E and VIRE rotary modes, in order, SOURCE of two letters at the top clockwise, itLK. All of

GETTING IT ALL TOGETHER

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Recently, several Word Ways contributors have suggested relationships between wordplay and chemistry (see "The Linguistic Genetic Message" Feb 1992, and the note on The Scientist Speculates in Feb 1994). Although none of the ideas appealed to me, I found the concept intriguing, and devised something of my own. In this article, I model protein chemistry with a combination of two different types of directed word chains. In addition, constructions from the combination chaining leads to interesting logology.

Before describing the protein model, I introduce a type of directed word chain which is different from those Word Ways has been publishing during the past few years. I use the same nomenclature and format as I have done in previous articles. There, words were chained with various degrees of overlap, but in all cases every letter participated in overlap to some extent. In this type, exactly one letter in each word is not overlapped.

To avoid handling a large mass of data, and yet produce a reasonable picture of this type of chain, I chose to work with full lists of 9, 10, and 11-letter words, but limit frags to short lists of common 3, 4, and 5-letter words.

<table>
<thead>
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<th>Size</th>
<th>Words</th>
<th>Size</th>
<th>Words</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>48,900</td>
<td>10</td>
<td>41,700</td>
</tr>
<tr>
<td>11</td>
<td>31,800</td>
<td>4</td>
<td>2530</td>
</tr>
<tr>
<td>5</td>
<td>4569</td>
<td></td>
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</tbody>
</table>

To start, my computer found a large list of frag.j.frag words. This was then culled to those that had at least one overlap with another such word. The yield was a working list of 1750. Repeated culling brought that down to the list in Appendix A. All words given there can join (overlap) at least one other in both the forward and backward direction. All but a few join in a tight network, the core. Figure 1 contains a sample of the core. The un-overlapped letters (joints) are set out with periods. Although I had to go outside my working list to bring in some, all the letters of the alphabet except q are used as joints. A few non-core side chains are also included in Figure 1. Chains which cannot be continued with the working list are marked with + or -.

I now model protein using the above type of chain in conjunc-
tion with ana-gram-mar chains (introduced to Word Ways in Nov 1990 by Chris McManus). Natural protein contains 20 amino acids in various proportions. I emulate those amino acids with the following 20 words: back, bone, break, cut, down, fall, fire, fish, fly, head, kick, light, out, over, pin, side, top, way, wind, wood. When two or more amino acids join, the result is a peptide. Amino acids may link up in any old way in a test tube, but in nature peptides and proteins must "make sense". Sense is emulated by requiring that acid-words may only join to make compound words. Fall.back.bone.head.way is an emulated peptide chain; it is a normal ana-gram-mar chain like those which have been extensively described in Word Ways.

A natural protein consists of two or more peptides. Peptides often join by cross-linking. This process is emulated as follows. Peptide chains are read from left to right, but cross-linking words may read either up or down.

fall.back.side fall.back.side.light head.pin.bone
pin.head.way fly.over.cut.back.bone.wood

Protein chaining may be further illustrated by a set of puzzles:

1) Join all 20 acids into a single peptide chain (this can be done in many ways).
2) Join all 20 acids into two chains of length 10, arranging them to get maximum cross-linking. The following solution with four cross-links (windhover is a bird) can be bettered.

wood.cut.back.kick.down.wind.break.fall.out.top
s h a f
bone.head.pin.fire.fly.over.fish.way.side.light

3) Arrange the 20 acids into three parallel chains of length 10. No acid may be used more than twice, and no acid in a particular location may be used in more than one cross-link. For example, out.s.pin and pin.e.wood are allowed, as is fall.a.way and side.s.way, but fly.a.way and fall.a.way is not. Here is a solution with seven cross-links, which I am reasonably sure can be bettered.

fall.out.back.break.over.cut.over.head.pin.fish
a f h s
way.side.kick.down.light.wood.wind.break.out.top
s e f
fly.way.back.bone.head.pin.fire.top.side.light

Although my choice of 20 words to serve as amino acids may seem arbitrary, it wasn't - surprisingly few frags can link with all others in a set. Appendix B lists compound words which can be made from the 20 frags; all come from Webster's Third or the Ninth or Tenth Collegiates.

Some open questions: how large a lattice can one construct in which every frag is cross-linked? What if the lattice must also be rectangular in outline? and how many different letters can be worked in as cross-links? These are questions for the future.
Appendix A

areologic alembroth allograph allochrom archicarp archimine areologic artichoke assapanic assignment backplate backstop backstrap backstrip bloomfall bodyplate braystone brothered capelline capewort caressing chickadee chokesman chokesmen cityscape craftsman craftsmen crossbill crossbred crossfall cystiform cystocop deepwater deerdrive deerhound denotable dialysing disciform discocarp diskelion domitable driveaway dropflies eavesdrop eightsmall eightman eightmen elaterins ellachick enteraden enterpart everlight evergreen everybody everyday faultman faultmen footplate footstall formulate fundiform funduline goosebill greenware haveyard haverneal hearthman heartnails heartskin honeycomb honeydew honeyeyon honeywort illuminer insinuating inscription kindheart kinbolls kingscraft kinneum laneate lattice lespfund lightered lightface lightman lightmen limberest lineiform lineolate limiscing livedyon livereyan mandelate monograph manywhere menisperm miterwork moonscape mouthpart nonescape outscouts outsearch outshouts overblame overbrave overcrum overdrive overfer overfly overhedge over impose overscape overshave oversmite overspend overtrust overtrusting overwrap overwrest pendulate penduline pentanone pentising piletiform piletiller piletirke piletirkeh redistill restiform rigandes rigancy rusticity rustyback sapsomin spermatin sternibra stonebass stoneface stonegall stonekey stonekeyness stoneware tableware telephone thereaway theremins theremins theretill tinctable toothplate topysaum trapsaping tresured tribesman tribesmen triskelion trispodal trispoline tripatal tripatulate tumescence waterbrod waterfall waterkin waygoose whenever whereaswherever wherestill wherewith worldward archiblast archisperm armature background backtenter blastocyst blastotid blastplate bodyweight boltstrike carposperm centimal cholestok combustable cystospasm discussate dropswaert eavesdrops entergrave enterocyst everywhere footbridge greenfinch greenflies greenware heatheart hearthead honeybloom honeydrops honeystone houndfoot iamentable lanceolate linoaneal logiscising mealymouth mineograph molariform monostick motorising nightstool noneastern noneatable overbridge overflight overglance overground overheight overnarrow overlapses overreach overscream overshit oversight overstruck panictide ravensstone restharrow ridgeplate riverscape singmaster spermocarp stilliform stoneflies tallywomen teleologic thermepile tressilate tripsonic tribesmen turnroundward waterbarb waterleaves waterfront waterphone waterscape wantonizing craftsman enterogram enterospasm graphologic graphomotor graphospasm hearthpenny hearthstone lightweight minearlogic pennyweight spermoblast sternothere sternotribe thereacross therearound thermograph thermomotor trainagrapb tribeswoman truckdriver

Appendix B

backbone backbreak backdown backfall backfire backkick backlight backout backbone backside backwind bonefish bonehead bonewood breakback breakdown breakfall breakhead breakout breakover breakwind cutback cutdown cutout cutover downtown downhill downstream downside downsbrief fallback fallfish fallfire firebreak firefirel fireflyy firestop firewood fishfall fishy fishwood flyback flyover flyway headlight headpin headway kickback kickdown kickout lightwood outback outbreak outfall outbreak outside outtop outwind overcut overfall overfire overfish overfly overhead overide overide overtop overwind pinbone pinfall pinfire pinfish pinhead pinhead sidekick sidelight sideways topkick topside wayback wayside windbreak windfall windfish windway woodout woodfish woodsie woodwind
classed small step breaka-way cut-a-way fall-a-way fly-a-way
out.s.pin over.flight over-c.over over.s.pin over.s.way pin.k.fish
pine.wood side.s.pin side.s.way top.f.light top.s.pin wind.h.over