Metaprogramming in the Genome

- The genome is a designed digital code
- Computer programs are designed digital codes
- We can use this symmetry to hypothesize unknown function
- This talk is a hypothesis about one small aspect:
- Metaprograms

Metaprogramming

- Computer programmers are lazy
  - That's why we invented computers
- We write systems that generate programs for us
- These are called *Metaprogramming Systems*
- The programs are called *Metaprograms*

Metaprogramming Systems

- The languages built by metaprogramming systems are domain specific
  - The problems they apply to are narrow
  - These narrow problem areas have to be solved repeatedly
- Metaprogramming languages
  - Focus on non-redundant aspects of the problem domain
  - Use a limitted, focused vocabulary
  - Leaves the repetitive details to the system

Metaprogramming Example

- Architecture electrical design
- Architect and Home Builder decide on location and number of electrical outlets
- Architect takes location map to electrician
- Electrician provides a detailed schematic of where the wires should go, what should go on which circuit, etc.
- A “computerized electrician” would be a metaprogramming system

Metaprogramming Example 2

- Subject/Verb/Object sentences
- Words are the primary focus
- Agreement is necessary but redundant
- Example: “Christa” “love” “child”
- Returns: “Christa” “loves” “a” “child”
- The added agreement and particles can be determined from the original specification alone
- This is how a metaprogram works

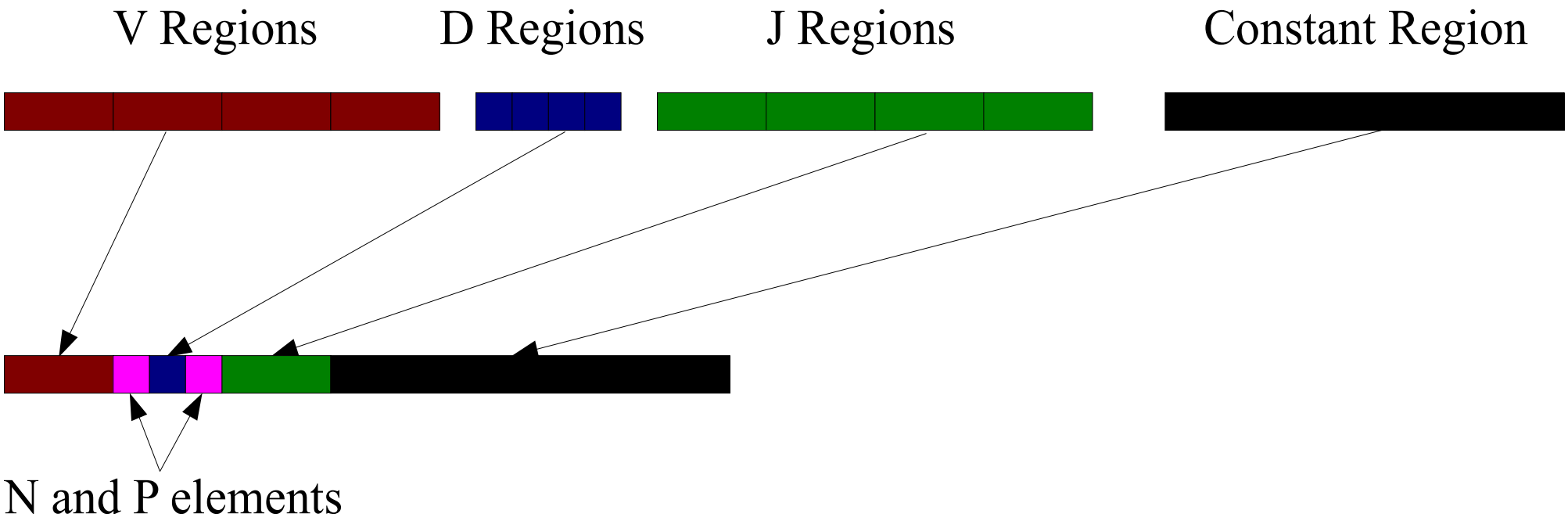
V(D)J Recombination

- This is the system the cell uses to generate millions of antibodies from just a few genes
- Antibodies are composed of a variable region and a constant region
- Variable region is a combination of several types of gene segments:
  - V (variable)
  - D (diversity)
  - J (joining).

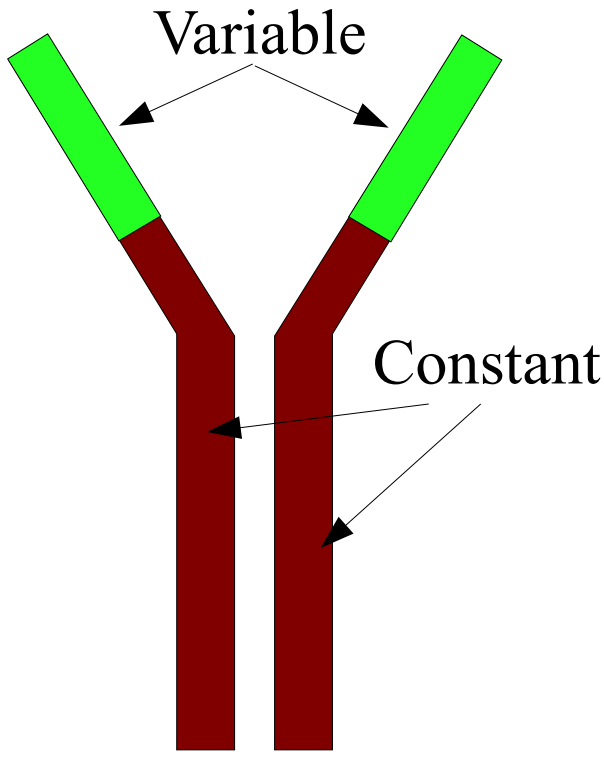
V(D)J Recombination

- Each antibody cell undergoes recombination to move one each of V, D, and J together to create a unique antibody

V(D)J Recombination



Antibody Structure and Regions



The Mystery

- Between each segment there are nucleotides which are not encoded in any segment
- There are two types – N (non-templated) and P (palindromic)
- What do these do?
- Current efforts so far classify them as “random”
- What can the Creation perspective offer?

V(D)J Recombination Attributes

- Segments of genes have a unique coding for a unique purpose
- Specialized system to eliminate redundancy
- This is starting to sound like a metaprogram

What Piece is Missing?

- We have the unknown functions of N and P elements.
- Question: What part in the metaprogramming model could those elements be serving?
- Answer: These are “combiners” which help make the parts make sense in terms of each other.
- Similar to the addition of particles and verb agreement in our original example.

Creationary Hypothesis

- N and P elements aid in the structural/functional integrity of joined segments.
- Is there any evidence?
  - In certain mouse antibodies, arginine is required at position 96
  - This was generated during recombination even when it wasn't coded for by either segment
- Further work – this needs to be empirically tested

Counter Evidence

- Some antibodies recombine in multiple ways
- Some recombinations are unproductive

The Take-Home Lesson

- We are created in God's image
- God created the world to be understood
- We can use engineering design principles from other disciplines as a heuristic for searching for new insights into biological function
- And perhaps geologic function, too!

Enterprise Metaprogramming

- Some metaprograms serve as a spec for multiple systems.
- Example - a data record layout can be used for:
  - Generating a database structure
  - Generating a programming interface
  - Generating a data-loading user interface
- Key characteristics:
  - Multiple, integrated systems
  - Coordinated changes based on a single set of genes

Other Thoughts

- N and P elements are not generated until 2 months of age
  - This could be counter-evidence
  - This could mean that fewer recombinations “make sense”
  - This could mean that the genome's symbolic manipulation passes through similar stages as a child's vocabulary

Other Thoughts

- Cleavage sites have “unused” regions of nucleotides by the RSSs. Could this contain metadata about the segment?
- Non-homologous end-joining uses a similar recombination method to V(D)J recombination. Perhaps similar processes are in play?