

# **ROSALIND UNRAVELS THE BUNDLE OF LIFE**

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AD HONOREM  
ROSALIND FRANKLIN

**JORDAN ALEXANDER KEY**  
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## ROSALIND UNRAVELS THE BUNDLE OF LIFE

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FOR  
ANNE LAVER

Duration: c. 9"

Summer, 2021

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## Rosalind Franklin:

Rosalind Franklin (1920 – 1958) was a British chemist and X-ray crystallographer, whose pioneering work was pivotal to our present understanding of the molecular structure of DNA, as well as RNA, viruses, coal, and graphite. Rosalind is best known now for her work on the X-ray diffraction imaging of DNA crystals during her time at King's College in London. Her X-ray diffraction pattern, Photo-51, was the image that ultimately led to the deduction that DNA has a double helix structure.

Rosalind's significant contributions to the discovery of the structure of DNA were largely unrecognized during her life, her work and data having been taken, used, and uncredited by the commonly recognized scientists James Watson (b. 1928) and Francis Crick (1916 – 2004), who were jointly awarded the Nobel Prize for Medicine in 1962, along with Maurice Wilkins, "for their discoveries concerning the molecular structure of nucleic acids and its significance for information transfer in living material."

Rosalind's contributions in deciphering the structure of DNA also went unrecognized by the Nobel Prize committee. Franklin was dead by the 1962 Nobel Prize award. The current rules prohibiting posthumous nominations or splitting the Prizes more than three ways were not extant until 1974, thus allowing the Prize committees to nominate Rosalind anytime between 1962 and 1974. However, the seminal papers of Watson and Crick did not properly cite Rosalind's work and so few people knew of her contributions until much later.

Beginning in 1975, Rosalind Franklin's contributions have been publicized and vindicated. Watson and Crick, despite their highly questionable research and citation practices and perhaps conscious exploitations of a disempowered female colleague, still hold the recognition of the Nobel Prize and title "discoverers of DNA."

Rosalind Franklin died in 1958 at the age of 37 from ovarian cancer contracted from working intimately with radioactive materials during her work in X-ray crystallography. Both Watson and Crick have lived long and productive lives, Francis Crick lived to 88 and James Watson is still alive at the age of 93. Likely, their longevity owes to not having had to work with highly radioactive X-ray technology during the mid 20<sup>th</sup>-century to make their "discovery."

The inscription on her tombstone reads:

IN MEMORY OF  
ROSALIND ELSIE FRANKLIN  
DEARLY LOVED ELDER DAUGHTER OF  
ELLIS AND MURIEL FRANKLIN  
25TH JULY 1920 – 16TH APRIL 1958  
SCIENTIST  
HER RESEARCH AND DISCOVERIES ON  
VIRUSES REMAIN OF LASTING BENEFIT  
TO MANKIND  
ת נ צ ב ה

The final characters on the tombstone are the Hebrew initials for “her soul shall be bound in the bundle of life.”

## **Story of the Music:**

This work, *Rosalind Unravels the Bundle of Life*, was written for organist Anne Laver and was originally intended for performance on the Italian Baroque Organ at the Memorial Art Gallery at the Eastman School of Music (further information about the organ given below), though this piece can be played on any organ. The form of the work is intimately tied to both the program of Rosalind's contributions to the discovery of DNA's helical structure and to the tuning of the pipe organ itself. The title of the work is referential to the epitaph on Rosalind Franklin's tombstone.

The form of the work generally is taken from the rather obscure 15<sup>th</sup> and 16<sup>th</sup> century form of a “modal spiral,” wherein through a progressive application of *musica ficta* one modulates either one semitone up or down by the conclusion of the piece. This odd modal modulation is necessitated by an initial, carefully placed contrapuntal moment, wherein if one chooses to apply some seemingly logical or necessary *ficta* to one note often to avoid a tritone harmony) another *ficta* is required on some nearby subsequent note, which itself will necessitate another *ficta* on some subsequent note. This domino effect of *ficta* continues until the end of the work, by which time all flats are either flattened or sharpened. Pieces of this style tend to follow progression of flats and modulate from some modal center of C or G to some center on C-flat (B) or G-flat (F-sharp). The pieces are rarely (perhaps only one known example) notated with the *ficta* given; these conceits are often obscured and only suggested by the text (title or lyrics), shape of the music given (as in the circular work *Salve Radix*), and/or by some canonic key. This conceit gives the work a modal “spiral” progression, spiraling around the circle of 4ths, and hence the name “modal spiral.”

We, however, are not dealing with spirals in this work, but helices. Thus, this work has two contrasting spirals, one moving forward through the piece and one moving backwards. Though we will not hear the piece played backwards, the modal scaffolding of the work presents two intertwining modal layers. At times, one layer will be more present than the other, but occasionally both appear together in equal proportion, creating moments of high pitch density and dissonance. Consequently, the harmonic scheme of the work follows two intertwined and chirally opposed modal spirals, namely a “modal helix.”

In addition to these two contrasting modal spirals, this work also presents two intertwined and contrasting rhythmic layers, which emerge both through cross-related, indivisible accent patterns and through the alternation between two tempos, which are related through a dectadic rhythmic hierarchy.

This helical, modulatory form was selected due to the tuning of the pipe organ, which is not in equal temperament. Thus, “key signatures” distal from C-major will sound very “out of tune.” Consequently, the work slowly progresses us from something that will sound highly “in tune” to something that sounds highly “out of tune:” G-major/mixolydian to F-sharp (G-flat) major/mixolydian. In my mind, this progression from a harmonic space familiar to us (“in tune”) to a space that is perhaps wholly alien sounding (“out of tune”), stands as a musical counterpart to X-ray crystallography.

In X-ray crystallography, one takes images that are simple geometric projections of more complex structures; these simple images, taken from various angles and giving various projections, must then be collectively interpreted to understand the 3-dimensional structure of an object that is not directly or easily observable. For example, the famous Photo-51 is not a helical image but an X-shape. It takes much experience as an X-ray crystallographer and understanding of the chemical structure of crystals to know that such a shape is indicative of a helix.

Thus, when we see or when Rosalind saw Photo-51, we are only seeing a projection, something that only points to the complete reality of something but does not and cannot give us a complete representation of it. To get a better understanding of the real object itself, we must take many projections (or have foreknowledge of many projections) and consider them collectively.

Similarly, a tuning system is like a complex crystalline structure, and a key (or mode) is only a particular projection of that pitch space, which itself is only one possible pitch space (or crystalline structure) possible in the universe of pitch. Thus, we can take a projection of our pitch space, let’s say G-major; given the pitch space we are imaging, G-major is clear and seemingly understandable, but taken from another vantage point, let’s say F-sharp major, the image is very different and seemingly unrelated, though both are projections of the same pitch object. To understand all this pitch space, we need to take and compare each projection, each key mode progressively, juxtapositionally, and collectively. Ultimately, our

pitch space resides behind these projections, and the universe of all possible pitch spaces is behind this singular crystalline pitch structure, which itself is merely a one configuration or metaphorical projection of all possible pitch spaces.

Photo-51 is only one projection of a vastly dense and complex 3-dimensional structure. Similarly, when we listen to the harmonic transformation of this organ from “in tune” to “out of tune,” we are observing singular projections, sometimes in succession and sometimes in juxtaposition, of a vastly more complex structure, which itself is not as easily observable. As Rosalind unraveled the mystery of life through the lens of X-ray projections of a crystal, we similarly unravel the life of an instrument through the various projections of its inner, metaphorical DNA that determines all its pitch capabilities: melody, harmony, counterpoint, mode, ambitus, and timbre. We cannot necessarily see the mechanisms (physical or mathematical) that give it such a “crystalline” structure, but we can indirectly observe the crystal through the projections of various tonalities and modalities.

## The Instrument:

The pipe organ is owned by the Eastman School of Music and is placed in the Fountain court of the University of Rochester's Memorial Art Gallery.

Size: 22' tall, 9' wide, 600 pipes

Builder: unknown, c. 1770

At the time of this composition, it is the only full-sized Italian baroque organ in North America. The keyboard has been kept in the condition in which it was found, therefore one can see the feel the grooves of centuries of fingers playing on it. It is representative of a typical Italian organ.

Characteristics:

- One manual
- Small pedalboard with short octave (see below)
- A single (spring or slider) windchest
- Limited number of stops
- Soft vocal sound of Principal 8' (the aesthetic was close to the vocal repertory)

Specifications, 14 stops:

Manual: C2 to C6

- Principale bassi 8'
- Principale soprano 8'
- Ottava 4'
- Decimaquinta 2' (reconstructed pipes)
- Decimanona 1 1/3'
- Vigesima Seconda 1'
- Vigesima Sesta e Nona 1/2' and 1/3'
- Flauto in ottava 4'
- Flauto in duodecima 2 2/3'
- Flauto in XVII 1 3/5' (from F2)
- Voce Umana (from D2)
- Tromboncini bassi
- Tromboncini sopranis

Pedal: C2 to G3 (lowest 6<sup>th</sup> has no accidentals, accidentals begin at A#2)

- Contrabassi 16'
- Tamburo (C#3, D#3, F#3, G#3)

Tiratutti (Ripieno)

Uccelliera

More information can be found here:

<https://www.esm.rochester.edu/organ/instruments/italian-baroque/>

# Notes on Registration and Notation:

## REGISTRATION

Though this piece is written for a very particular instrument, given I wish the work would be potentially performed on any organ, there are no particular registrations suggested. However, I will give some general suggestions, which may or may not be taken into consideration. Ultimately, I trust the taste and orchestration capabilities of the organist.

Suggestions:

1. General comments applicable to any organ:
  - a. All staccato marks need to be taken into consideration with the instrument and space. The staccato should not sound too short as to sound foreshortened or awkwardly terse. There should simply be a sense of *detaché* playing on repeated notes or where there are staccato markings. Where there are slurs, one should play less *detaché* and more *legato*. Naturally, the shortness of the staccatos and the degree of attachment in the slurs will vary depending on the reverberance of the space.
  - b. Where there are tenuto markings, the note should be ever so slightly stretched. It should not feel artificial, but like a slight and natural *rubato*.
2. If on **simple organs**:
  - a. The work is not intimate, but joyous. Thus, if changes in registration are not available, I suggest a bright and somewhat loud character throughout.
3. If on **more complex organs**:
  - a. The work is not intimate, but joyous and bombastic. However, the piece has moments where there can be a dynamic pull-back for dramatic effect. If the organist sees fit, there are many possibilities for registration change (and use of swell/crescendo pedal) to allow for dramatic shifts and effects. I fully encourage the organist to explore these possibilities if the instrument allows.

- b. The piece was designed for a one-manual instrument, but the piece should be played on multiple manuals with various sounds if the organist and instrument can facilitate this. I can and did imagine various instrumental choirs between the left and right hands (sometimes one with a solo reed and one on something like accompanimental flutes and/or principles). Thus, look for opportunities for soloistic, echo, and general orchestration changes. In my own organ playing, I try to be as colorful as my skills allow. I would be thrilled to hear this work with many, vibrant, colorful, and dramatic changes in timbre as we also shift dynamically through tonal spaces.
  - i. Note: even specialized stops like the Zymbelsten are not sacrilegious. Be creative but use good taste always!

## NOTATION

This piece was originally conceived using Jordan Key's system of pan-rational rhythmic notation. The application of tempo changes is a compromise to make the reading of the music perhaps easier for those uncomfortable with the rhythmic notation. **Versions of both notations are provided in this score.**

First given is the version with tempo changes. These tempo changes are proportional to 4:5. In essence, the notes that are under Tempo II ( $\text{♪} = 128 \text{ bpm}$ ) are 8<sup>th</sup> and 16<sup>th</sup> notes, while the notes under Tempo I ( $\text{♪} = 320 \text{ bpm}$ ) are 8<sup>th</sup>-note quintuplets by comparison to the 8<sup>th</sup> notes in Tempi II. Perhaps more simply put, the “8<sup>th</sup>-notes” under Tempo I are actually 20<sup>th</sup>-notes and the “8<sup>th</sup>-notes” under Tempi II are true 8<sup>th</sup>-notes with all notes sharing a common whole note at 16 bpm.

Thus, the second given score does not have tempo changes, but rather time signature changes between dyadic and dectadic rhythmic hierarchies (see explanation of pan-rational rhythmic notation below), which allows for the fluid interchange and intermingling of note values that are powers of 2 (half, quarter, 8<sup>th</sup>, 16<sup>th</sup>, etc) as well as powers of 5 and multiples of 2 and 5 (5<sup>th</sup>, 10<sup>th</sup>, 20<sup>th</sup>, 25<sup>th</sup>, 40<sup>th</sup>, etc.). If one wishes to read from the pan-rational rhythmic score, I suggest reading the explanation of the system given below. Otherwise, simply follow the tempo changes precisely.

# Explanation of Pan-Rational Rhythmic Notation:

This work uses what I call “pan-rational time signatures” (known elsewhere and erroneously as “irrational time signatures”). I do not call them “irrational” since they are in no way “irrational” (either psychologically or mathematically). They are “rational” proportions, but do not use powers of 2 for the bottom number (not written over 2, 4, 8, 16, 32, 64, etc.). Such a system of time signature grew out of questions like “why isn’t there a ‘fifth’ or ‘third’ note?” Well, many music teachers will simply say, “because there isn’t one,” but of course there is.

What we call a triplet is actually just some multiple or divisions of a “third note,” and similarly the quintuplet some “fifth note.” Systems of subdividing fundamental note values (like the breve or whole-note) into groups other than “dyadic-rationals” (note subdivisions in the form  $\frac{1}{2^n}$ ) into “pan-rationals” (third, fifth, seventh as compared to half, fourth, eighth, sixteenth, etc.) have existed at prior points in music history (particularly the late Middle Ages and Renaissance), using uncommon and arcane systems of mensuration. Such systems have long fallen out of favor; however, if reincorporated into our system of musical language, they can allow for the fluid notations of some rather complex rhythmic ideas without the use of excessive tempo changes or tuplet (and embedded tuplet) markings.

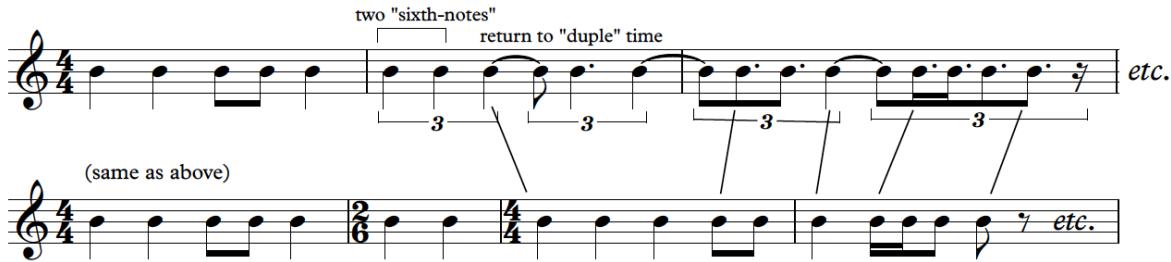
This work employs my system of pan-rational rhythmic notation to execute a rhythmic hierarchy with not only dyadic note subdivisions, but also notes that are pentadic and dectadic (note subdivisions in the form of  $\frac{1}{5^n}$  and  $\frac{1}{2^n5^m}$ , e.g. 5<sup>th</sup>-notes and their subdivisions and combinations with dyadic values, like 10<sup>th</sup> notes). Thus, this piece employs a whole-note value that is simultaneously dyadically (2), pentadically (5), and dectadically (2\*5) divisible.

The system of pan-rational rhythmic notation (“pan-rationalism”) is the culmination of my dissertation, which surveyed past and present systems of exceptional rhythmic notation in an effort to understand how systems of “non-dyadic” rhythmic notation came into being and why/how they disappeared from use in order that I could fashion a better, more comprehensive system that would allow for the notation of any subdivision or combination of note values apart from tuplets and the requirements of their aggregation. By this, I mean that pan-rational notation no longer requires exceptional rhythmic values be confined to tuplets, which themselves require their own completion and grouping. This grouping disallows easy intermingling of dyadic and non-dyadic rhythmic values and the presentation of non-dyadic rhythmic values without their compete set of related subdivisions (i.e. pan-rationalism permits the presentation of fractional parts of a tuplet).

For example, imagine if I wanted to write a quarter note triplet in a 4/4 time signature, but I only wanted two-thirds of that triplet (namely, two quarter notes of the three within the quarter-note triplet), and then I wanted to return directly to duple time with no hint of the prior triplet. What would I do? Well, I would have to write the two notes of the triplet, but then, in returning to the simple duple time from the 4/4, I would have to endlessly tie over values from within triplets.

However, if I just recognize that I can create “sixth notes,” then I can specify that I want two “sixth-notes” without the use of triplet and many ties subsequently. This can be done using a “pan-rational” time signature, namely 2/6. See Figure 1.

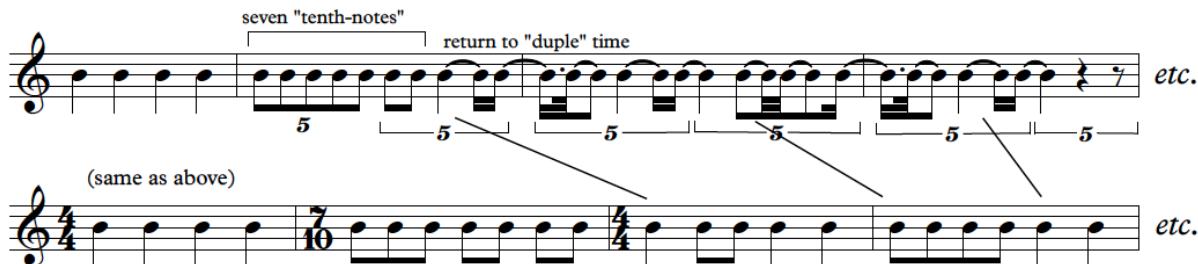
**Figure 1:**



Why “2/6” and “sixth-notes” rather than “third-notes”? Well, if we consider the “whole-note” as the fundamental value of rhythm (perhaps appropriately since it is “whole”), then to get the quarter-note triplets, we must recognize that the whole-note must be divided equally into six parts. Then, to get only two of these six equal divisions of the whole note, we simply specify “2,” just as one might specify “3” in 4 equal divisions of the whole to get 3/4 rather than 4/4.

Similarly, if we want seven units of five equal divisions of the whole note (1 and 2/5’s of an eighth-note quintuplet), we will recognize that we must divide the whole into 10 equal parts and play seven of those parts, thus requiring a 7/10 time signature and “tenth-notes.” See Figure 2.

**Figure 2:**



Such a system allows for the rapid alternation between different tempos without the use of tempo markings on each measure. Furthermore, it utilizes and recognizes those rhythmic fluctuations that are proportional to each other. The notational possibilities of non-dyadic time signatures as compared to tempo changes are demonstrated, in a rudimentary form, in Figure 3.

Figure 3:

The figure consists of three staves of musical notation, each with a different time signature and note values, demonstrating complex rhythmic structures.

- (with tempo changes)**: A staff in common time (indicated by a '4') with quarter notes. Above each note is a tempo marking:  $\text{♩} = 100$ ,  $\text{♩} = 150$ ,  $\text{♩} = 100$ ,  $\text{♩} = 150$ ,  $\text{♩} = 100$ ,  $\text{♩} = 150$ ,  $\text{♩} = 100$ ,  $\text{♩} = 150$ . The word "etc." follows the eighth note.
- (with non-dyadic time signature changes)**: A staff showing alternating time signatures: common time (4), 6/8, 4/8, 6/8, 4/8, 6/8, 4/8, 6/8. The notes are quarter notes. The word "etc." follows the eighth note.
- (with compound non-dyadic time signatures)**: A staff showing a time signature of  $5(2+3)$ . The notes are quarter notes. The word "etc." follows the eighth note.

Naturally, there are limits to the performability of such diverse rhythmic structures; consequently, the number of available non-dyadic rhythmic values is limited to a relatively small subset of low primes (2, 3, 5, 7, 11, 13, and maybe 17 and 19). Beyond such unique subdivisions, performability becomes exceedingly difficult and the difference between closely values rhythmic subdivisions becomes difficult to accurately perform and perceive. Thus, as the potential of performer of this piece, do not initially worry that the rhythmic subdivision contained herein might be unperformable; they are well within the capabilities of human performance and perception!

However, the challenge of this work (beyond the typically technical issues) is that this piece presents rhythmic structures that are unique to music at present (i.e. concatenations of various combinations of dyadic and tridecadic note values without their respective aggregates). However, I imagine the prospect of a wholly unique rhythmic world yet to be explored might be well-worth the new cognitive challenge.

To notate this music, I have made two general additions to our present system of rhythmic notation: first, the interpretation of time signature; second, the meaning of note shapes.

In regards to time signature, you will find the time signatures in this work are in the form of  $\frac{k}{2^n 5^m}$ , where the lower number designates the unique subdivisions available within the rhythmic hierarchy according to the available unique prime factors of the number given (note n or m may be 0) and k represents the number of those equal subdivisions of the whole note appearing in each measure (e.g. 10/10 means that the whole note may be divided into either 10 equal parts or any combination or subdivision of the prime factors of 10). The charts below give the notation of these values along with all theoretical further subdivisions. Those notes highlighted in green are those used in this piece.

To differentiate (5<sup>th</sup>-notes (generally called q-notes) from 2<sup>nd</sup>-notes (p-notes) depending on the pan-rational hierarchy in use in any moment, a slash (backward and forwards respectively) have been placed over the note heads. The tempo value of these notes, if one desires it can be calculated by taking the tempo of the whole note (16 bpm in this piece) and multiplying it by the value of the note (e.g., the tempo for the 10<sup>th</sup>-note is  $16 * 10 = 160$  bpm or as close as one can reasonably get).

For further clarification of this system of rhythmic notation, see this summary video:  
<https://www.youtube.com/watch?v=fN4fU4laue4>

If the performer has any questions or needs any clarification on this system of pan-rational rhythmic notation, please do not hesitate to contact the composer (contact information is given below) or refer to his thesis, wherein this system is comprehensively given.

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**Dissertation Title:** “Pan-Rational & Irrational Rhythm, The History, Development, and Modern Implementation of Nondyadic Rational Rhythms in Western Music” (University of Florida, 2021)

## Decaplex Two-Dimensional Rhythmic Hierarchy:

Hierarchy for  $\frac{k}{10}$ , where  $k$  is an integer partition of the whole-note,  $p$  and  $q$  are the prime factors of 10 ( $p = 2$  and  $q = 5$ ), and  $n$  is any positive integer. Areas highlighted in green are those values used in this piece.

		p-hierarchy				
		$p^{-2}$ note	$p^{-2}q$ note	$p^{-2}q^2$ note	$p^{-2}q^3$ note	$p^{-2}q^4$ note
		$p^{-1}q^{-1}$ note FTU <sup>2</sup> 	$p^{-1}$ note 	2/5 <sup>th</sup> note 	$p^{-1}q^2$ note 	$p^{-1}q^3$ note 
q-hierarchy		$q^{-2}$ note 	$q^{-1}$ note 	$\frac{k}{10}$ FTU ( $p^0q^0$ note) 	5 <sup>th</sup> note 	$q^2$ note 
		$pq^{-2}$ note 	$pq^{-1}$ note 	half note 	10 <sup>th</sup> note 	$pq^2$ note 
		$p^2q^{-2}$ note 	$p^2q^{-1}$ note 	quarter note 	20 <sup>th</sup> note 	$p^2q^2$ note 
		$p^3q^{-2}$ note 	$p^3q^{-1}$ note 	8 <sup>th</sup> note 	$p^3q$ note 	$p^3q^2$ note 
		$p^4q^{-2}$ note 	$p^4q^{-1}$ note 	16 <sup>th</sup> note 	$p^4q$ note 	$p^4q^2$ note 
						$p^4q^3$ note 
						$p^4q^4$ note 

**Congruent Rest Values to the Above Notes in the RED REGION:**

$\frac{k}{pq(n)}$	$q$	$q^2$	$q^3$	$q^4$
$\underline{\underline{1}}$				
$p$	$pq$ 	$pq^2$ 	$pq^3$ 	$pq^4$ 
$p^2$	$p^2q$ 	$p^2q^2$ 	$p^2q^3$ 	$p^2q^4$ 
$p^3$	$p^3q$ 	$p^3q^2$ 	$p^3q^3$ 	$p^3q^4$ 
$p^4$	$p^4q$ 	$p^4q^2$ 	$p^4q^3$ 	$p^4q^4$ 

NOTE: Any complete measure of rest is marked by a whole rest, regardless of the length of that measure. Thus, we do not require a 2/5ths rest.

# Rosalind Unravels the Bundle of Life

- Fantasia upon a Modal Helix ad honorem Rosalind Franklin -

Jordan Alexander Key  
Summer 2021

**Tempo I (  $\text{♩} = 80$  )**

**Tempo II (  $\text{♪} = 128$  )**

**Tempo I**

12

**Tempo II**

**Tempo I**

17

Tempo II

Tempo I

16

7

16

7

16

7

16

4

4

4

4

4

4

4

4

Musical score for piano, page 21, measures 1-5. The score consists of two staves. The upper staff uses a treble clef and has a key signature of one sharp (F#). The lower staff uses a bass clef. Measures 1-4 show a repeating pattern of eighth-note chords (F# major) with a bass note on the third beat of each measure. Measure 5 begins with a half note (F#) followed by a quarter note (C) and a half note (F#).

Musical score for piano, page 26, measures 30-33. The score consists of two staves. The top staff is in treble clef and the bottom staff is in bass clef. Measure 30: Treble staff has eighth-note pairs (F#-G, B-A), Bass staff has a half note (D). Measure 31: Treble staff has eighth-note pairs (F#-G, B-A), Bass staff has a half note (D). Measure 32: Treble staff has eighth-note pairs (E-G, B-A), Bass staff has eighth-note pairs (D-F, A-C). Measure 33: Treble staff has eighth-note pairs (E-G, B-A), Bass staff has eighth-note pairs (D-F, A-C).

30 **Tempo II**      **Tempo I**

34

38 **Tempo II**      **Tempo I**

43

47

51

**Tempo II**

10 16

10 16

10 16

**Tempo I**

55

59

63

Measures 63-66: The top staff consists of a continuous eighth-note pattern. The middle staff has eighth-note pairs with a sharp sign. The bottom staff has eighth-note pairs with a dash.

67

Measures 67-70: The top staff has eighth-note patterns. The middle staff has eighth-note pairs. The bottom staff has eighth-note pairs with a dash.

71

Measures 71-74: The top staff has quarter notes with a long horizontal line. The middle staff has eighth-note pairs. The bottom staff has eighth-note pairs with a dash.

75

Measures 75-78: The top staff has quarter notes with a long horizontal line. The middle staff has eighth-note pairs. The bottom staff has eighth-note pairs with a dash.

A musical score for piano, showing three staves. The top staff uses a treble clef, the middle staff an alto clef, and the bottom staff a bass clef. The key signature is one sharp. Measure 79 begins with a whole note on the top staff. The middle staff has eighth-note pairs. The bottom staff has eighth-note pairs followed by a measure of rests. Measures 80-83 show eighth-note pairs on the top staff, sixteenth-note pairs on the middle staff, and rests on the bottom staff. Measures 84-87 show eighth-note pairs on the top staff, sixteenth-note pairs on the middle staff, and rests on the bottom staff.

83

(in seven)

A musical score for piano, featuring three staves. The top staff uses a treble clef, the middle staff a treble clef, and the bottom staff a bass clef. Measure 87 begins with a forte dynamic. The top staff has eighth-note pairs with sharp accidentals. The middle staff has eighth-note pairs with sharp accidentals. The bottom staff has sustained notes with sharp accidentals. Measure 88 starts with a forte dynamic. The top staff has eighth-note pairs with sharp accidentals. The middle staff has eighth-note pairs with sharp accidentals. The bottom staff has sustained notes with sharp accidentals. Measure 89 starts with a forte dynamic. The top staff has eighth-note pairs with sharp accidentals. The middle staff has eighth-note pairs with sharp accidentals. The bottom staff has sustained notes with sharp accidentals. Measure 90 starts with a forte dynamic. The top staff has eighth-note pairs with sharp accidentals. The middle staff has eighth-note pairs with sharp accidentals. The bottom staff has sustained notes with sharp accidentals.

Musical score for orchestra and piano, page 10, measures 91-92. The score consists of two systems separated by a vertical bar line. The left system (measures 91-92) starts with a treble clef, a key signature of one flat, and a common time signature. It features a woodwind section playing eighth-note patterns and a bassoon section playing quarter notes. The right system begins with a bass clef, a key signature of one flat, and a common time signature. It includes sections for strings, woodwinds, and brass, with dynamic markings like forte and piano. Measure 92 concludes with a repeat sign and a double bar line.

95

99

**Tempo II**

**Tempo I**

**Tempo II**

**Tempo I**

103

108

113

Tempo II

Tempo I

117

Tempo II

121

Tempo I      Tempo II      Tempo I      Tempo II

126

Tempo I

129

133

**Tempo II**

**Tempo I**

The right side of the score shows measures 133 and 134. Measure 133 ends with a measure change to 3/8 time. Measure 134 begins with a 4/4 measure followed by a 3/4 measure.

137

141

**Tempo II**

**Tempo I**

145

149

**Tempo II**

**Tempo I**

7      16      7      16      7      16      7      16

4      4      4      4      4      4      4      4

153

157

160

Musical score page 27, measures 160-164. The score consists of three staves: treble, bass, and bass. The treble staff has a continuous eighth-note pattern. The bass staff has sixteenth-note patterns with various dynamics and rests. Measure 160 ends with a bass note followed by a fermata. Measures 161-164 show the continuation of these patterns.

164

Musical score page 27, measures 164-168. The score consists of three staves: treble, bass, and bass. The treble staff has a continuous eighth-note pattern. The bass staff has sixteenth-note patterns with sustained notes and rests. The bass staff concludes with a series of eighth-note pairs.

168

Musical score page 27, measures 168-172. The score consists of three staves: treble, bass, and bass. The treble staff has a continuous eighth-note pattern. The bass staff features sustained notes and rests. The bass staff concludes with a single eighth-note followed by a fermata.

172

Musical score page 27, measures 172-176. The score consists of three staves: treble, bass, and bass. The treble staff shows eighth-note patterns with slurs. The bass staff has sustained notes and rests. The bass staff concludes with a single eighth-note followed by a fermata.

176

Musical score page 28, measure 176. The score consists of three staves. The top staff is treble clef, the middle staff is bass clef, and the bottom staff is another bass clef. The music begins with a single note on the first beat, followed by a sixteenth-note pattern on the second beat. This pattern repeats throughout the measure. The bass staves show continuous eighth-note patterns.

180

Musical score page 28, measure 180. The score consists of three staves. The top staff is treble clef, the middle staff is bass clef, and the bottom staff is another bass clef. The music begins with a sixteenth-note pattern on the first beat, followed by a bass note on the second beat, and then a sixteenth-note pattern on the third beat. This pattern repeats throughout the measure.

183

Musical score page 28, measure 183. The score consists of three staves. The top staff is treble clef, the middle staff is bass clef, and the bottom staff is another bass clef. The music begins with a sixteenth-note pattern on the first beat, followed by a bass note on the second beat, and then a sixteenth-note pattern on the third beat. This pattern repeats throughout the measure.

187

Musical score page 28, measure 187. The score consists of three staves. The top staff is treble clef, the middle staff is bass clef, and the bottom staff is another bass clef. The music begins with a sixteenth-note pattern on the first beat, followed by a bass note on the second beat, and then a sixteenth-note pattern on the third beat. This pattern repeats throughout the measure.

190

5  
4  
5  
4  
5  
4  
5  
4

5  
4  
5  
4  
5  
4  
5  
4

193

5  
4  
5  
4  
5  
4  
5  
4

5  
4  
5  
4  
5  
4  
5  
4

197

5  
4  
5  
4  
5  
4  
5  
4

5  
4  
5  
4  
5  
4  
5  
4

201

5  
4  
5  
4  
5  
4  
5  
4

5  
4  
5  
4  
5  
4  
5  
4

205

208

211

215

A musical score for piano, featuring three staves. The top staff uses a treble clef, the middle staff an bass clef, and the bottom staff an bass clef. Measure 9 begins with a sixteenth-note pattern in the treble clef staff. Measures 10 and 11 show sustained notes in the bass clef staves. Measure 12 starts with a sixteenth-note pattern in the treble clef staff, followed by sustained notes in the bass clef staves.

224

11 11 11

3 8 16 3 8 16 9 16 7 8

Tempo II    Tempo I    Tempo II

3 8 16 3 8 16 9 16 7 8

3 8 16 3 8 16 9 16 7 8

3 8 16 3 8 16 9 16 7 8

229 **Tempo I**

**Tempo II**

Musical score for piano, page 11, measures 233-234. The score consists of two staves. The top staff uses a treble clef and has a key signature of one sharp. The bottom staff uses a bass clef and has a key signature of one sharp. Measure 233 starts with a dynamic of  $\frac{3}{8}$ . The first measure of the top staff is labeled "Tempo I" and contains a single eighth note. The second measure is labeled "Tempo II" and contains six sixteenth notes. The first measure of the bottom staff is labeled "Tempo I" and contains a single eighth note. Measures 234 start with a dynamic of  $\frac{9}{16}$ . The first measure of the top staff contains six sixteenth notes. The second measure of the top staff contains eight sixteenth notes. The first measure of the bottom staff contains four eighth notes. The second measure of the bottom staff contains four eighth notes.

237

**Tempo II**

**Tempo I**

241

**Tempo II**

**Tempo I**

**Tempo II**

245

**Tempo I**

high C# not available on original organ, play if available

low F# and D# not available on original organ, play if available

248

252

9  
8  
9  
8  
9  
8

254

9  
8  
9  
8  
9  
8

256

11  
8  
11  
8  
11  
8

258

11  
8  
11  
8  
11  
8

261

263

267

271

275

**Tempo II**

9  
8  
9  
8  
9  
8  
16  
7  
16  
7  
16  
7  
16  
8

278

**Tempo I**

9  
8  
9  
8  
9  
8  
16  
7  
16  
7  
16  
6  
8  
7  
16  
6  
8  
7  
16

**Tempo II**

**Tempo I**

282

287

292

**Tempo II**

**Tempo I**

8  
16  
8  
16

4  
4  
4  
4

296

**Tempo II**    **Tempo I**

8  
16  
8  
16

3  
8  
3  
8

3  
16  
3  
8

3  
3  
3  
3

301

**Tempo II**

8  
4  
8  
4

16  
3  
16  
3

**Tempo I**

7  
16  
7  
16

6  
4  
6  
4

**Tempo II**

7  
16  
7  
16

6  
4  
6  
4

305

**Tempo I**

6  
4  
6  
4

4  
4  
4  
4

6  
4  
6  
4

308

312

Tempo II

Tempo I

315

Tempo II                    Tempo I

319

323

326

329

molto rit.  
Tempo II

(Tempo II)

332

Tempo I

336

339

343

348

**Tempo II**

**Tempo I**

**Tempo II**

**Tempo I**

**Tempo II**

**molto rit.**

## **Tempo I**

353

Tempo I

7 6/4

6/4

# Broadly

A musical score for orchestra and piano. The top staff shows three voices: soprano, alto, and bass. The soprano and alto sing eighth-note chords in unison, while the bass provides harmonic support. The middle staff shows the piano's bass line and harmonic progression. The bottom staff shows the piano's treble line, which includes sustained notes and eighth-note chords. The score is labeled "Broadly" and includes measure numbers 355-360.

PAN-RATIONAL SCORE

Decaplex:

q-notes = 80 bpm

p-notes = 32 bpm

pq-notes = 160 bpm

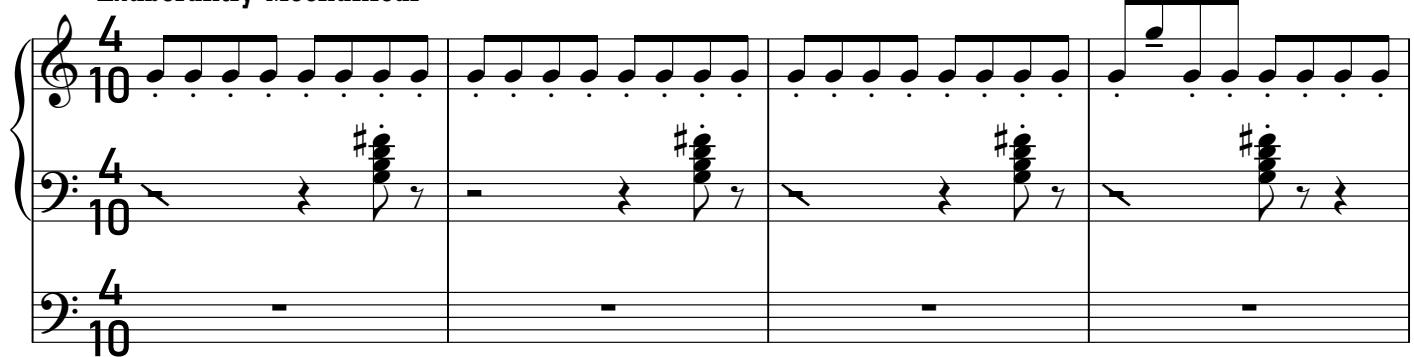
41

# Rosalind Unravels the Bundle of Life

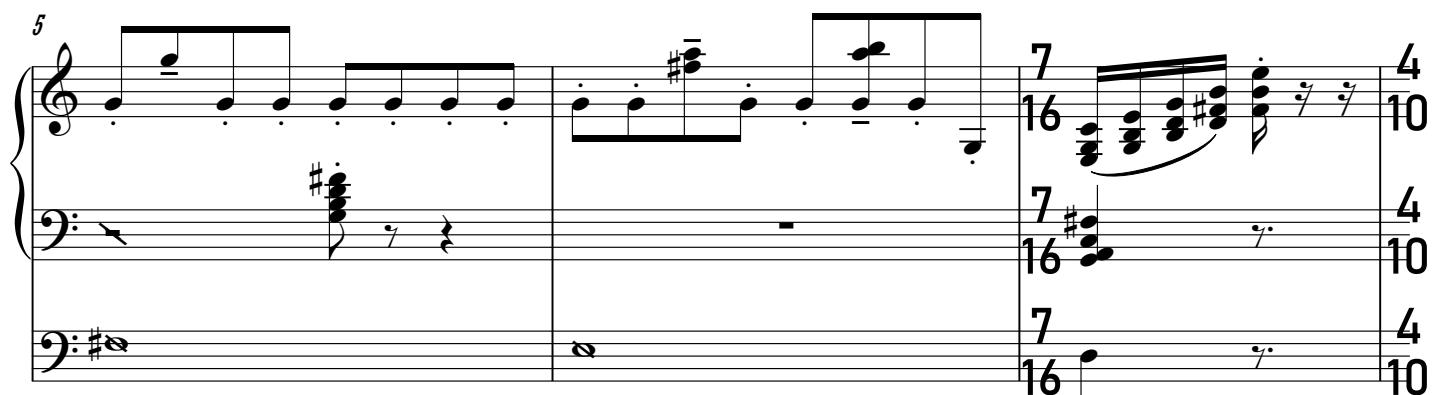
- Fantasia upon a Modal Helix ad honorem Rosalind Franklin -

Exuberantly Mechanical

Jordan Alexander Key  
Summer 2021



Musical score page 1 featuring two staves. The top staff is in treble clef with a tempo of 4/10. The bottom staff is in bass clef with a tempo of 4/10. Both staves show eighth-note patterns. Measure 4 begins with a sixteenth-note pattern.



Musical score page 2 featuring three staves. The top staff is in treble clef with a tempo of 5/10. The middle staff is in bass clef with a tempo of 7/16. The bottom staff is in bass clef with a tempo of 7/16. Measures 5 and 7 show eighth-note patterns, while measure 6 is a rest. Measure 10 concludes the section.



Musical score page 3 featuring three staves. The top staff is in treble clef with a tempo of 4/10. The middle staff is in bass clef with a tempo of 4/10. The bottom staff is in bass clef with a tempo of 4/10. Measures 8 and 20 show eighth-note patterns, while measures 9 and 19 are rests. Measure 20 concludes the section.

12

20 3 7 16 3 10 3 10  
20 3 7 16 3 10 3 10

17

16 7 10 4  
16 7 10 4  
16 7 10 4

21

- - - -  
- - - -  
- - - -  
- - - -

26

3 8 3 8  
3 8 3 8  
3 8 3 8

30

30

34

34

38

38

43

43

47

51

55

59

63

Measures 63-66: Treble staff: eighth-note pattern. Alto staff: eighth-note pairs with sharp signs. Bass staff: eighth-note pairs.

67

Measures 67-70: Treble staff: eighth-note pattern. Alto staff: eighth-note pairs. Bass staff: eighth-note pairs with a bass clef and a sharp sign.

71

Measures 71-74: Treble staff: sustained notes with grace notes. Alto staff: eighth-note pairs. Bass staff: eighth-note pairs with a bass clef and a sharp sign.

75

Measures 75-78: Treble staff: sustained notes with grace notes. Alto staff: eighth-note pairs. Bass staff: eighth-note pairs with a bass clef and a sharp sign.

80

Measures 80-81: The top staff consists of eighth-note patterns. The middle staff has a bass note at measure 80 followed by rests at 81. The bottom staff has eighth-note patterns.

84

Measures 84-85: The top staff consists of eighth-note patterns. The middle staff has a bass line with eighth notes and rests. The bottom staff has eighth-note patterns.

88

Measures 88-89: The top staff consists of eighth-note patterns. The middle staff has eighth-note patterns. The bottom staff has eighth-note patterns.

92

Measures 92-93: The top staff consists of eighth-note patterns. The middle staff has eighth-note patterns. The bottom staff has eighth-note patterns.

96

9 20 9 20 9 20 9 20

100

9 20 7 16 3 10 9 20 7 16 3 10 9 20 7 16 3 10

104

9 20 7 16 3 10 9 20 7 16 3 10 9 20 7 16 3 10

109

9 20 7 16 3 10 9 20 7 16 3 10 9 20 7 16 3 10

113

Treble: 8, 16, 4, 10, 4  
Bass: 8, 16, 4, 10

117

Treble: 3, 20, 16, 3  
Bass: 3, 20, 3, 16, 3, 20

121

Treble: 3, 8, 10, 16, 16, 6  
Bass: 3, 20, 3, 10, 2, 3, 16, 16, 7, 7, 6  
Bass: 3, 20, 8, 10, 10, 16, 16, 10

126

Treble: 6, 10, 4, 10  
Bass: 6, 10, 4, 10  
Bass: 6, 10

129

Musical score page 49, measure 129. Treble and bass staves. Treble staff has eighth-note patterns. Bass staff has eighth-note chords with grace notes.

133

Musical score page 49, measure 133. Treble and bass staves. Treble staff shows sixteenth-note patterns. Bass staff includes a 3/8 measure.

137

Musical score page 49, measure 137. Treble and bass staves. Treble staff has eighth-note patterns. Bass staff includes a 3/20 measure.

141

Musical score page 49, measure 141. Treble and bass staves. Treble staff has eighth-note patterns. Bass staff includes a 7/16 measure.

145

149

153

157

160

Musical score page 51, system 160. The score is for three voices. The top voice has a continuous sixteenth-note pattern. The middle voice has eighth-note patterns with grace notes. The bottom voice has sustained bass notes with dots.

164

Musical score page 51, system 164. The score is for three voices. The top voice has a continuous sixteenth-note pattern. The middle voice has eighth-note patterns with grace notes. The bottom voice has sustained bass notes with dots.

167

Musical score page 51, system 167. The score is for three voices. The top voice has a continuous sixteenth-note pattern. The middle voice has eighth-note patterns with grace notes. The bottom voice has sustained bass notes with dots.

170

Musical score page 51, system 170. The score is for three voices. The top voice has a continuous sixteenth-note pattern. The middle voice has eighth-note patterns with grace notes. The bottom voice has sustained bass notes with dots.

174

177

180

183

187

5 10 5 10  
5 10 5 10  
5 10 5 10

190

5 10 4 5 10  
5 10 4 5 10  
5 10 4 5 10

193

5 10 4 5 10  
5 10 4 5 10  
5 10 4 5 10

196

5 10 5 10  
5 10 5 10  
5 10 5 10

200

204

208

211

215

7  
20  
7  
20

7  
20  
7  
20

219

7  
20  
7  
20

7  
20  
7  
20

223

9  
20  
11  
20

3  
20  
3  
20

3  
16  
3  
16

3  
20  
3  
16

228

9  
16  
7  
20

7  
20  
11  
20

11  
20  
3  
20

3  
20  
3  
16

231

3 20 3 16 3 20 3 16 9 20  
3 20 3 16 3 20 3 16 7 20  
3 20 16 20 3 20 9 16 7 20  
3 20 16 20 3 20 9 16 7 20

235

7 20 7 20 7 20  
7 20 7 20 7 20  
7 20 7 20 7 20

237

11 20 11 20 11 20  
11 20 11 20 11 20  
11 20 11 20 11 20

241

3 8 4 10 3 16 7 16 6 10  
3 8 4 10 3 16 7 16 6 10  
3 8 4 10 3 16 7 16 6 10

245

high C# not available on original organ, play if available

low F# and D# not available on original organ, play if available

248

252

254

256

11  
20

11  
20

11  
20

258

-

-

-

261

6  
10

6  
10

6  
10

4  
10

263

4  
10

4  
10

4  
10

267

Measures 267-270: Treble staff has eighth-note patterns. Bass staff has eighth-note patterns. Basso continuo staff has sustained notes with bassoon slurs.

271

Measures 271-274: Treble staff has eighth-note patterns. Bass staff has eighth-note patterns. Basso continuo staff has sustained notes with bassoon slurs.

275

Measures 275-278: Treble staff has sixteenth-note patterns. Bass staff has sixteenth-note patterns. Basso continuo staff has sustained notes with bassoon slurs.

278

Measures 278-281: Treble staff has sixteenth-note patterns. Bass staff has sixteenth-note patterns. Basso continuo staff has sustained notes with bassoon slurs.

60

281

Musical score page 60, measures 281-285. The score consists of three staves: treble, bass, and bass. The treble staff has sixteenth-note patterns. The bass staves have eighth-note patterns with grace notes and slurs.

286

Musical score page 60, measures 286-290. The treble staff shows sixteenth-note patterns. The bass staves show eighth-note patterns with grace notes and slurs. A circled measure 287 is shown with a bracket below it.

290

Musical score page 60, measures 290-294. The treble staff shows sixteenth-note patterns. The bass staves show eighth-note patterns with grace notes and slurs. Measure 290 includes a 16th note followed by a 4th note. Measures 291-294 include a 16th note followed by a 4th note.

294

Musical score page 60, measures 294-298. The treble staff shows sixteenth-note patterns. The bass staves show eighth-note patterns with grace notes and slurs. Measures 294-298 include a 4th note followed by a 20th note.

298

3  
20  
3  
20  
3  
20  
3  
20

3  
16  
3  
16  
3  
20  
3  
8

3  
20  
3  
20  
3  
20  
3  
8

3  
10  
3  
16  
3  
16  
3  
16

302

3  
10  
3  
16  
3  
16  
3  
16

3  
10  
3  
16  
3  
16  
3  
16

7  
16  
7  
16  
7  
16

6  
10  
6  
10  
6  
10

305

6  
10  
6  
10  
6  
10

6  
10  
6  
10  
6  
10

4  
10  
4  
10  
4  
10

307

6  
10  
6  
10  
6  
10

6  
10  
6  
10  
6  
10

4  
10  
4  
10  
4  
10

311

5  
8  
5  
8  
5  
8

314

5  
8  
10  
4  
5  
4  
10

318

20  
16  
7  
3  
20  
16  
7  
3  
10  
-

322

10  
4  
3  
10  
4  
10  
3  
10  
4  
10  
3  
10  
4  
10  
3  
10

326

10 10 10  
10 10 10  
10 10 3  
10 10 10

molto rit.

329

7 16 4 4  
16 7 4 4  
16 7 4 4

A Tempo

332

4 4 4  
10 10 10  
4 4 4

336

2 10 2 10 2 10  
2 10 2 10 2 10  
2 10 2 10

339

This section consists of three staves. The top staff is in treble clef, the middle in bass clef, and the bottom in bass clef. All staves are in common time (indicated by '4'). Measure 10 starts with a forte dynamic. Measures 11 and 12 show eighth-note patterns. Measure 13 concludes with a half note.

342

This section consists of three staves. The top staff is in treble clef, the middle in bass clef, and the bottom in bass clef. All staves are in common time (indicated by '4'). Measure 10 starts with a forte dynamic. Measures 11 and 12 show eighth-note patterns. Measure 13 concludes with a half note.

346

This section consists of three staves. The top staff is in treble clef, the middle in bass clef, and the bottom in bass clef. All staves are in common time (indicated by '4'). Measure 10 starts with a forte dynamic. Measures 11 and 12 show eighth-note patterns. Measure 13 concludes with a half note.

350

3  
10  
2  
16  
3  
7  
6  
10

*molto rit.***Broadly**

354

6  
10  
6  
10  
6  
10

357