Glycogen linkable D-Glucose possibles

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http://homepage.mac.com/whitby/

http://web.me.com/whitby/Octahedron/Welcome.html

Reference

1. Lubert Stryer, *Biochemistry* 2d ed., W. H. Freeman, San Francisco, 1981, Chapter 16:Glycogen and disaccharide metabolism.
2. Octahedron1stEd.pdf
3. COgroups.pdf
4. Ltriplets.pdf
5. Dglucose.pdf

Introduction

Glycogen is described as a polymer whose monomer is D-glucose. Two monomers make one of two joins–1,4-linkage or 1,6-linkage. Repeated joins of the same type produce a linear chain. Each of the joins between D-glucose units is depicted in the literature as between the C-atom in the 1-position and an O-atom which is in turn joined to the C-atom in either the 6-position or the 4-position.

Because the backbone of each monosaccharide has been produced by the cleft-to-cleft joining of C-atoms, each of the di-L-triplets which might be suitable as D-glucose backbones has been examined to see if it can join with an identical di-L-triplet so that the C-atom at one of its ends can cleftly join to the C-atom at the opposite end of the other di-triplet while being in the same orientation. Each was then examined to see if either of the end C-atoms could join with the C-atom three positions away in the same manner–cleft-to-cleft with both monomers having the same orientation.

Each of the same D-glucose suitable backbones was also examined to see if an O-atom could be used to link the 1-position C-atom of one di-triplet to the 4-, and 6-position C-atoms of an identical triplet and so make the glycogen linkages.

Table 1 shows the di-L-triplets which can make the glycogen linkages either C-atom to C-atom or C-atom to O-atom to C-atom. The figures depicting the C-C linked di-triplets are shown first. Those depicting the C-O-C linked di-triplets are shown next. The di-triplets which could not be linked with O-atoms in each of the 1,4- and 1,6-linkages are shown in the figures at the end.

Table 1:

Di-triplet	Join	1,4-linkage				1,6-linkage				Angle
		Move	x	y	z	Move	x	y	z	
OBGOBR	C-C	2,2	0	4	0	23,4	4	4	0	atn(1)
OBROBG	C-C	5,2	-4	0	0	45,4	-4	-4	0	atn(1)
BRGOBR	C-C	52,2	-2	2	0	5,2 56,2	-6	0	2	atn[sqr(11)]
BGROBR	C-O-C	56,4 4,1	-4	-2	4	4,3	0	-6	0	2atn[sqr(1/2)]
OBR-GRO	C-O-C	32,1 2,1	1	3	0	51,2 4,3	-2	-6	2	118.5 deg
OBROGR	C-O-C	54,4 6,1	-4	-4	2	46,2 4,1	0	-4	2	atn[sqr(4/5)]
OGR-OBR	C-O-C	546,2 2,1	-4	-2	4	546,1 4,1	-2	-4	2	atn[sqr(1/2)]

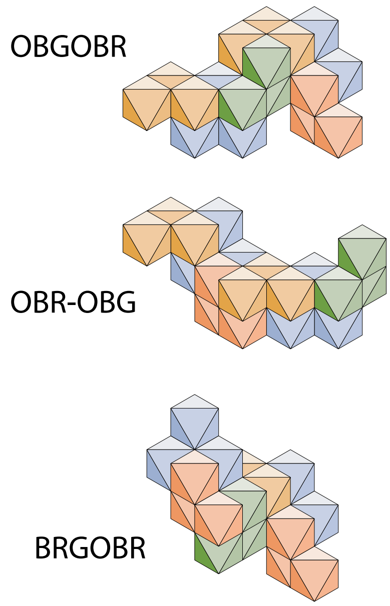


Fig. 1 Di-L-triplets capable of making 1,4- and 1,6-chains.

The two di-triplets at the top of the figure result from the cleft joining of the C-atoms in the orange position of each triplet. The bottom triplet results from the cleft joining of the C-atoms in the red position of each triplet. None of the di-triplets that result from the joining of a C-atom in the orange position with a C-atom in the red position are capable of forming both a 1,4-chain and a 1,6-chain.

Each of the three di-L-triplets shown above can be joined in each of two ways with an identical di-triplet to form a chain so that each unit of the chain is in the same orientation as any other unit of the chain. In the 1,6-chain, the end C-atom of one unit is joined to the C-atom at the opposite end of the second unit; in the 1,4-chain, an end C-atom of one unit is joined to the fourth C-atom (including the end C-atom) of an identical unit. The chains formed by these di-triplets are shown in the following figures.

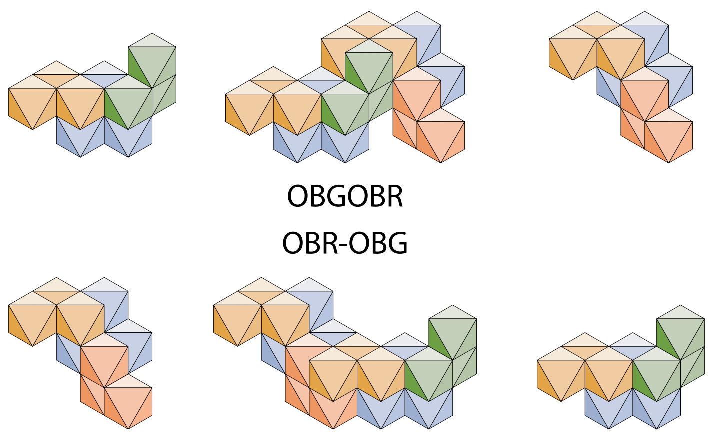


Fig. 2 OBGOBR and OBR-OBG–two ways of pairing the same triplets
Each triplet of OBR-OBG has the same orientation as one of the triplets of OBGOBR. In OBR-OBG, the red C-atom of the OBR triplet is joined to the orange C-atom of the OBG triplet. In OBGOBR, the orange C-atom of the OBR triplet is joined to the green C-atom of the OBG triplet.

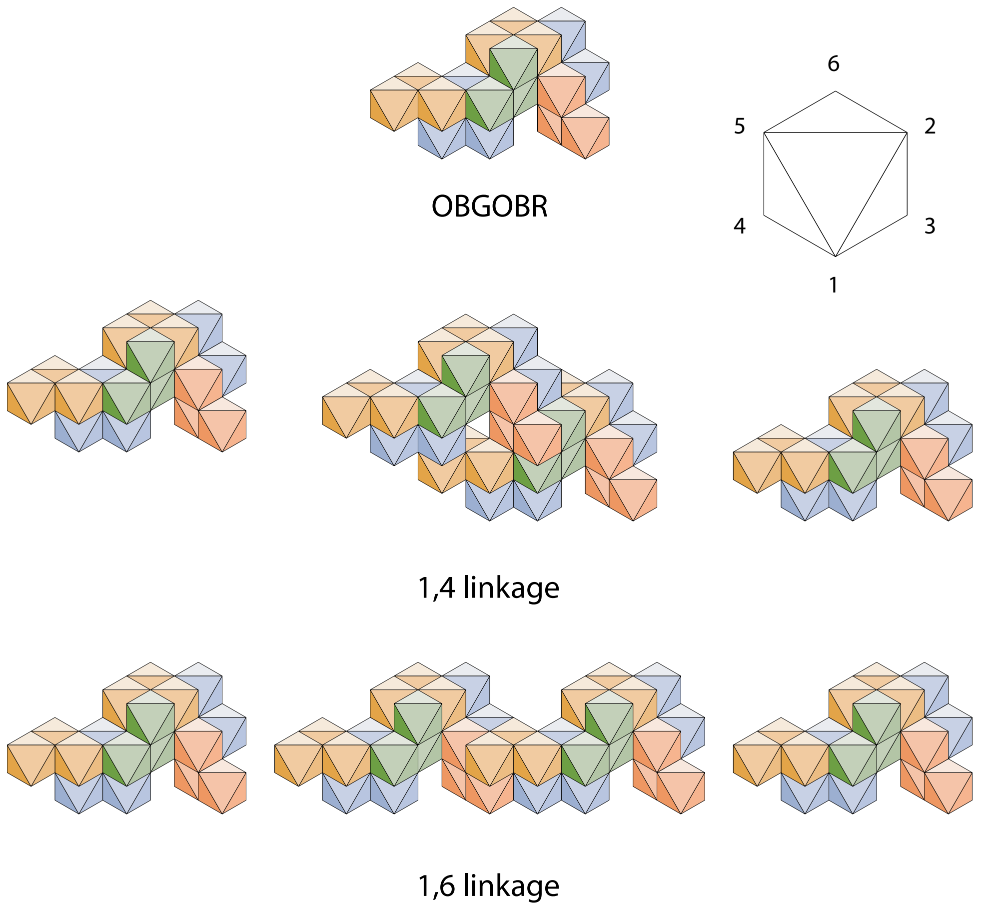


Fig. 3 OBGOBR–Glycogen linkages between di-triplets

The OBGOBR di-triplet is shown at the top of the figure. Examination shows that the outer orange C-atom can join with the red C-atom of an identical di-triplet in the same orientation. The orange C-atom cannot make a join with the inner orange C-atom of the second unit, but the red C-atom can make a join with the green C-atom of the second unit. On that basis, the red C-atom can be considered the 1-position, the green C-atom the 4-position, and the outer orange C-atom can be considered the 6-position.

The 1,4 linkage between the two di-triplets is shown in the middle row of the figure. The individual di-triplets are shown on either side and joined in the middle. The join is between the red C-atom of the di-triplet on the left and the green C-atom of the di-triplet on the right.

The 1,6 linkage is shown at the bottom of the figure. The two di-triplets are shown at the left and at the right. The assembly is in the middle. The join is between the red C-atom of the di-triplet on the left and the orange C-atom at the left end of the di-triplet on the right.

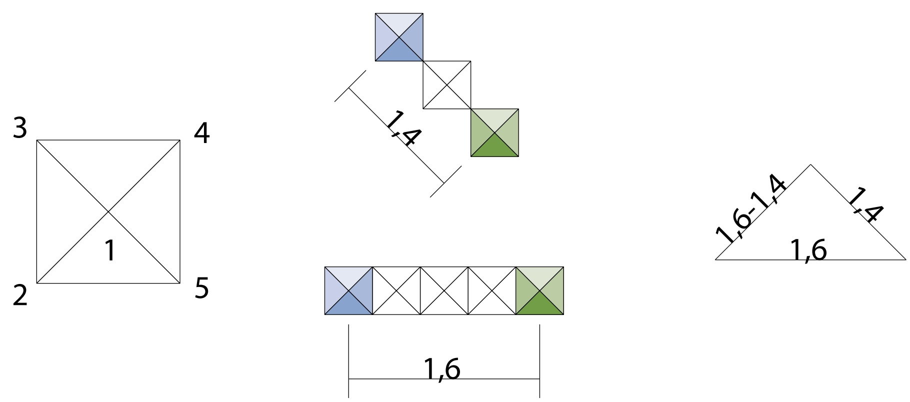


Fig. 4 OBGOBR–Geometry of glycogen linkages

The 1,4-linkage requires the vertexial move 5,2 which is shown at the top of the figure. The move is from the blue octahedron to the green octahedron. The length of the 1,4-vector is S*sqr(8) where S is the edge length of the He-octa.

The 1,6-linkage requires the move from the blue octahedron to the green octahedron shown at the bottom of the figure. The edgial move is 45,4. The length of the 1,6-vector is S*4.

The vector triangle is shown on the right of the figure. The angle between the 1,4- and the 1,6-vectors is atn(1).

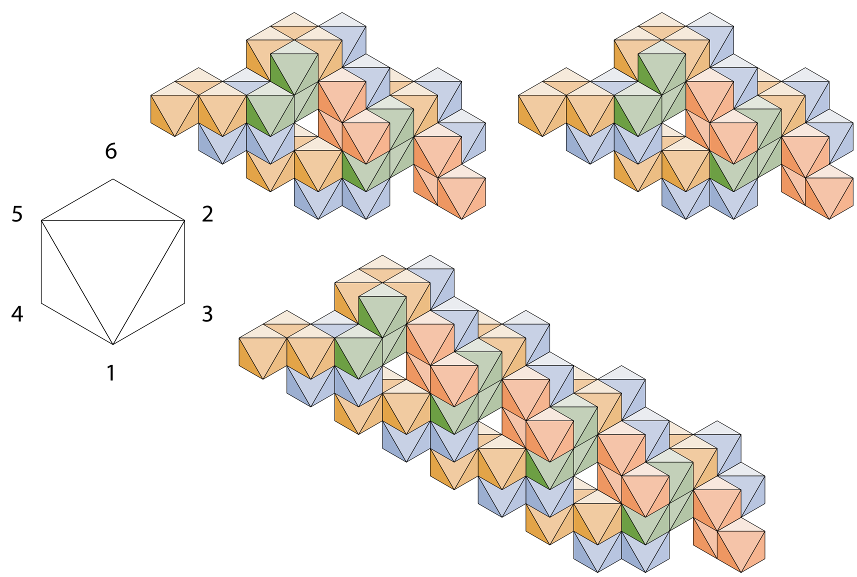


Fig. 5 OBGOBR–Strand of four di-triplets

Two pairs of 1,4-linked OBGOBR di-triplets are shown at the top of the figure. The pairs are joined with the same 1,4-linkage to form the four di-triplet strand at the bottom.

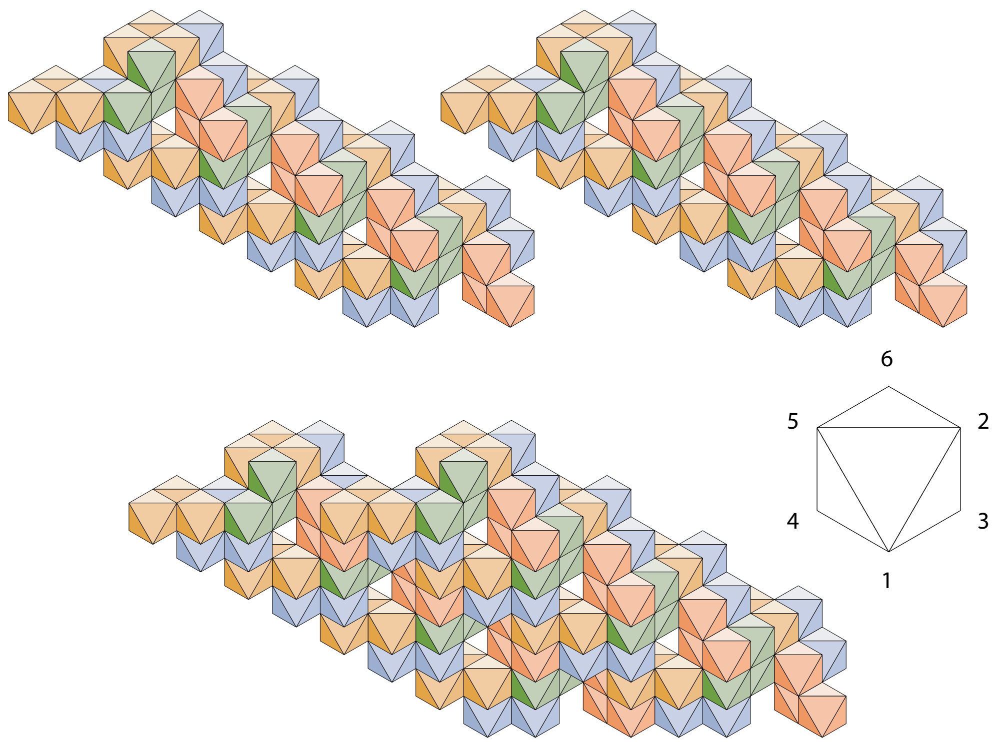


Fig. 6 OBGOBR–Two 1,4-strands joined by 1,6-links.

Two strands, each consisting of four 1,4-linked OBGOBR di-triplets, are shown at the top of the figure. The strands are joined at the bottom so that each of the di-triplets of one strand is 1,6-linked to a di-triplet of the other. Each di-triplet of the right strand is joined by its outer orange C-atom to the red C-atom of a di-triplet of the strand on the left. The red C-atom is in the 1-position and the outer orange C-atom is in the 6-position.

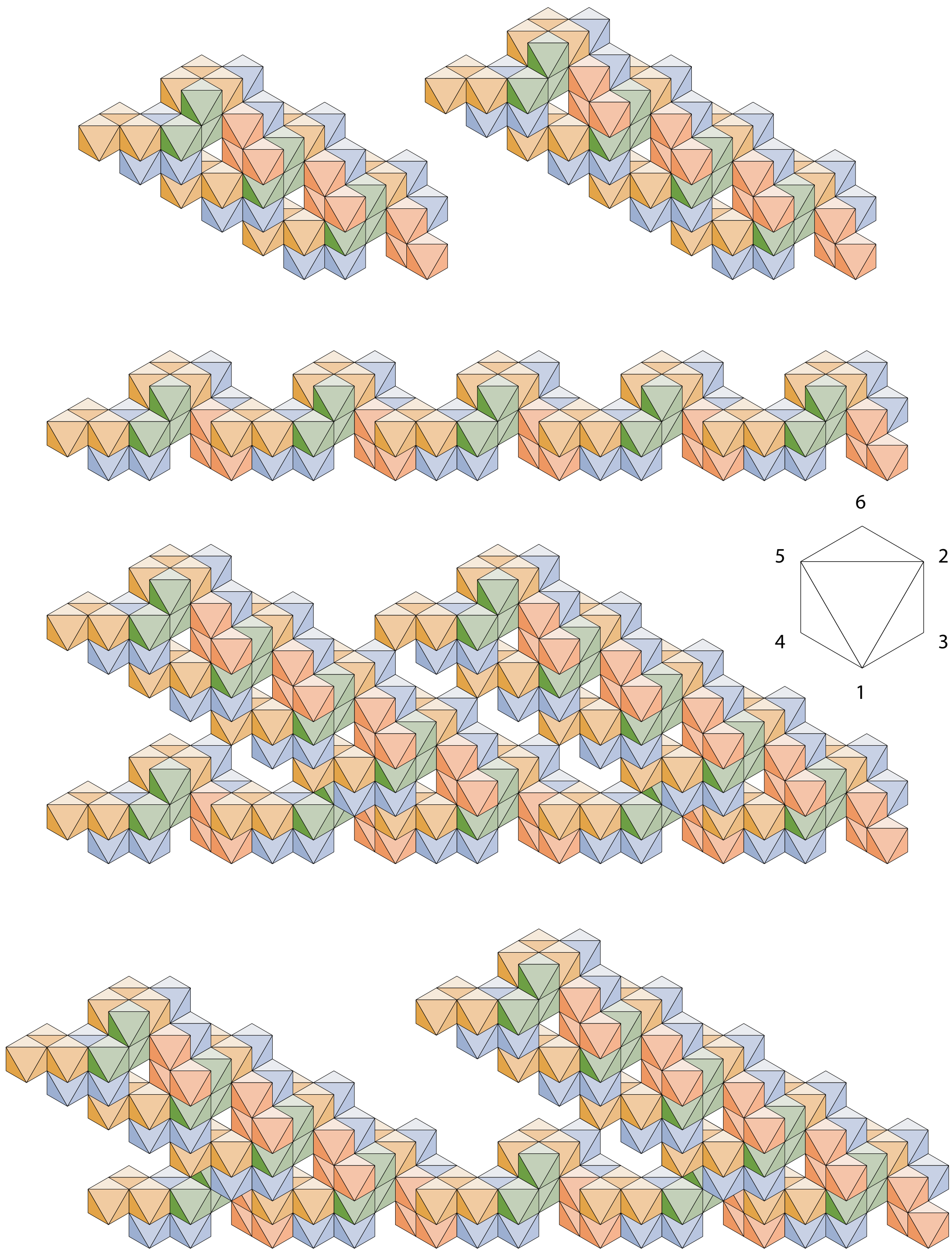


Fig. 7 OBGOBR–1,4-strands linked by a 1,6-strand

Two 1,4-strands are in the top row of the figure. Below them is a 1,6-strand. In the third and fourth rows, two 1,4-strands are linked by a 1,6-strand.

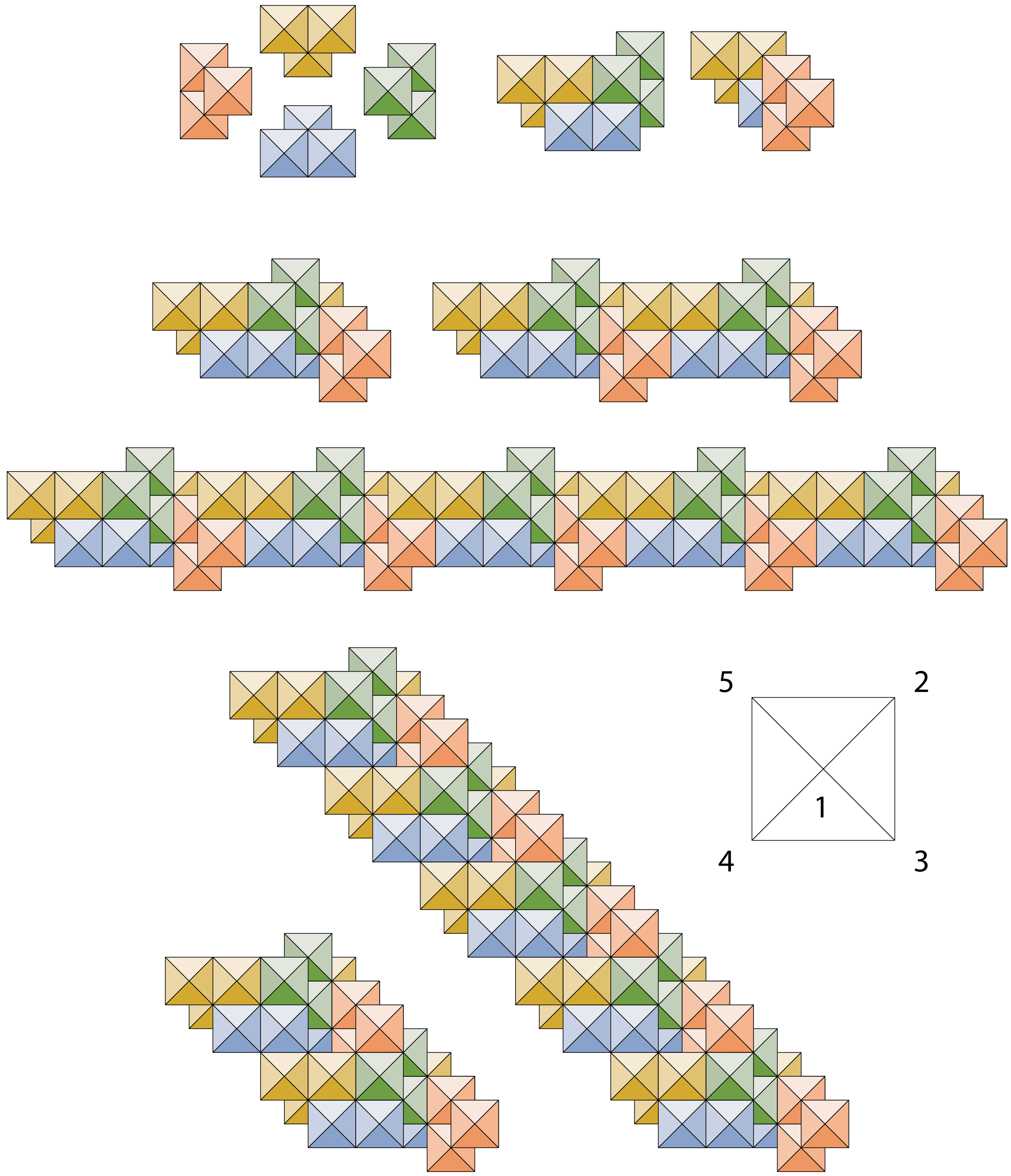


Fig. 8 OBGOBR–Vertexial view of 1,4- and 1,6-strands

This view of the OBGOBR strands was chosen because the axis of each strand is parallel to the projection plane and each is shown in its true length. The four orientations of the C-atom for this view are shown at the top left.At the right of the top row, the two triplets of OBGOBR are shown. In the second row, the di-triplet is shown on the left and a 1,6-linked pair is shown on the right. A 1,6-strand occupies the third row. In the bottom row, a 1,4-linked pair is shown on the left and a 1,4-strand is shown on the right

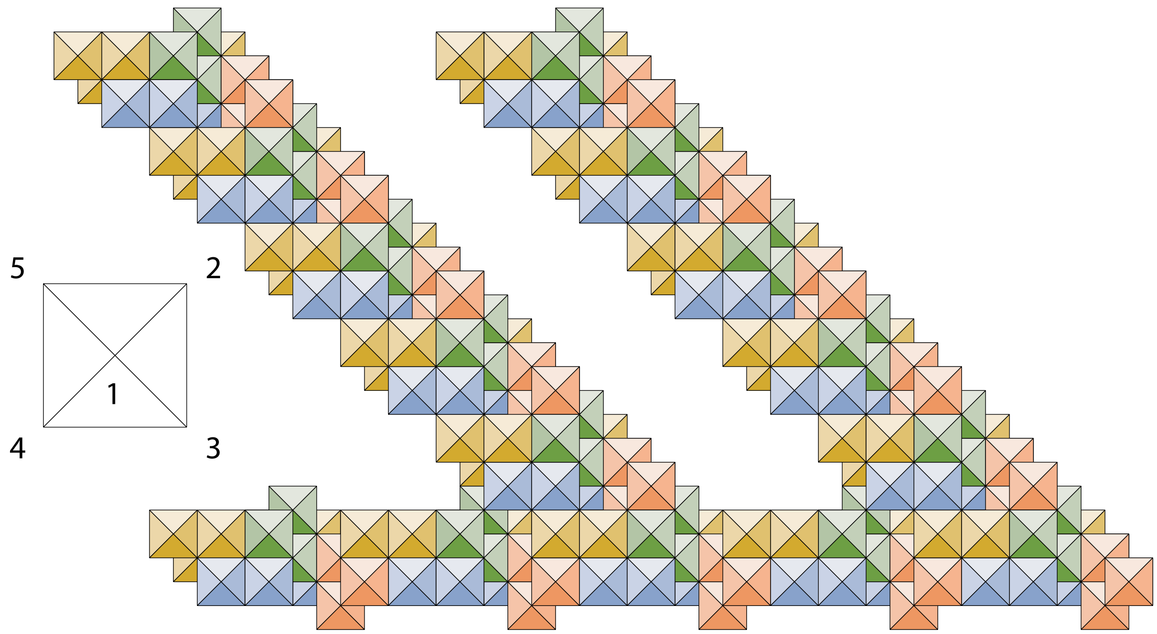


Fig. 9 OBGOBR–Two 1,4-strands linked by a 1,6-strand, true view

The figure shows two 1-4-strands composed of five OBGOBR di-triplets linked by a 1,6-strand which is also composed of five OBGOBR di-triplets. The axis of each1,4-strand makes an angle of 45-degrees with the axis of the1,6-strand. The 1,4-strand on the right makes a 1,4-join with the rightmost di-triplet of the 1,6-strand; the 1,4-strand on the left makes a 1,4-join with the middle di-triplet of the 1,6-strand.

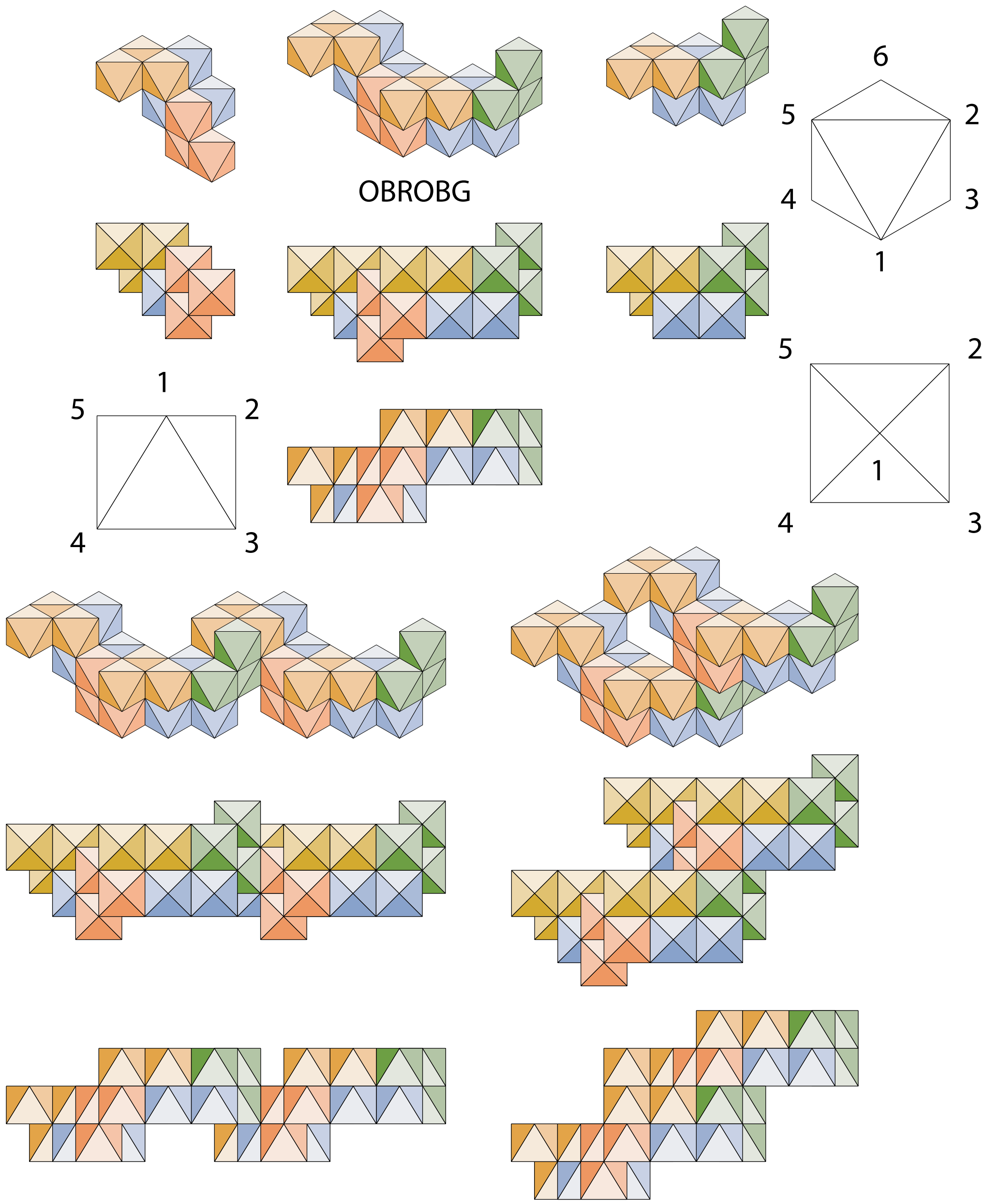


Fig. 10 OBROBG–The di-triplet and its 1,4- and 1,6 linkages in three projections

The di-triplet OBROBG is shown in a facial view in the middle of the top row of the figure flanked by its triplets. An octahedron in the same facial orientation with numbered vertexes is shown to its right.

The di-triplet with flanking triplets is shown in the second row in a vertexial view. An octahedron with the same vertexial orientation is shown on the right. The numbering corresponds to that of the facial octahedron above.

A view of the di-triplet alone occupies the third row. The viewing direction is parallel to the projection plane of the facial view of the di-triplet in the first row. A numbered view of an octahedron in the same orientation is shown to the left of the di-triplet.

Each of the glycogen linkages is shown using the same three views in the last three rows.

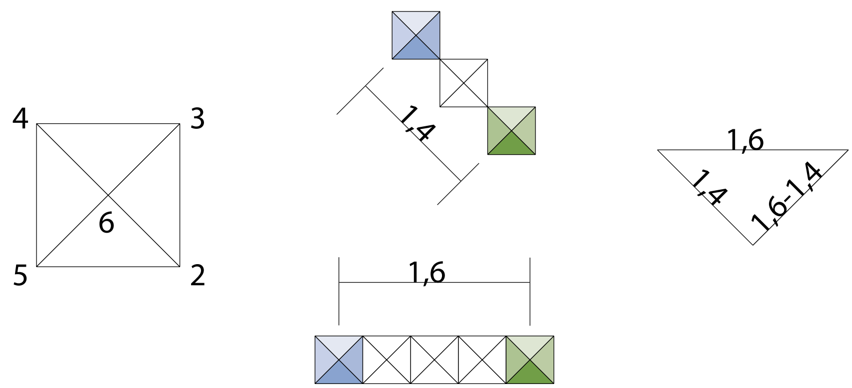


Fig. 11 OBROBG–Geometry of glycogen linkages

At the top of the figure, the 1,4-linkage results in the 1,4-vector shown. The move is from the blue octahedron to the green octahedron which is the vertexial move 2,2. The length of the vector is S*sqr(8).

The 1-6-vector is the result of the edgial move 32,4 which is from the blue octahedron to the green octahedron. The length of the vector is S*4.

The vector triangle is shown on the right of the figure. The length of the 1,6-1,4-vector is S*sqr(8).

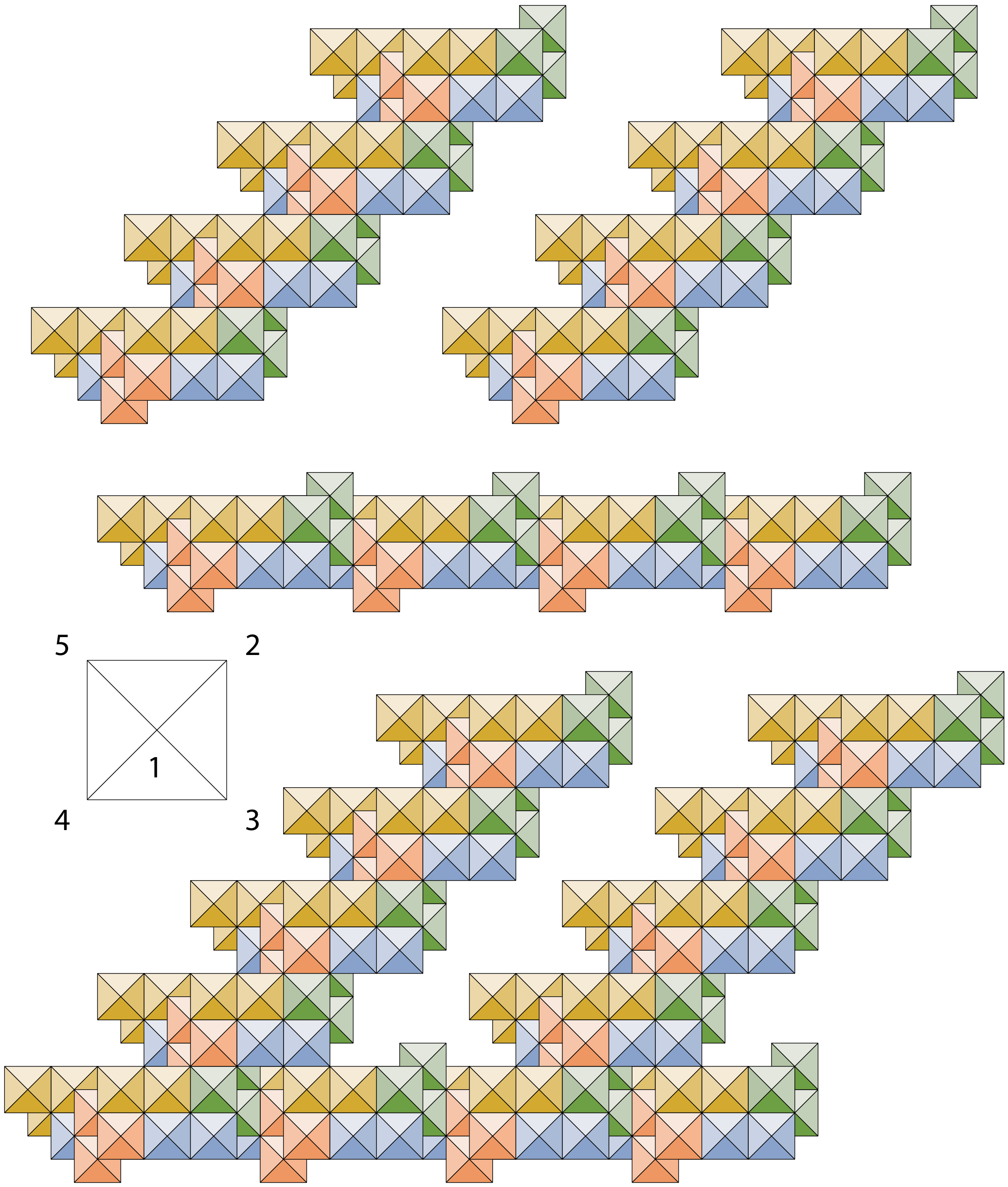


Fig. 12 OBROBG–1,4- and 1,6-strands
Two 1,4-strands consisting of four OBROBG di-triplets each are shown in the top row of the figure. A 1,6-strand consisting of four OBROBG di-triplets is in the middle row. At the bottom, each of the two 1,4-strands is joined to the 1,6-strand by a 1,4-linkage. The left strand is joined to the di-triplet at the left end of the 1,6-strand; the right strand is joined to the third di-triplet.

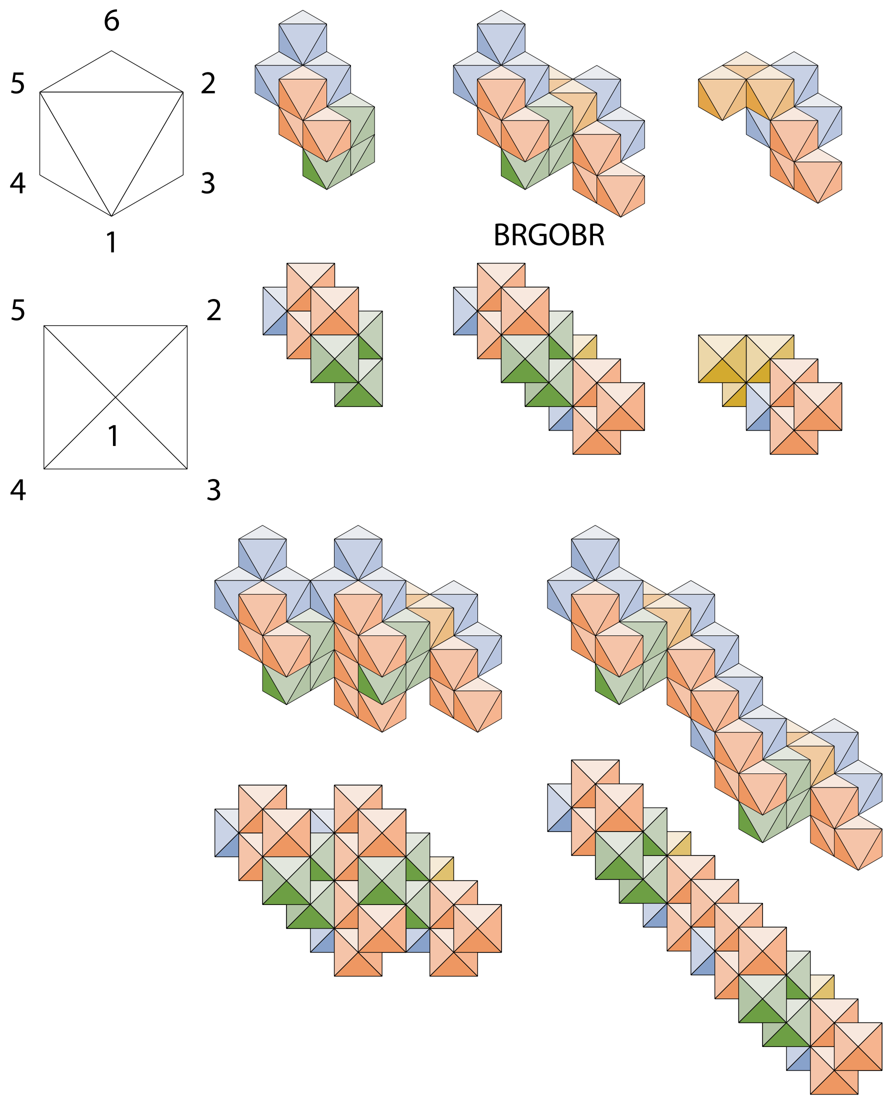


Fig. 13 BRGOBR–Two views of the di-triplet and its glycogen linkages

The BRGOBR di-triplet flanked by its triplets is shown in an octahedral facial view at the top of the figure. In the second row, the di-triplet and its triplets are shown in a vertexial view. In the third row, two di-triplets are shown in a 1,4-linkage on the left and a 1,6-linkage on the right.The green C-atom is in the 4-position and the red C-atom on the end is in the 1-position.

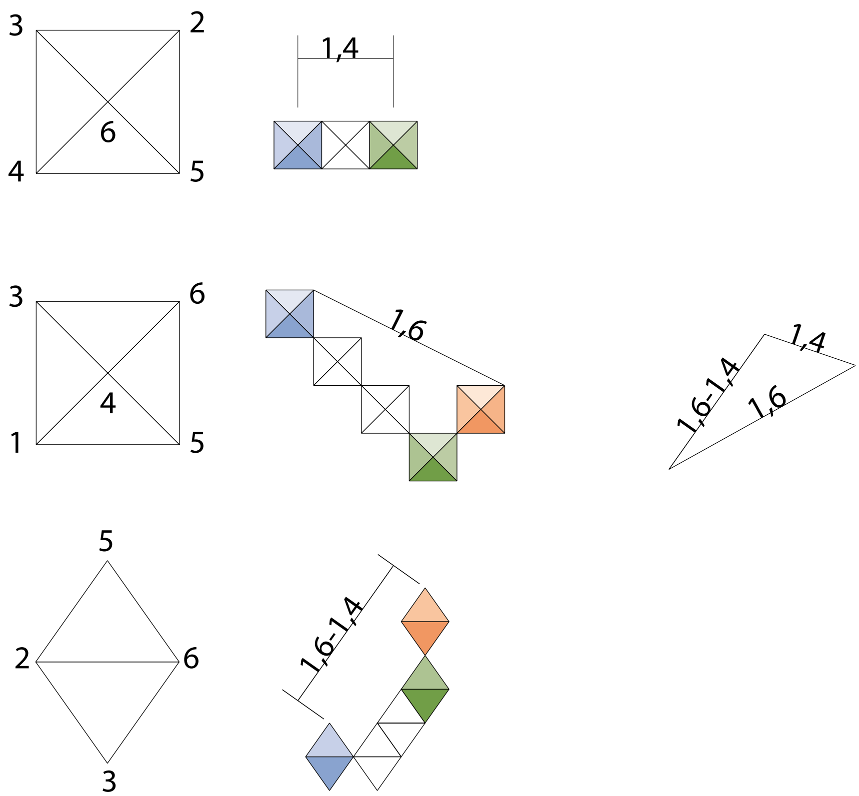


Fig. 14 BRGOBR–Geometry of the glycogen linkages

The 1,4-vector is shown at the top. It is the result of the edgial move 25,2 from the blue octahedron to the green octahedron. The length of the vector is S*2 where S is the edge length of the He-octa.

The 1,6-vector is shown in the middle row. It is the result of two moves. The first is from the blue octahedron to the green octahedron which is the vertexial move 5,3. The second move is from the green to the red and is the vertexial move 6,1. The length of the vector is S*sqr(20).

The 1,6-1,4-vector is shown in the bottom row. The move from the blue to the green is the facial move 546,1. The move from the green to the red is the vertexial move 5,1, The length of the vector is S*sqr(12).

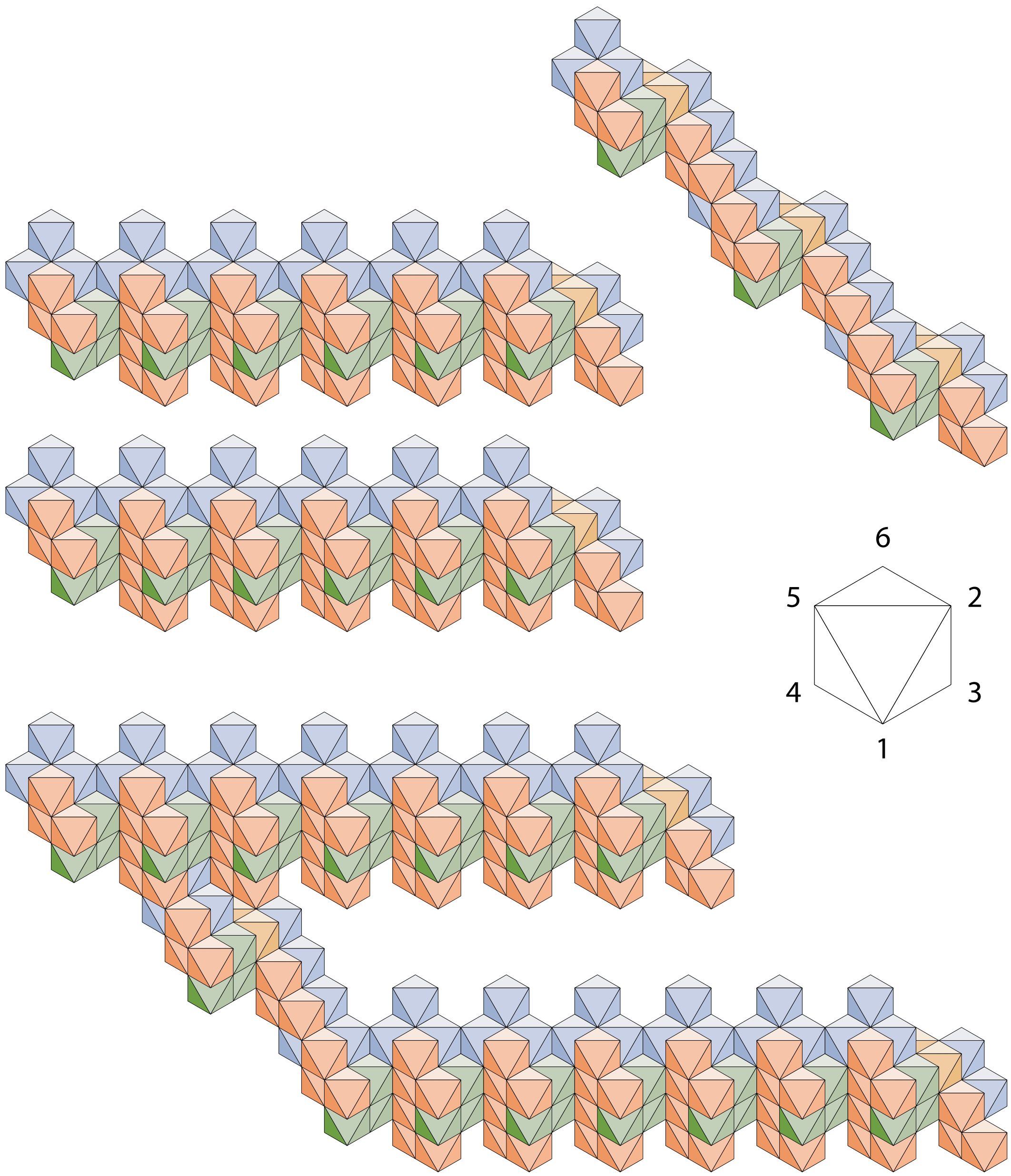


Fig. 15 BRGOBR–1,4- and 1,6-strands

A 1,6-strand consisting of three BRGOBR di-triplets is in the upper right of the figure. In the upper left are two identical 1,4-strands consisting of six of the same di-triplets. At the bottom, the two 1,4-strands have been linked by the 1,6-strand.

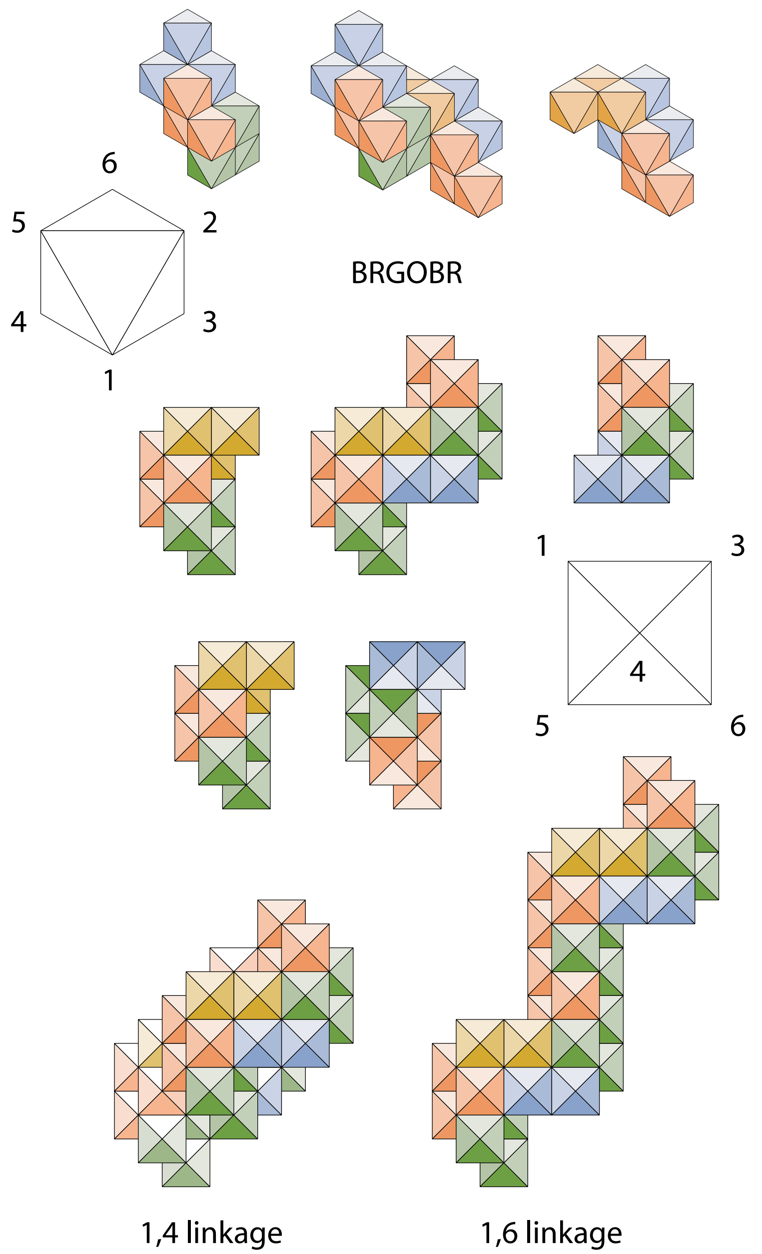


Fig. 16 BRGOBR–A vertexial view of the di-triplet and its glycogen linkages

This vertexial view of the BRGOBR di-triplet was chosen because it is perpendicular to the plane of the di-triplet. The di-triplet with its triplets shown separately on either side is shown in a facial view at the top of the figure. The vertexial view of the same units is shown in the next row. In the next row, the two triplets are shown side by side. The triplet on the right has been rotated 1/2-turn to point up the relationship of the two. At the bottom, two di-triplets with a 1,4-linkage are shown on the left; two di-triplets with a 1,6-linkage are shown on the right.

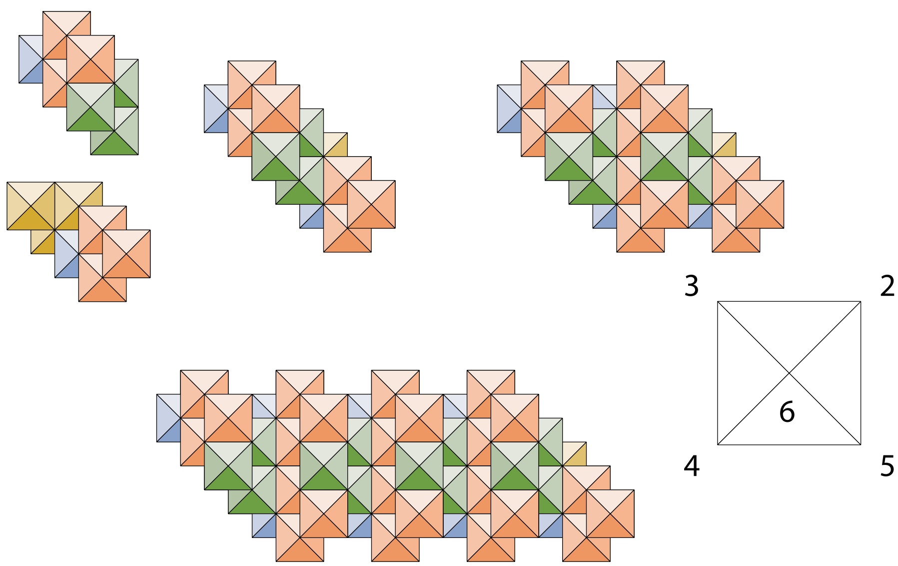


Fig. 17 BRGOBR–True view of a 1,4-strand

The BRGOBR di-triplet is shown in the middle of the top row. On the left of the row, the two triplets are shown separately. On the right there are two di-triplets with a 1,4-linkage. A 1,4-strand consisting of four di-triplets is shown at the bottom. The axis of the strand is parallel to the projection plane and provides a true view of it.

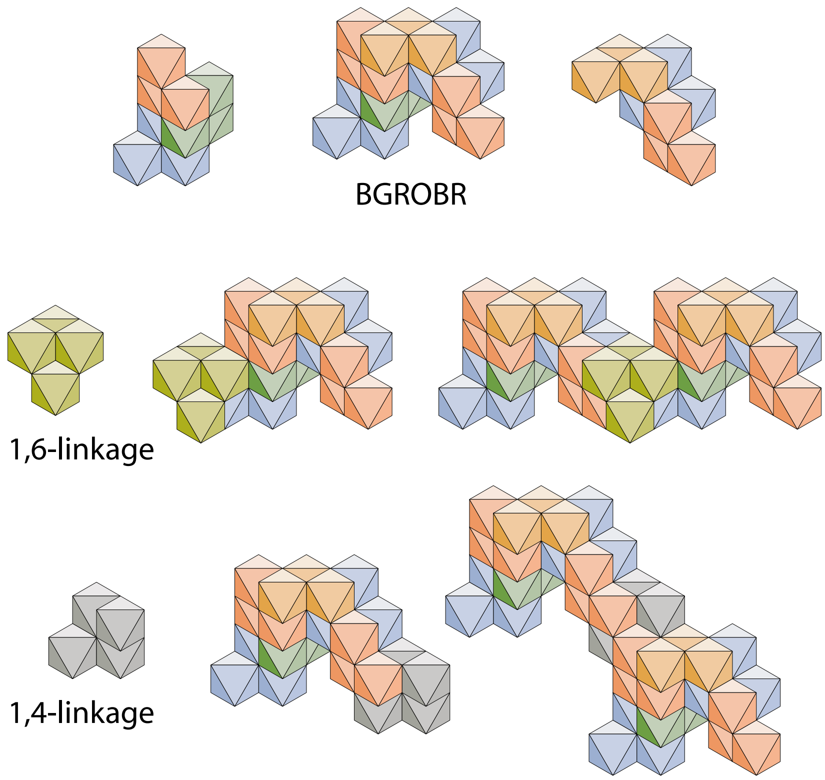


Fig. 18 BGROBR–The di-triplet and its glycogen linkages
The di-triplet BGROBR is shown in the middle of the top row flanked by its two triplets.In the second row, the O-atom on the left joins with the blue C-atom at one end of the di-triplet to form the assembly shown in the middle of the row. The red C-atom at the end of a second di-triplet joins with the O-atom to produce the 1,O,6-linkage at the right side of the second row. The O-atom at the left side of the bottom row joins with the red C-atom at the end of the di-triplet to form the assembly in the middle of the row. The inner red C-atom of an identical di-triplet joins to the assembly to form the 1,O,4-linkage on the right of the bottom row.

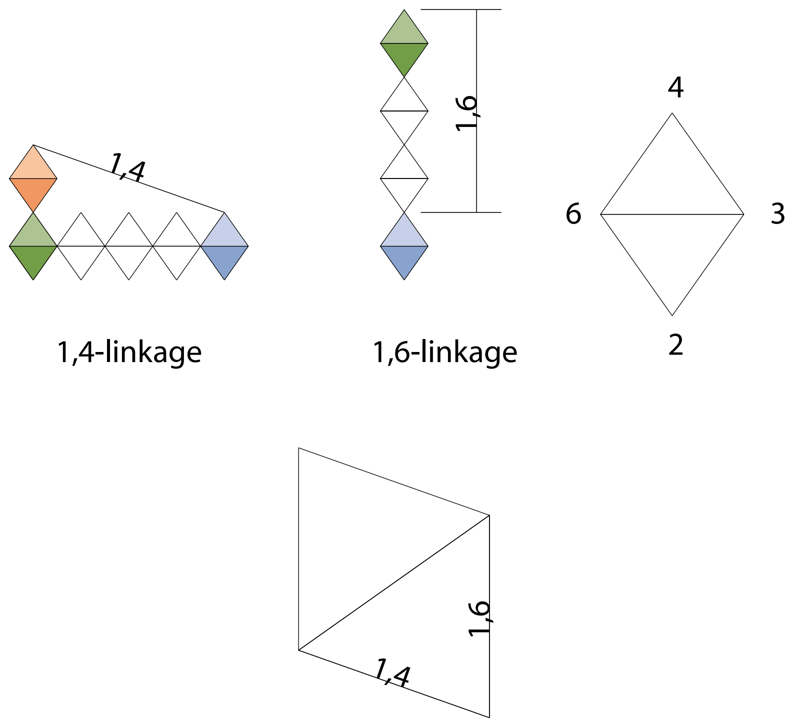


Fig. 19 BGROBR–Geometry of glycogen linkages

The figure shows the vectorial geometry of the 1,O,4- and 1,O,6-linkages of the BGROBR di-triplet.

The 1,4-linkage is the result of two octahedral moves. The move from the blue octahedron to the green octahedron is 56,4, and the move from the green octahedron to the red octahedron is 4,1. The length of this vector is S*sqr(18) where S is the length of the edge of the He-octa. The 1,4-vector makes an angle with the bottom of the page of atn[sqr(1/8)].

The 1,6-linkage is the result of one octahedral move from the blue octahedron to the green octahedron. It is 4,3 and its length is S*sqr(18).

The relationship between the two vectors is shown in relation to an octahedron in a different orientation. Each vector is the altitude of a face of the octahedron. The angle between the vectors is atn[sqr(8)].

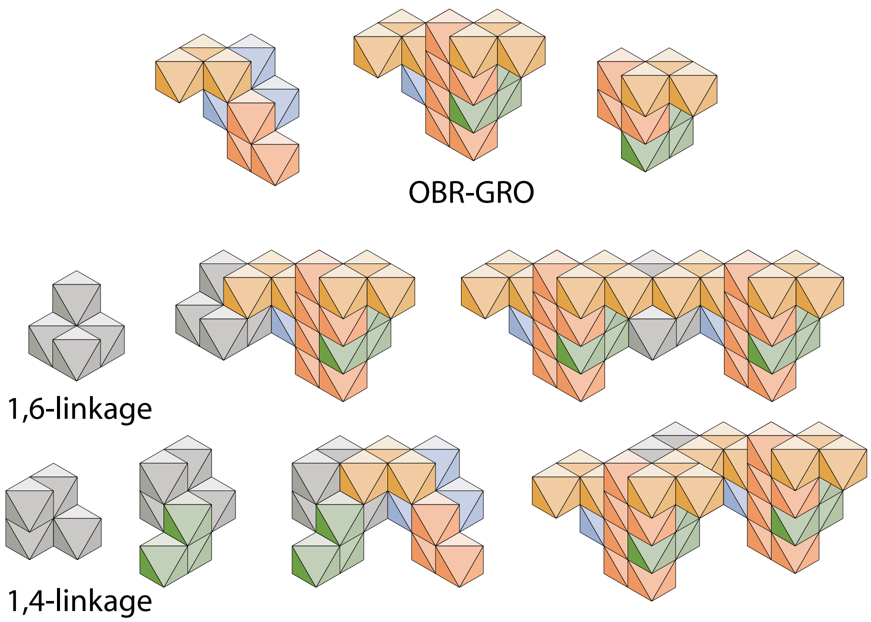


Fig. 20 OBR-GRO–The di-triplet and its 1,O,4- and 1,O,6-linkages

The top row shows the OBR-GRO di-triplet flanked by its triplets.

In the middle row, the O-atom on the left joins with the C-atom on the left end of the di-triplet to form the assembly in the middle of the row. The orange C-atom on the right end of the di-triplet joins to the O-atom of the middle assembly to make the 1,O,6-linkage.

In the bottom row, the O-atom on the left is the link between the C-atom in the 1-position of one di-triplet and the C-atom in the 4-position of a second di-triplet. The green C-atom is in the 4-position and it joins with the O-atom in the manner shown. The orange C-atom of the OBR triplet joins with the O-atom in the manner shown. The green C-atom, O-atom, and orange C-atom comprise the 1,O,4-linkage. The pair of 1,O,4-linked di-triplets are shown on the right.

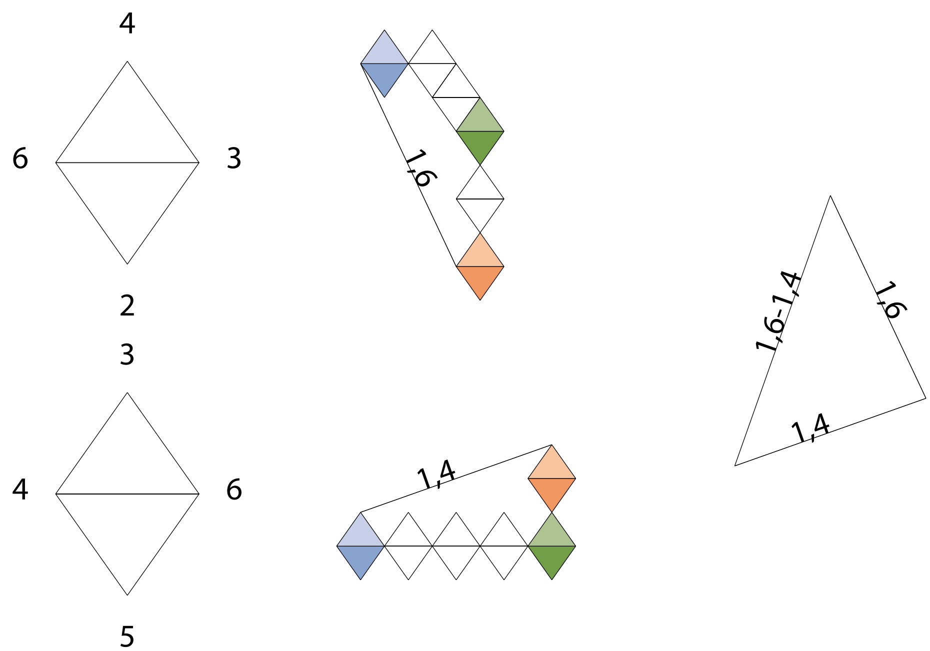


Fig. 21 OBR-GRO–Geometry of glycogen linkages

The relationship of the two OBR-GRO di-triplets joined by an O-atom in a 1,6-linkage is shown at the top of the figure. The first move is from the blue octahedron to the green octahedron and is the facial move 123,1. The second move is from the green to the red and is the vertexial move 2,2. The length of the vector is S*sqr(22).

At the bottom of the figure, the 1,4-link using an O-atom consists of two moves. The first move from the blue to the green is the edgial move 26,4. The second move from the green to the red is the vertexial move 3,1. The length of the vector is S*sqr(5)

The vector triangle is shown at the right of the figure. The angle between the 1,4-vector and the 1,6-vector is 118.515-degrees.

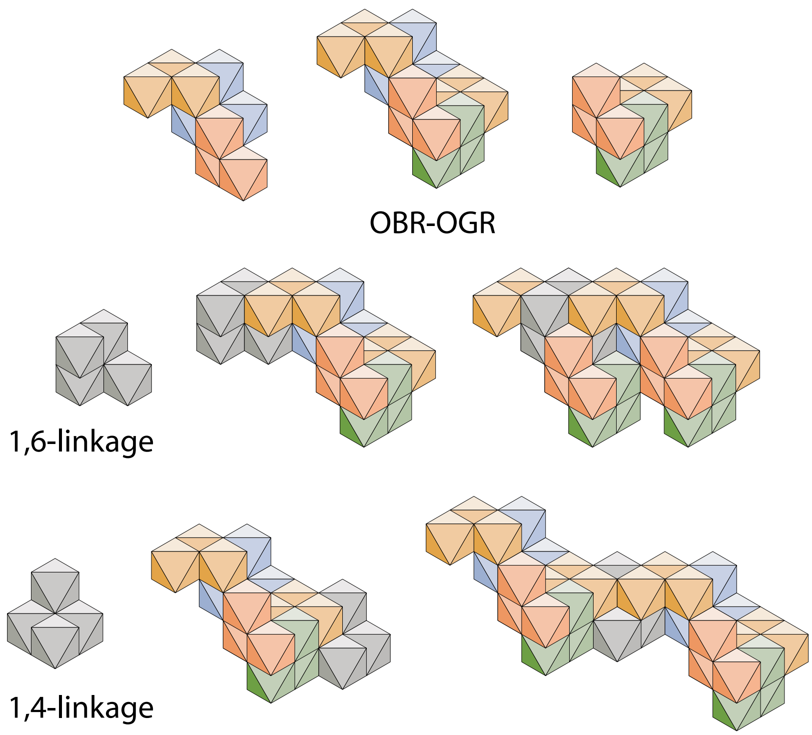


Fig. 22 OBR-OGR–The di-triplet with its 1,O,4- and 1,O,6-linkages
In the top row, the OBR-OGR di-triplet is shown with its triplets.

In the middle row, the O-atom on the left acts as the link between the orange C-atom at one end of a di-triplet and the red C-atom at the other end of an identical triplet to make a 1,O,6-linkage.

In the bottom row, the O-atom on the left links the orange C-atom at the end of one di-triplet with the orange C-atom at the 4-position of an identical di-triplet to form a 1,O,4-linkage.

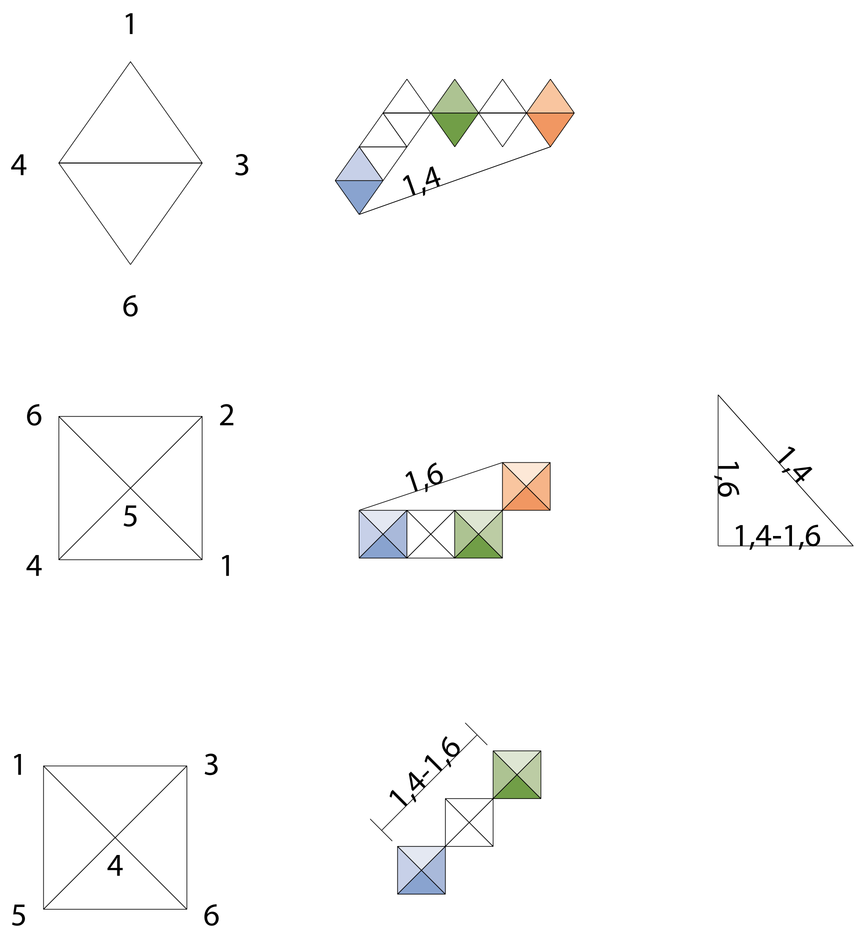


Fig. 23 OBROGR–Geometry of glycogen linkages

The 1,O,4 linkage is shown at the top of the figure. It consists of two octahedral moves. The first move is from the blue octahedron to the green octahedron and is the facial move 123,1. The second move is from the green octahedron to the red octahedron and is the edgial move 23,2. The length of the 1,4-vector is S*sqr(18) where S is the edge length of the He-octa. The vector lies in an edgial plane of the octahedron.

The 1,O,6 linkage is shown in the middle row. It consists of two octahedral moves. The first move is from the blue to the green and is the edgial move 21,2. The second move is from the green to the red and is the vertexial move 2,1. The length of the 1,6-vector is S*sqr(10). The vector lies is a vertexial plane of the octahedron.

The angle between the two vectors is atn[sqr(4/5)]. This is shown in the vector triangle on the right hand side of the figure. The vectorial difference is shown in the bottom row of the figure. The move is from the blue to the green octahedron and is the vertexial move 3,2. Its length is S*sqr(8). The angle between the 1,6-vector and the 1,4-1,6-vector is 90-degrees.

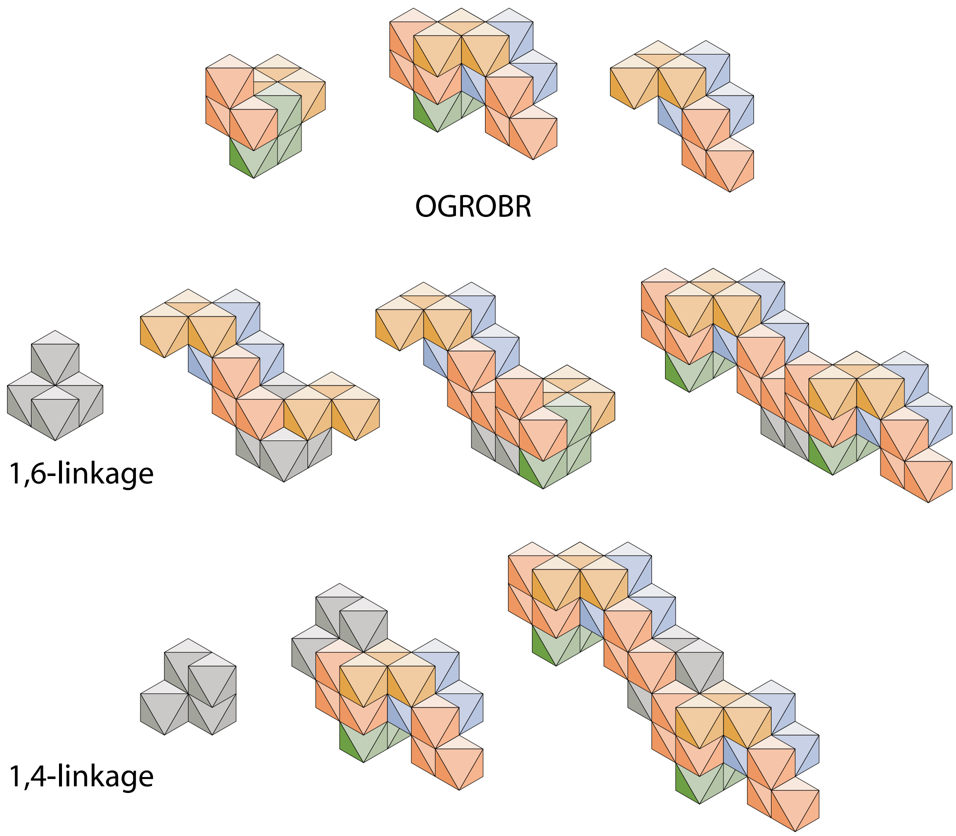


Fig. 24 OGROBR–The di-triplet and its 1,O,6- and 1,O,4-linkages

The OGROBR di-triplet is shown in the top row with its triplets on either side.

In the second row, the O-atom on the left is used to link the red C-atom at the end of one di-triplet to the orange C-atom of an identical di-triplet. The linkage is shown just to the right of the O-atom. The OBR triplet of one di-triplet is shown joined to the OGR triplet of the second di-triplet in the next assembly. The 1,O,6-linkage between two complete di-triplets is shown at the right side of the row.

In the bottom row, the O-atom on the left is joined to the red C-atom in the 4-position to form the assembly shown next. An assembly consisting of two1,O,4-linked di-triplets completes the row.

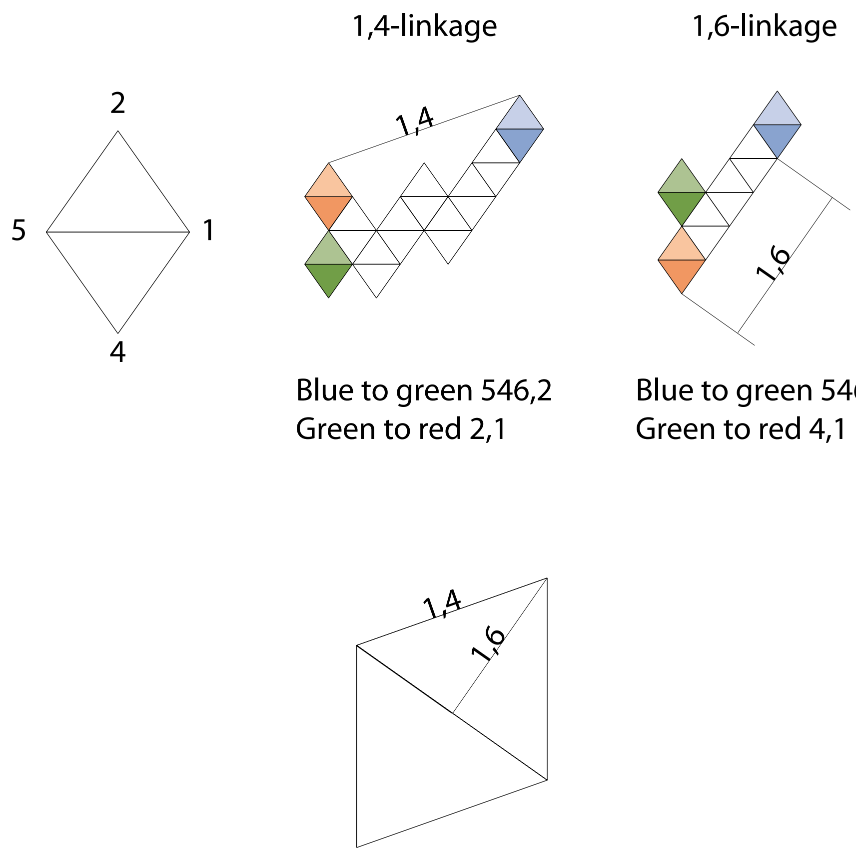


Fig. 25 OGROBR–Geometry of glycogen linkages

The figure shows the geometrical relationship between the move vectors for the 1,O,4-linkage and the 1,O,6-linkage between OGROBR di-triplets. The vectors are parallel to the projection plane and are to scale. The plane of the moves is octahedral edgial. The edgial view of the octahedron in the upper left of the figure has its near vertexes labeled and is the reference for the octahedral moves which define the linkage vectors.

The 1,4-linkage is composed of two octahedral moves. The 546,2 move is parallel to a facial diameter of the octahedron and is marked by the move from the blue octahedron to the green octahedron. The 2,1 move is parallel to a vertexial diameter of the octahedron and is marked by the move from the green octahedron to the red octahedron. The combined move is marked by the move from the blue octahedron to the red octahedron. This is represented by the vector labeled 1,4. Its magnitude is S*sqr(18) where S is the edge length of the He-octa.

The 1,6-linkage is composed of two octahedral moves. The 546,1 move is marked by the blue octahedron and the green octahedron; the 4,1 move is marked by the green octahedron and the red octahedron. The combined move is from the blue octahedron to the red octahedron and is parallel to an altitude of an octahedral face. It is represented by the vector labeled 1,6 whose magnitude is S*sqr(12).

At the bottom of the figure, the two vectors are shown in relationship to an edgial view of an octahedron in a different orientation.

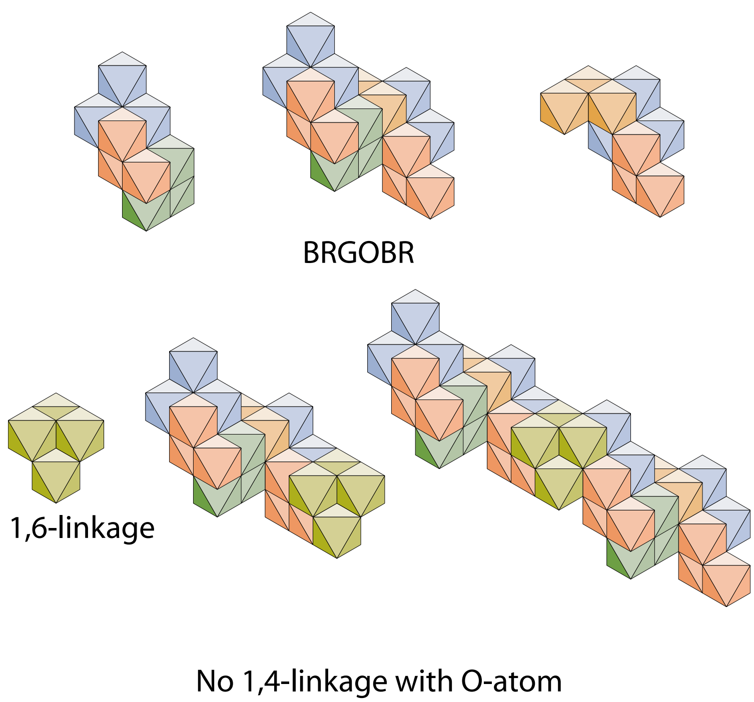


Fig. 26 BRGOBR–The di-triplet cannot make a 1,O,4-linkage

The BRGOBR di-triplet is shown at the top of the figure with its two triplets shown separately. The bottom row shows how an O-atom can link the red C-atom at the end of one di-triplet with the blue C-atom at the end of an identical di-triplet to form a 1,O,6-linkage. No 1,O,4-linkage was found.

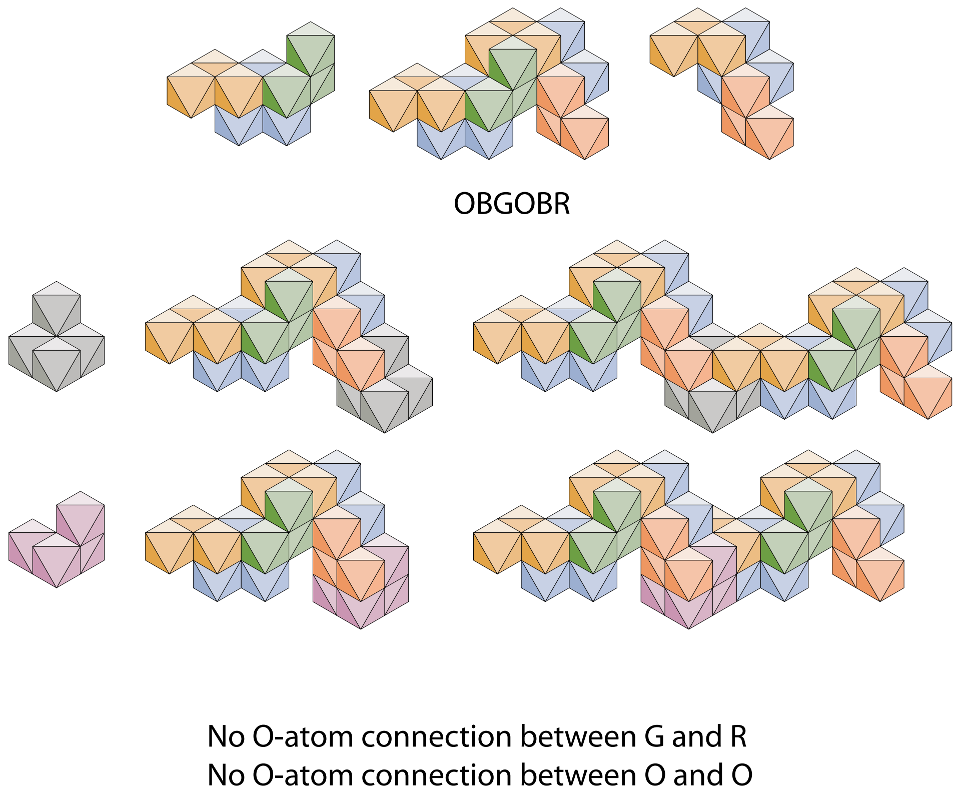


Fig. 27 OBGOBR–Linking 1,6 and 1,4 with O-atoms

The figure shows two ways in which two OBGOBR di-triplets can be linked with an O-atom. In the middle row, the gray O-atom on the left joins with the red C-atom to form the middle unit. The orange C-atom of a second di-triplet joins with the O-atom to make a 1,6-linkage. In the bottom row, the violet O-atom is used to link the same two di-triplets. Either the red C-atom or the orange C-atom could be the 1-position. In one case, the green C-atom is in the 4-position; in the other case, the orange C-atom is in the 4-position. No connection can be made between the green C-atom and the red C-atom using an O-atom as a link. The same is true for the two orange C-atoms. So, the OBGOBR di-triplet cannot make glycogen.

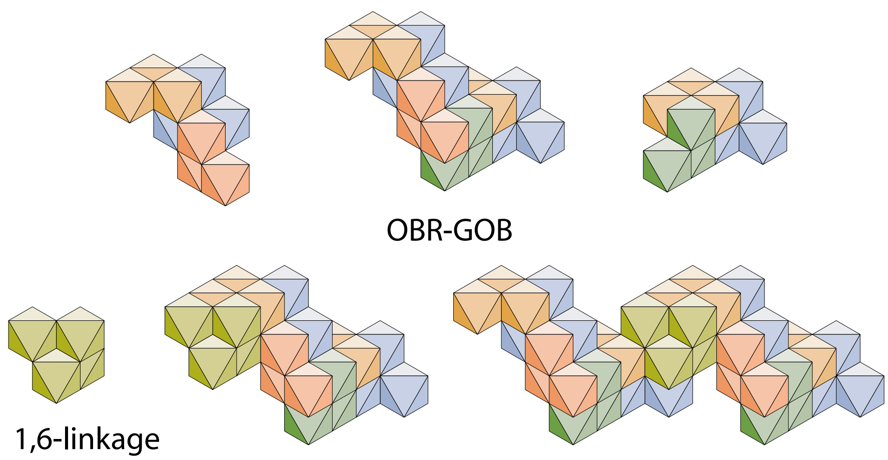


Fig. 28 OBR-GOB–Linking 1,6 and 1,4 with O-atoms

The second row of the figure shows how two OBR-GOB di-triplets can be 1,6-linked with an O-atom. The orange C-atom at one end cannot be linked to the green C-atom with an O-atom; the blue C-atom at the other end cannot be linked to the red C-atom by an O-atom. OBR-GOB di-triplets cannot be linked by O-atoms to produce both 1,4 and 1,6 strands characteristic of glycogen.

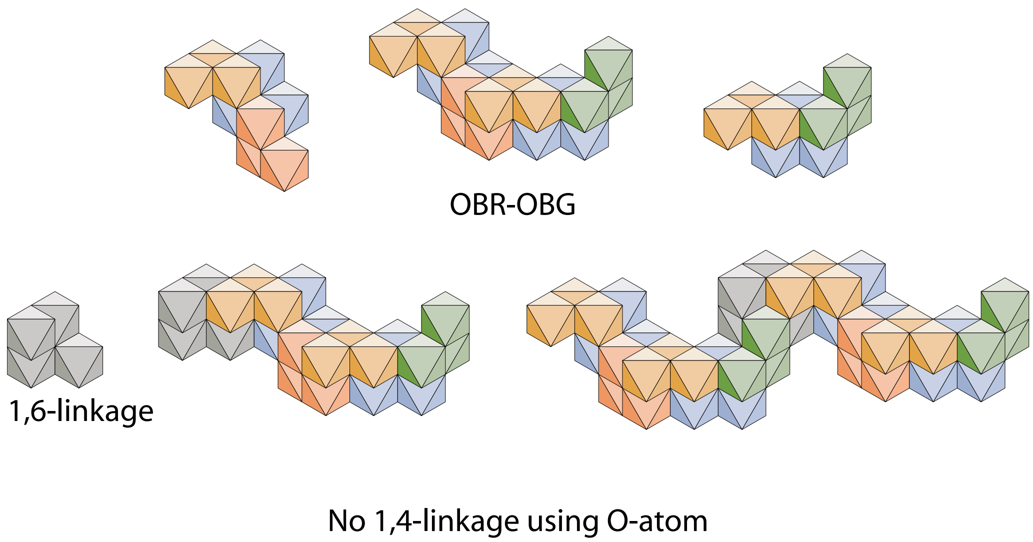


Fig. 29 OBR-OBG–Linking 1,4 and 1,6 with O-atoms
The second row of the figure shows how an O-atom can join the end C-atoms of two OBR-OBG di-triplets to form a 1,6-link. Neither the inner orange C-atom nor the red C-atom can be joined to the appropriate end C-atom to produce a 1,4-link.

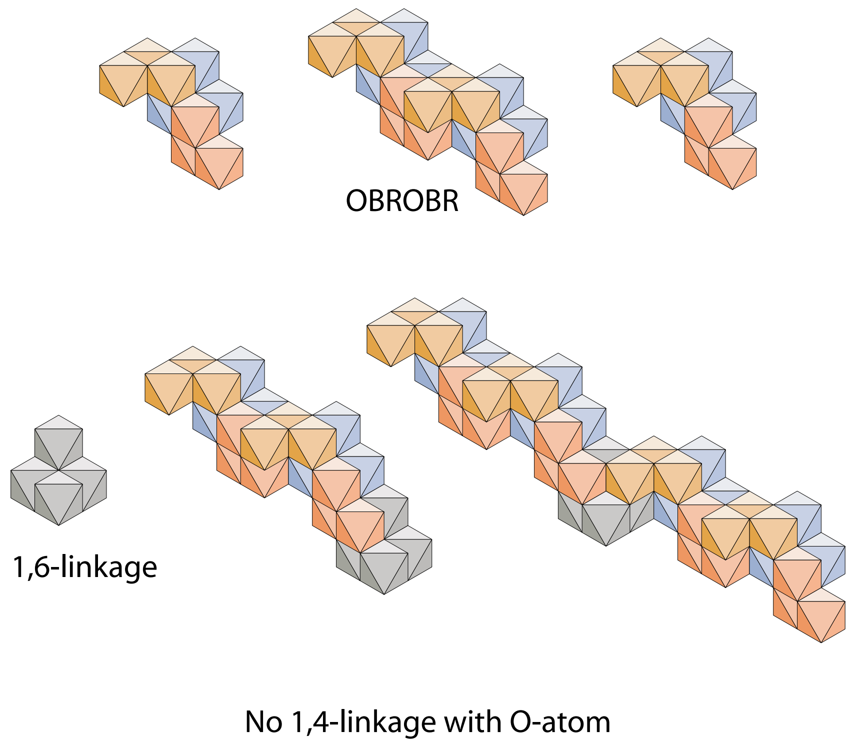


Fig. 30 OBROBR–Linking 1,4 and 1,6 with O-atoms

The second row of the figure shows a way of linking two OBROBR di-triplets by their end C-atoms using an O-atom as a link. Neither of the end C-atoms can be linked by an O-atom to the appropriate inner C-atom whether orange or red.

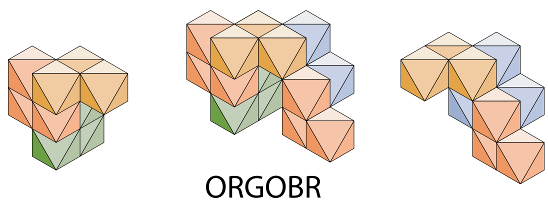
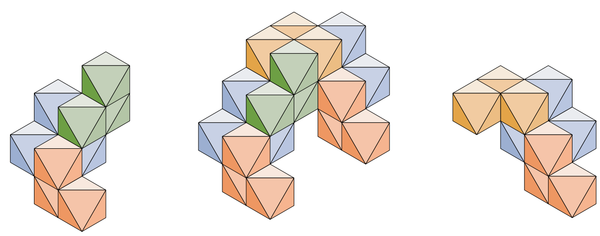


Fig. 31 ORGOBR–Linking 1,4 and 1,6 with O-atoms
The ORGOBR di-triplet cannot make a1,6 strand using an O-atom as a link.



RBGOBR

No O-atom link between R and R

Fig. 32 RBGOBR–Linking 1,4 and 1,6 with O-atoms
The end C-atoms of RBGOBR cannot be linked with an O-atom to form a 1,6 strand.