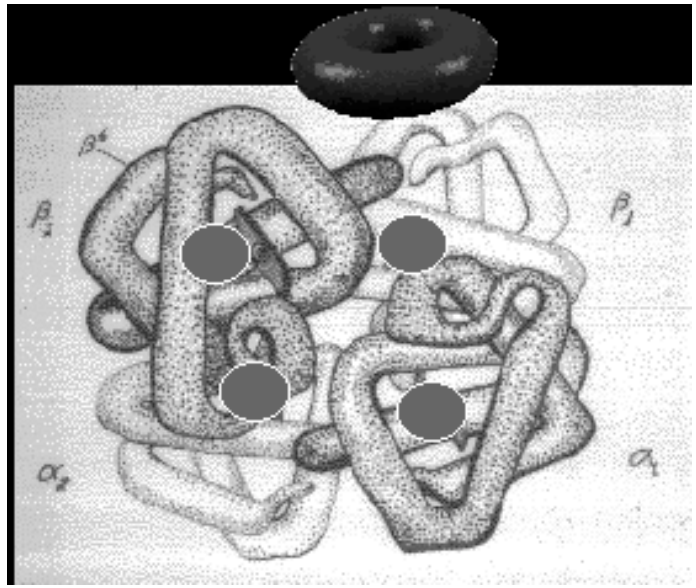
BIO 342 - Computer Applications In Biology

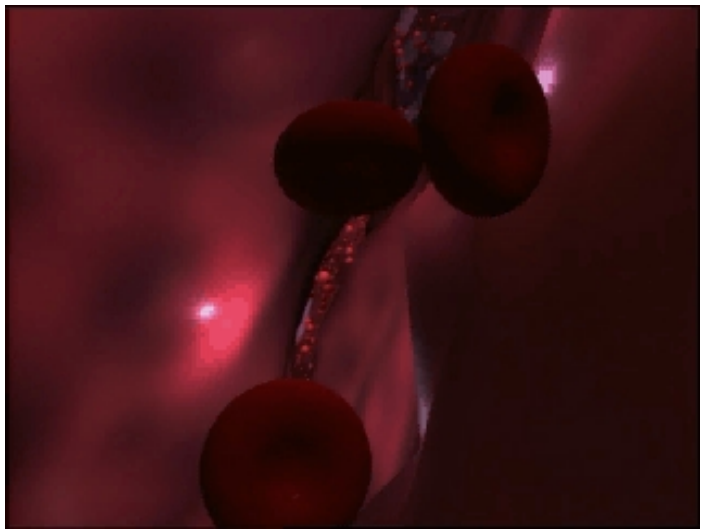
Outline for Sickle Cell Disease

- Epidemiology
- Distribution
- Complications
- Research
- Healthy Living
- Sickle Cell Model

Red Blood Cells & Hemoglobin

- Hemoglobin is the main protein in the RBC.
- Each hemoglobin can carry up to four molecules of oxygen.

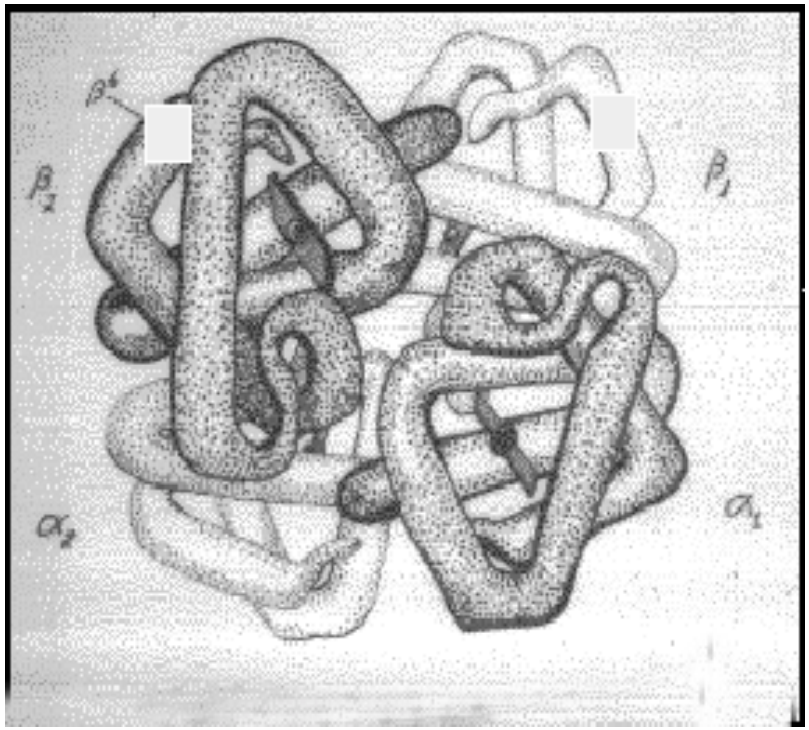




- Oxygen

What Makes The RBC Sickle?

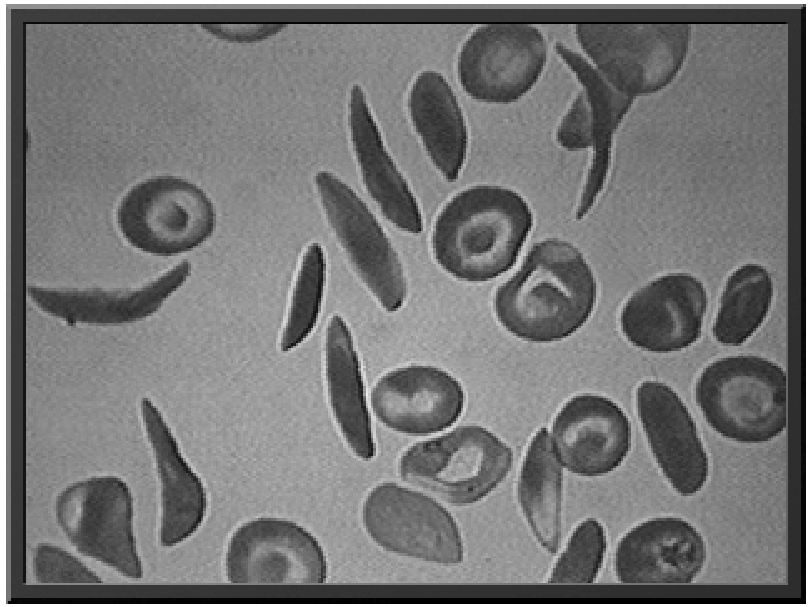
- A Person with Sickle Cell has a valine in place of a glutamic acid in their hemoglobin.



- Site of Substitution

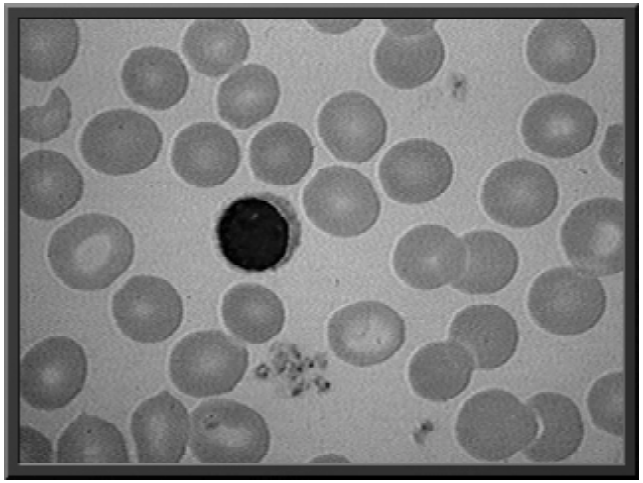
What Makes The RBC Sickle?

- This change in the hemoglobin causes it to form long chains in its deoxygenated state, thus giving the RBC a characteristic “sickle” shape.

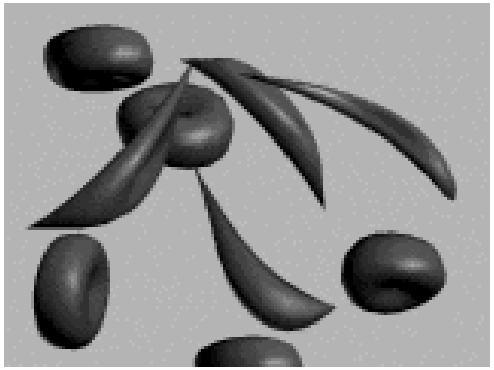


Normal vs. Sickle RBC

- Normal
  - Disc shaped.
  - Soft (like bag of jelly).
  - Easily flows through small blood vessels.
  - Lives for 120 days.

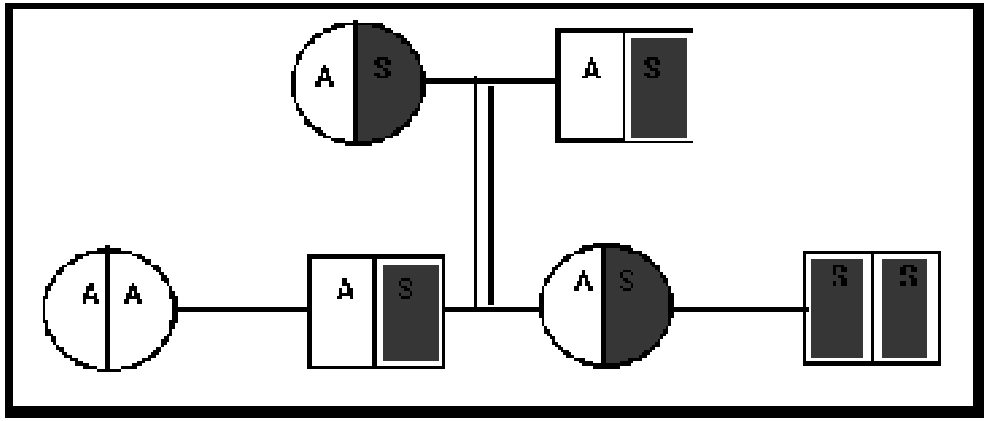


- Sickle
  - Sickle Shaped.
  - Hard (like piece of wood).
  - Often gets stuck in small blood vessels.
  - Lives for 20 days or less.

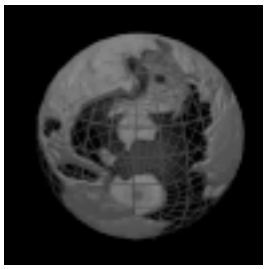


Sickle Cell Trait

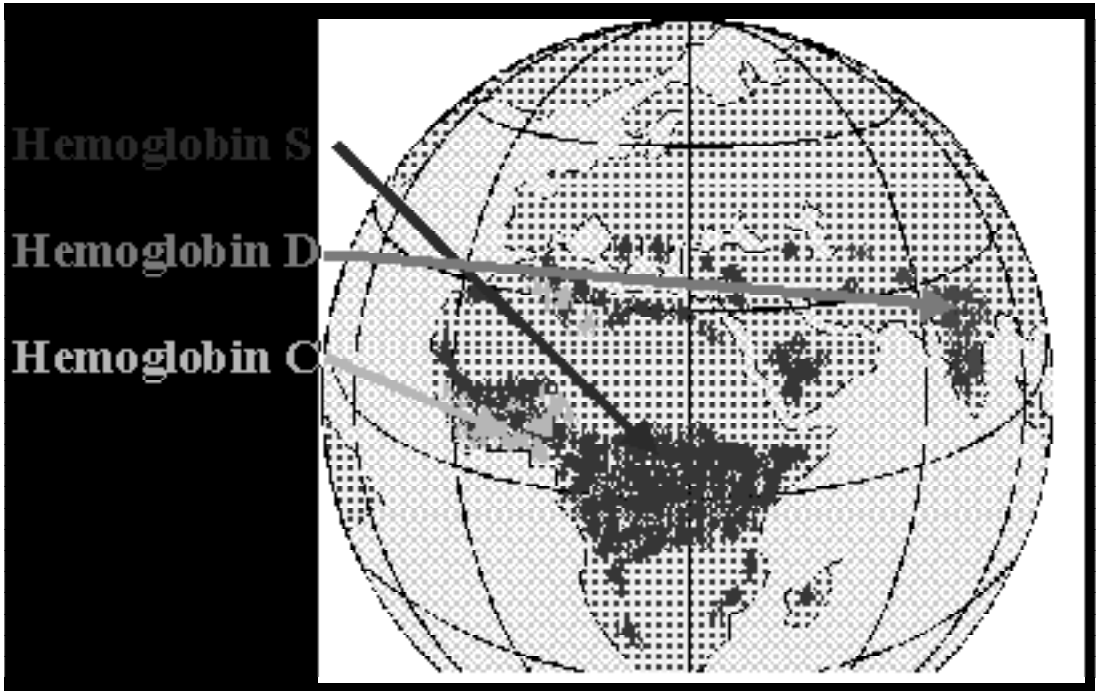
- Individuals carry one normal hemoglobin and one sickle hemoglobin.
- Does not produce Sickle Cell Disease in individual, however, offspring may have disease.



Distribution



Sickle Cell Disease is found in Africans, Saudi Arabians, Iranians, and Asiatic Indians.



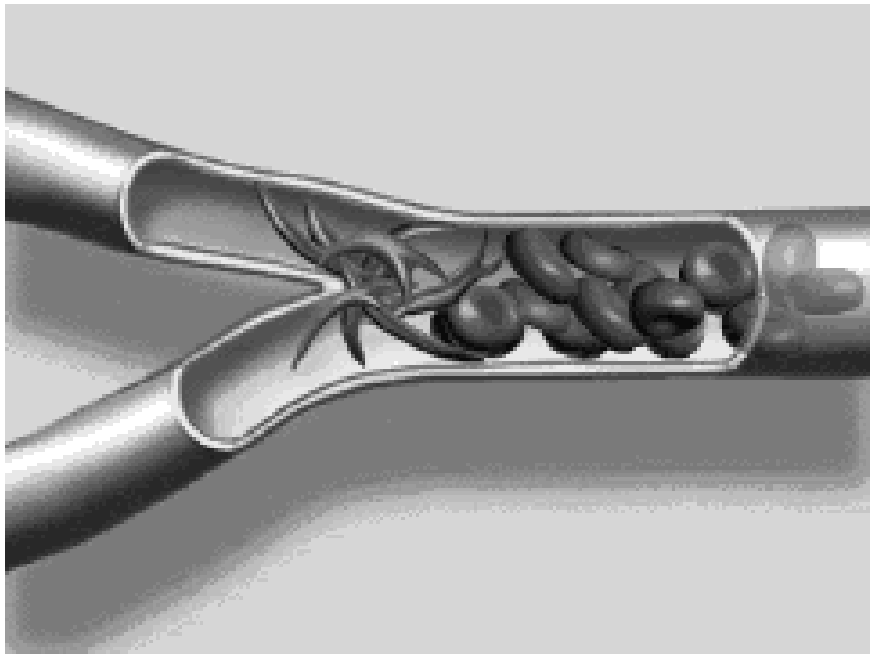
Sickle Cell Disease is present in 1 out of every 400 African-Americans, while Sickle Cell Trait is present in 1 out of every 12 African-Americans.

Complications

- Sickle cells become trapped and destroyed in the spleen.
- Shortage of RBC’s or anemia.
- Stroke or brain damage.
- Kidney failure.
- Pneumonia or chest syndrome.
- Increased infections.

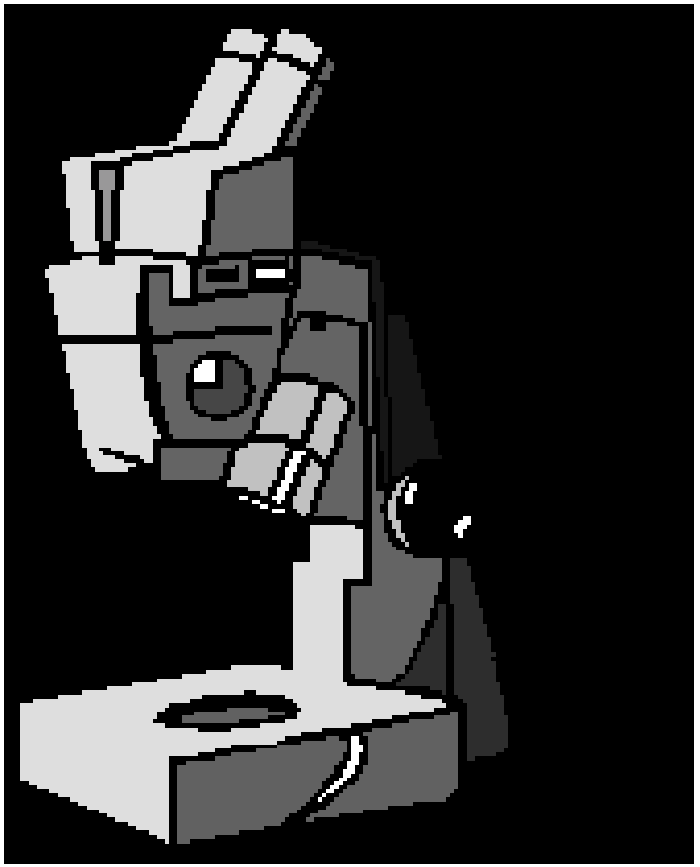
Complications

- Pain episodes due to vessel occlusion.



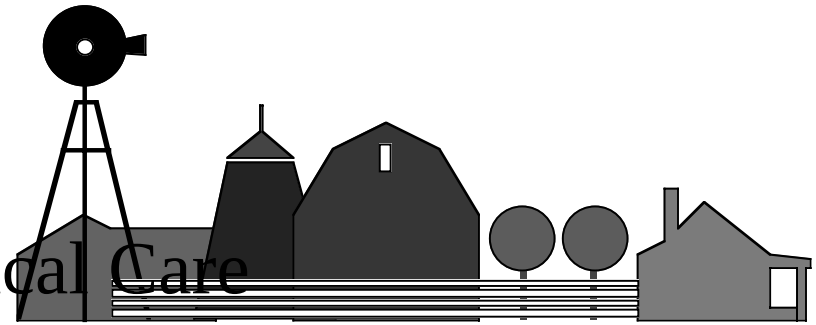
Current Research

- Hydroxyurea
- Bone Marrow Transplant
- STOP Study
- Gene Therapy
- Adhesion Blockers



Living With Sickle Cell (FARMS)

- F - Fluids, Fevers, & Food
- A - Air & Oxygen
- R - Rest
- M- Medications & Medical Care
- S - Situations & Support



Sickle Cell Model

- Built using Stella.
- Tracks Sickle Cell Disease Progression via
  - Numbers of Normal People
  - Numbers of Sickle Cell Trait People
  - Numbers of Sickle Cell Anemia People

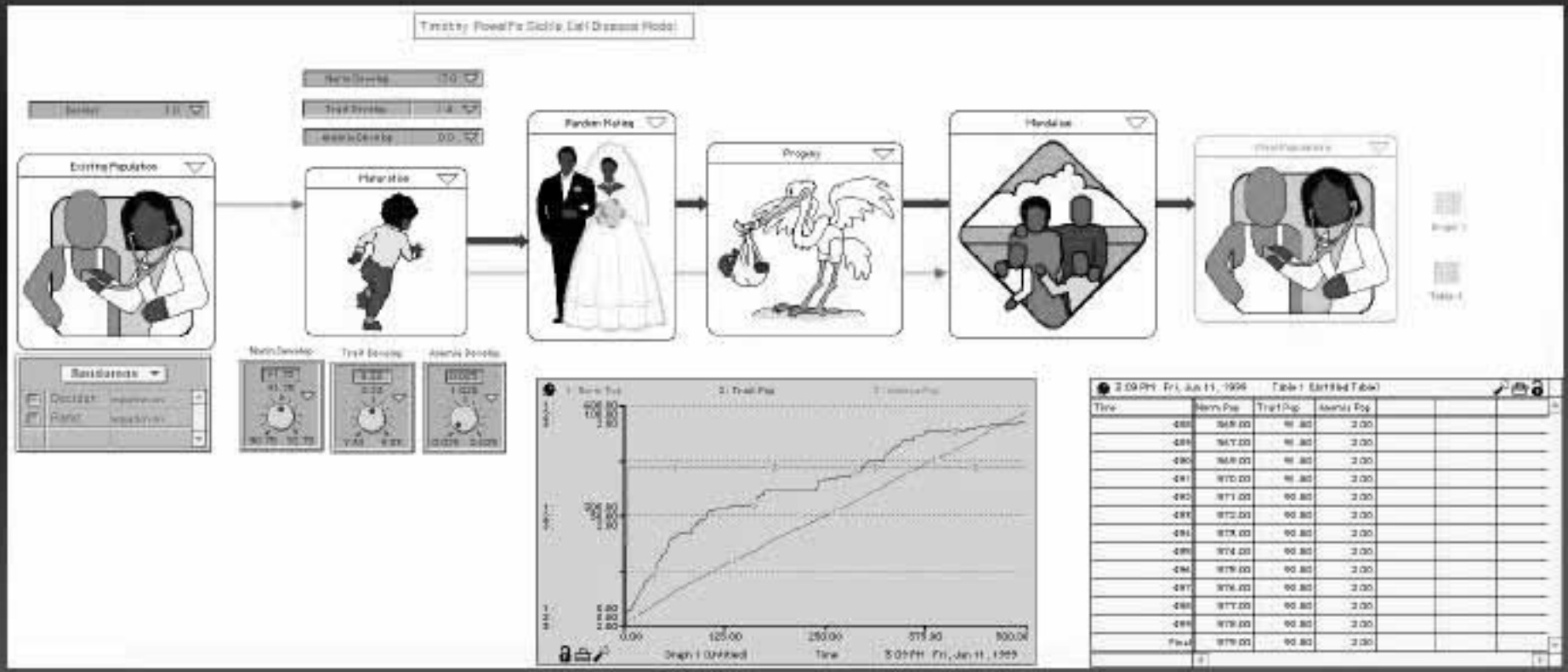
Sickle Cell Model

- Model Incorporates
  - Existing Normal, Trait, and Disease Populations.
  - Maturation Sector.
  - Random Mating.
  - Mendalian Principles of Genetics.

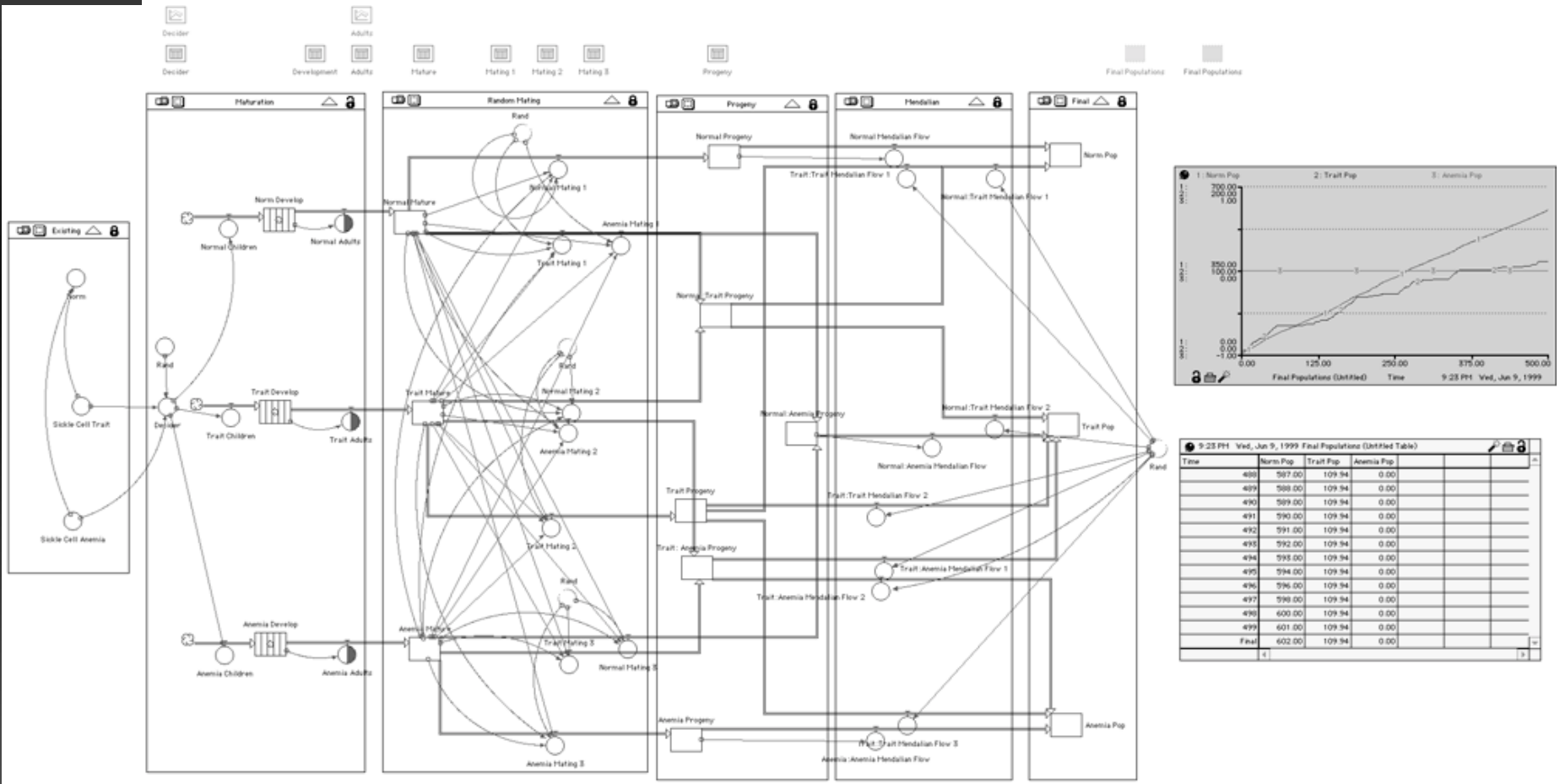
Sickle Cell Model

- Model Allows User to Alter:
  - Randomness.
  - Normal, Trait, and Anemia Ratios.
- Model Allows User to Monitor:
  - Final Numbers of Normal, Trait, and Anemia Populations.

Sickle Cell Model - Overview



Sickle Cell Model - Detail



Time	Norm Pop	Trait Pop	Anemia Pop
488	587.00	109.94	0.00
489	588.00	109.94	0.00
490	589.00	109.94	0.00
491	590.00	109.94	0.00
492	591.00	109.94	0.00
493	592.00	109.94	0.00
494	593.00	109.94	0.00
495	594.00	109.94	0.00
496	596.00	109.94	0.00
497	598.00	109.94	0.00
498	600.00	109.94	0.00
499	601.00	109.94	0.00
Final	602.00	109.94	0.00

Sickle Cell Model - Equations

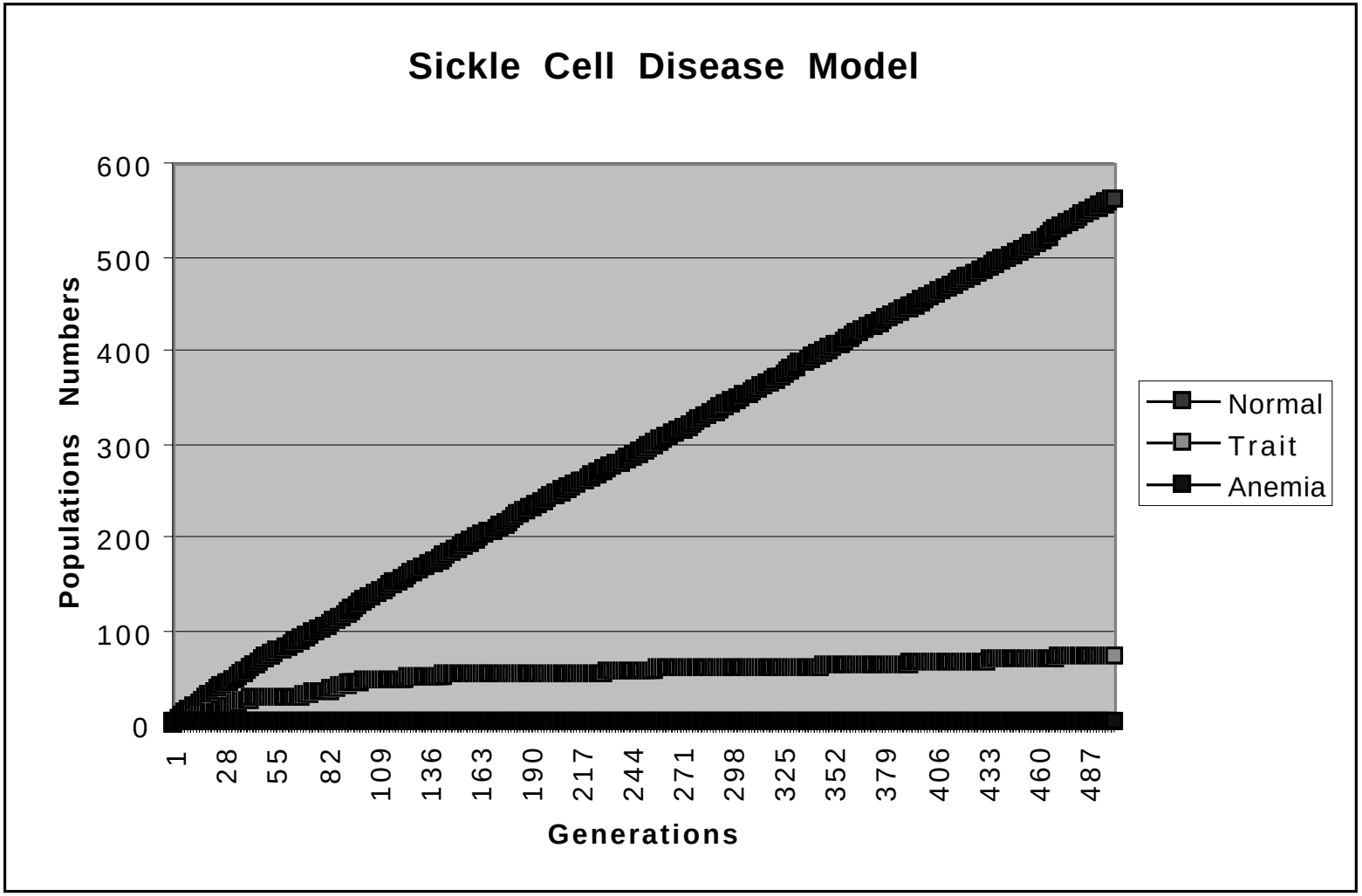
"Between Numbers" Mating Hypothesis Equations

Normal Mating = IF (Rand > (SCT Mature / (Norm Mature + SCT Mature + SCA Mature)) THEN (1) ELSE (0)

**SCT Mating = IF (SCT Mature / (Norm Mature + SCT Mature + SCA Mature)) >= Rand > (SCA Mature / (Norm Mature + SCT Mature + SCA Mature)) THEN (1) ELSE (0)

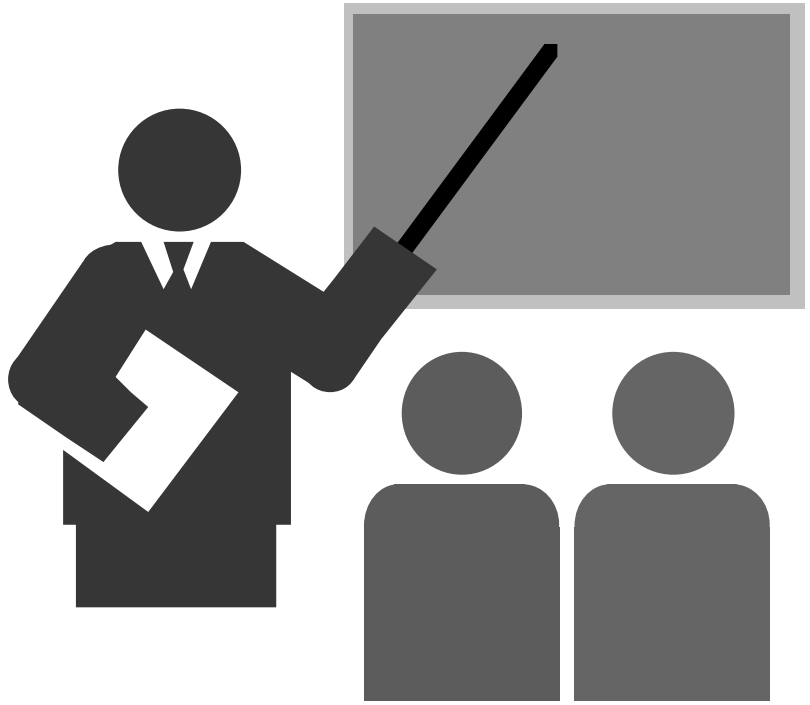
SCA Mating = IF (Rand <= (SCA Mature Mature / (Norm Mature + SCT Mature + SCA Mature)) THEN (1) ELSE (0)

Sickle Cell Model - Results

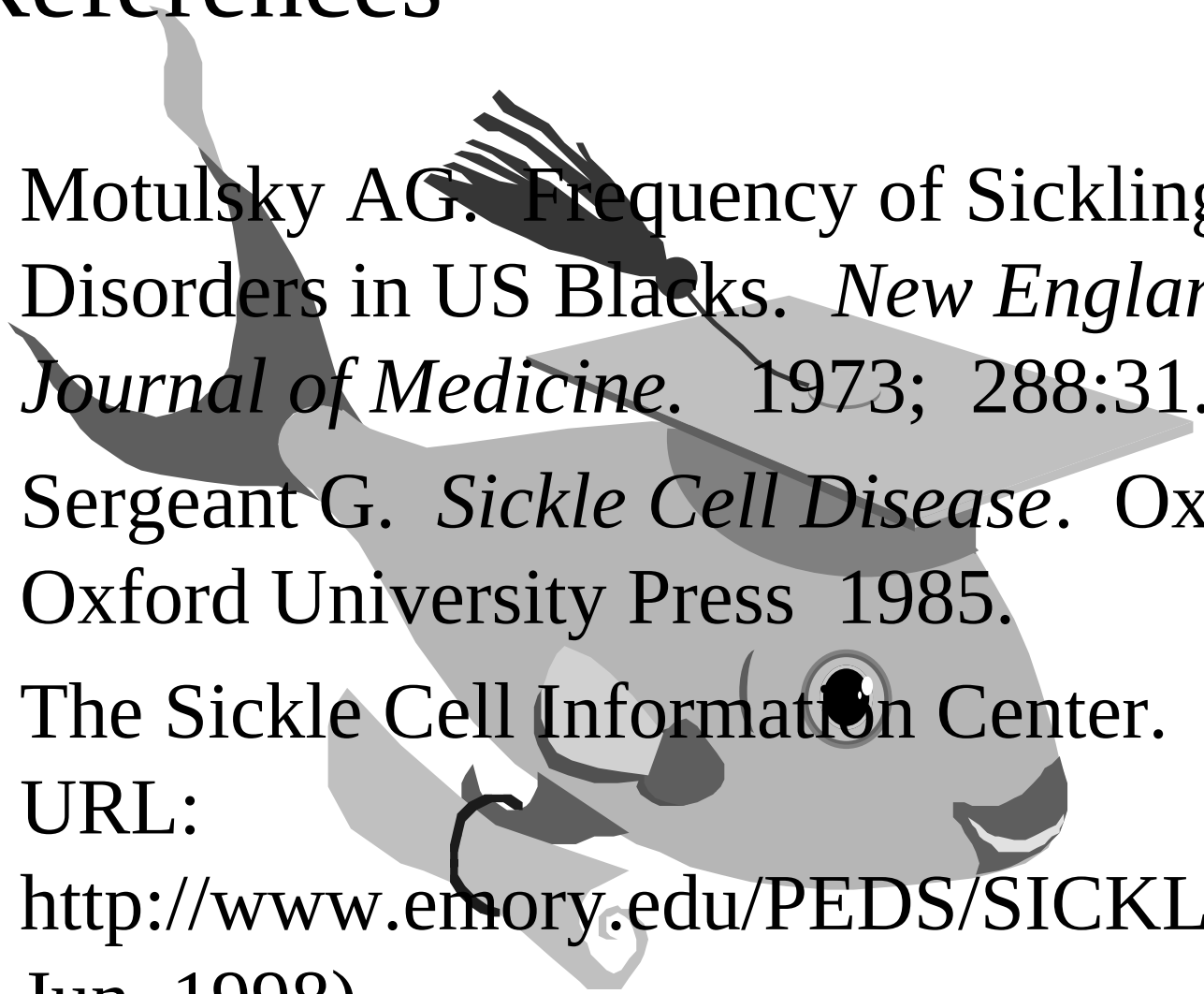


Sickle Cell Model - Conclusions

- Populations of Normal, Sickle Cell Trait, and Sickle Cell Disease remained constant.
- Need to run model over longer period of time.



References



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