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 directted 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.

Size	Words	Size	Words
9	48,900	3	604
10	41,700	4	2530
11	31,800	5	4569

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 unlapped 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 ⊣. Two incidental chains are given at the bottom of Figure 1. From the beginning of the search, I excluded words beginning ant.e. and ant.i. or ending .ess.

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 follow. 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
          s              a                f                 e
        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.

Figure 1

over.n.arrow
}fort.h.with.y.wind.h.over.c.limb.e.rest.h.arrow.p.late
stern.e.bra.y.stone
over.p.reach
over.s.pent.a.none.a.stern
reach.i.eve.r.green.g.ill
stern.o.tribe.s.man
over.w.eight
man.o.graph
eight.s.man
stern.o.there.a.round.s.man
body.w.eight
man.y.where.a.wah.z.goose.b.ill
}brand.y.ball
outs.e.arch
}spine.b.ill
ball.y.hack.t.horn.p.outs
}bell.y.band.y.ball
outs.h.outs
}spine.s.cent
cape,r.bush.w.hack
spin.e.scent{
}sheep.s.wool.s.hears.e.cloth.e.spin
tail.s.pins.t.ripe{
city.s.cape
cape.l.line.o.graph
spin.e.tail.o.ring
moon.s.cape
cape.r.wort.h.ward.s.woman.i.sing
cent-e-ring.m.aster{
there.a.cross.b.ill.u.miner.a.logic
cent.i.gram.o.phone{
}cane.s.cent
outs.e.arch.i.mime.o.graph
cent.i.liter{
train.a.graph
form.y.late
graph.o.logic.i.sing
form.u.late
enter.o.graph
tress.i.late.s.cent.i.molar.i.form
graph.o.motor.i.sing.s.tress
therm.o.graph
tress.u.red
eight.b.all.o.therm
red.e.fault.s.man
table.l.and{
therm.o.motor
red.e.liver.y.dom.i.table.w.are
red.i.still.i.form
goose.s.hare.b.rain.s.pout{
druve,a,way.z.goose
over.s.truck
river.s.cape
dee.r.drive
goose.b.one{
tele.p.hone
truck.d.river
drive.w.ell
hone.y.moon.s.truck
river.a.ins.u.lance.o.lat
ell.a.chick.a.dee.p.water.p.hone
stone.g.ale.x.ins
water.b.rod.k.night.s.tool.p.late
can.v.asses.s.ion.o.graph
arch.i.blast.o.disc.i.form.i.can
can.v.ass.a.panic.u.late
over.j.ump.i.rage.p.roof.l.ess.o.rant.i.pole.s.tar.n.side.s.way.z.goose

Appendix A

areologic alembroth allograph allotherm archicarp archimime areologic artichoke assapanic assession backplate backstall backstops backstrap backstrip bloomfell bodyplate braystone brothered capelline caperwort caressing chickadee chokerman chokermen cityscape craftsman craftsmen creamware crossbill crossbred crossfall cystiform cystocarp deepwater deerdrive deerhound denotable dialysing discasing disciform discocarp diskelion domitable driveaway drivewell dropflies eavesdrop eightball eightsman eightsmen elaterins ellachick enteraden enterfare enterpart evenlight evergreen everybody everywhen faultsman faultsmen footplate footstall formulate formylate fundiform funduline goosebill greenbill greenware havenward havermeal hearthman hearthmen heartikin honeycomb honeydrop honeymoon honeywort illuminer inchasing insulance ionograph kindheart kingbolts kingcraft kinswoman lamellate latescent liepsfund lightered lightface lightsman lightsmen limberest lineiform lineolate lionising liverydom liveryman liverymen mandelate manograph manywhere menisperm miterwort moonscape mouthpart nonescape outscouts outsearch outshouts overblame overbrave overclimb overcover overcrust overelate overflies overheave overhover overleave overlover overmarch overplies overscare overshave oversmite overspend overspent overtrust overusing overweave overwrest pendulate penduline pentanone pentising pileiform rakestele reachieve redefault redeliver redistill restiform riverains rodknight rosellate roundsman roundsmen rusticity rustyback spasmotin spermatin sternebra stonebass stoneface stonegale stonegall stonewall stoneware tableware telephone thereaway theremins theretill tinctable toolplate topsyturn trapesing tressured tribesman tribesmen trikerion tripodial tripoline tripudial turnplate turnwrest waterbrod waterfall waterskin waterwall wayzgoose whencever whereaway wheretill worthward

archiblast archisperm arrowplate background backtenter blastocyst blastodisc blastodisk blastplate bodyweight boltstrake carposperm centimolar chokestrap combatable cystospasm discutable dropsywort eavesdrops entergrave enterocyst everywhere footbridge greenfinch greenflies greensward hearthward honeybloom honeydrops honeystone houndsfoot lamentable lanceolate lineograph logicising mealymouth mimeograph molariform moonstruck motorising nightstool noneastern noneatable overbridge overflight overglance overground overheight overnarrow overpasses overpreach overscream overslight overstrain overstress overstrike overstruck overweight paniculate ravenstone restharrow ridgeplate riverscape singstress spermocarp stilliform stoneflies tallywoman teleologic thermopile tressilate tripestone tripewoman turnaround wardswoman waterbrose waterleave waterphone waterscape womanising

craftswoman enterograph enterospasm graphologic graphomotor graphospasm hearthpenny hearthstone lightweight minearlogic pennyweight spermoblast sternothere sternotribe thereacross therearound thermograph thermomotor trainagraph tribeswoman truckdriver

Appendix B

backbone backbreak backdown backfall backfire backkick backlight backout backside backwind bonefish bonehead bonewood breakback breakdown breakfall breakhead breakout breakover breakwind cutback cutdown cutout cutover downcut downfall downlight downside downwind fallback fallfish fallout fireback firebreak firefall firefly firelight fireside firetop firewood fishfall fishway fishwood flyback flyover flyway headfish headlight headpin headway kickback kickdown kickout lightwood outback outbreak outfall outkick outside outtop outwind overcut overfall overfire overfish overfly overhead overlight overside overtop overwind pinbone pinfall pinfire pinfish pinhead sidehead sidekick sidelight sideway topkick topside wayback wayside windbreak windfall windfish windway woodcut woodfish woodside woodwind

back.s.pin	back.s.top	break.a.way	cut.a.way	fall.a.way	fly.a.way
out.s.pin	over.f.light	over.c.over	over.s.pin	over.s.way	pin.k.fish
pin.e.wood	side.s.pin	side.s.way	top.f.light	top.s.pin	wind.h.over