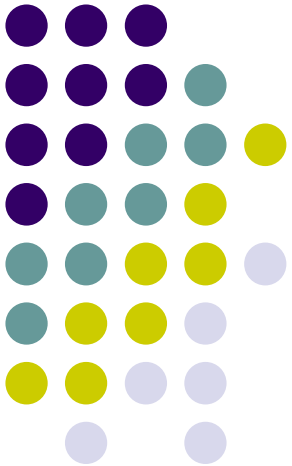
Alu Elements

PCR Workshop 2005



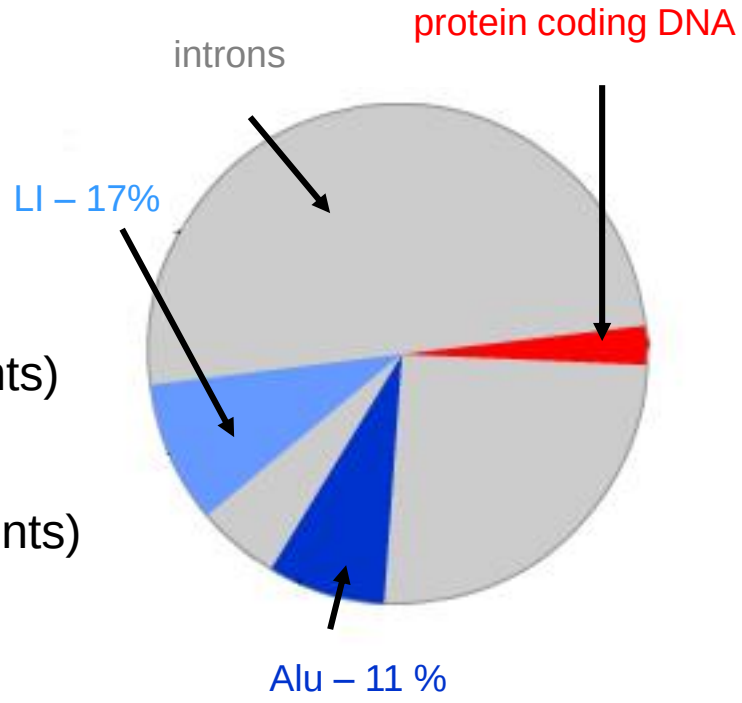
Instruction manuals that come with new gadgets are notoriously frustrating…but at least they do not insert, just when you are getting to the bit that matters, five copies of "Ode to Joy" or a garbled version of a set of instructions for how to saddle a horse…

Mother Nature concealed a dirty little secret in the genome. Each gene is far more complicated than it needs to be, it is broken up into many different 'paragraphs' (called exons) and in between lie long stretches (called introns) of random nonsense and repetitive bursts of wholly irrelevant sense, some of which contain real genes of a different kind…

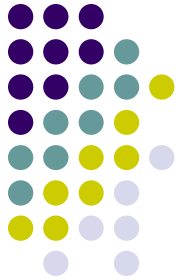
Matt Ridley, Genome

Background Information

- Approx 6 billion base pairs of DNA in body
- Only 3 – 10% actually code for proteins
- 90 – 97% introns (intervening regions)
- within introns are repeating elements
  - LINE (long interspersed repeating elements)
    - L1 most common
  - SINE (short interspersed repeating elements)
    - Alu most common

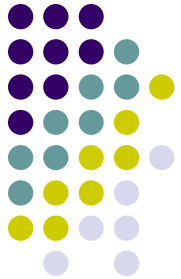


Alu Elements



- *Alu* elements probably arose from a gene that encodes the RNA component of the signal recognition particle, which labels proteins for export from the cell.
- Roughly 1 million copies --11% of total genome
- Recognition site for restriction enzyme Alu I (A G^C T) is found within the Alu region – hence the name.
- Approx 300 bp in length
- Alu does not encode any functional molecules and depends on the machinery of active L1 elements to be copied and moved about the genome.

Alu is a “parasite” of L1



- Alu has a internal promoter within its sequence to start transcription
- However, it lacks the gene for reverse transcriptase – required to convert RNA to dsDNA
- Alu requires LINE (L1) in order to jump
- Functional L1 elements are about 6,500 bp in length and encode:
  - an endonuclease that cuts DNA and a
  - reverse transcriptase that makes a DNA copy of an RNA transcript.

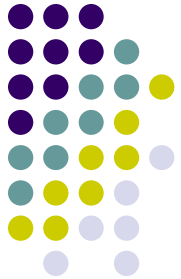
Retrotransposon – “Jumping Gene”

- Copy and paste model
- Transcribed into mRNA by RNA polymerase
- Converted to double stranded DNA by reverse transcriptase
- Integrated into different spot in genome at the site of a single or double stranded break

Effects

- Majority of alu insertions are “evolutionary neutral”
- Occasionally an alu insertion occurs in a functioning gene
  - neurofibromatosis type 1
  - certain types of heart disease
  - some types of hemophilia

PV92 Alu Locus

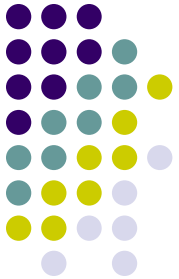


- Human specific Alu region
- Insertion occurred relatively recently in human history (last million years)
- differences in allele and genotype frequencies between modern populations and are tools for reconstructing human prehistory
- DNA fingerprinting marker

PV92 continued

- 2 alleles
- 3 genotypes
  - +/+
  - +/-
  - -/-
- Important to note that having this insert is not diagnostic of anything.

Lab Notes



- Step 1: Extract cheek cell DNA
- Step 2: Amplify PV92 region with PCR
- Step 3: Electrophorese DNA fragments from PCR run
- Step 4: Analyze results
- Step 5: (Optional) Input class data on web to analyze results and compare data with other classes or reference groups
  - Use PIN numbers to label DNA tubes
  - Parental consent form prior to experiment
- Check on district policy regarding using body fluids in class