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APPENDICES

APPENDIX A

BUFFERS AND REAGENTS

1. 10% SDS solution

Sodium dodecyl sulfate	10	g
Distilled water to	100	ml

Mix the solution and store at room temperature

2. 0.5 M EDTA (pH 8.0)

Disodium ethylenediamine tetraacetate.$2H_2O$	186.6	g

Dissolve in distilled water and adjust pH to 8.0 with NaOH

Distilled water to	1,000	ml

Sterilize the solution by autoclaving and store at room temperature

3. 50X Tris acetate buffer (50X TAE buffer)

Tris base	242	g
Glacial acetic	57.1	ml
0.5 M EDTA pH 8.0	100	ml
Distilled water to	1,000	ml

4. 6X loading dye

Bromphenol blue	0.25	g
Xylene cyanol	0.25	g
Glycerol	50	ml
1 M tris (pH 8.0)	1	ml
Distilled water to	100	ml

Mix and stored at 4 $^{\circ}C$

5. 2% agarose gel (w/v)

Agarose	1.6	g
1X TAE	80	ml

Dissolve by heating in microwave oven and mix occasionally until no granules of agarose are visible.

6. Ethydium bromide

Ethydium bromide	10	mg
Distilled water	1	ml

Mix the solution and store at 4 °C

7. Denaturing solution

NaOH 0.5 M	10	g
NaCl 1.5 M	43.8	g
Distilled water to	500	ml

Mix the solution and store at room temperature

8. Neutralizing solution

NaCl 1.5 M	43.8	g
Tris base 1 M pH 7.2	60.5	g
Distilled water to	500	ml

Mix the solution and store at room temperature

9. 20X SSC

NaCl 3 M	87.6	g
Sodium citrate 0.3 M	44.1	g
Distilled water to	500	ml

Mix the solution and store at room temperature

10. 10% Sodium-N-Lauroylsarcosine

Sodium-N-Lauroylsarcosine	10	g
Distilled water to	100	ml

Mix the solution and store at room temperature

APPENDIX B

CHEMICAL AGENTS AND INSTRUMENTS

Materials

1. Pipette tip: 10 μl, 200 μl 1000 μl (Axygen Scientific, USA and Euro Lab® Labortechnik KG, German)
2. Microcentrifuge tube: 0.2 ml, 0.5 ml, 4.5 ml (Axygen Scientific, USA)
3. Polypropylene conical tube: 15 ml, 50 ml (Corning, USA)
4. Polystyrene round-botton tube: 5 ml (Becton Dickinson, USA)
5. Beaker: 50 ml, 100 ml, 200 ml, 500 ml, 1,000 ml (Pyrex)
6. Flask: 250 ml, 500 ml, 1,000 ml (Pyrex)
7. Reagent bottle: 100 ml, 250 ml, 500 ml, 1,000 ml (Duran, USA)
8. Cylinder: 25 ml, 50 ml, 100 ml, 250 ml, 500 ml, 1,000 ml (Witeg, Germany)
9. Glass pipette: 5 ml, 10 ml (Witeg, Germany)
10. Pipette rack (Eppendorf, Germany)
11. Thermometer (Precision, Germany)
12. PARAFILM (American National Can, USA)
13. Plastic wrap
14. Aluminum foil
15. Acridisc syringe filter 0.2 μ m (PALL Gelman Laboratory)
16. Nylon membrane (PALL Gelman Laboratory)
17. 3MM whatman paper
18. Stirring-magnetic bar
19. Combs (Bio-RAD)
20. Electrophoresis chamber set (Bio-RAD)
21. Timer (Canon, China)

Equipment

1. Automatic adjustable micropipette: P2 (0.1-2.5 μl), P10 (0.5-10 μl), P20 (2-20 μl), P100 (10-100 μl), P200 (10-200 μl), P1000 (0.1- 1 ml) (Eppendorf, Germany)
2. Pipette boy (Tecnomara, Switzerland)
3. Vortex (Scientic Industry, USA)
4. pH meter (Ecomet, UK)
5. Stirring hot plate (Corning, USA)
6. Microcentrifuge (Eppendorf, Germany)
7. Thermal centrifuge (Heraeus, Germany)
8. Dynal MPC (Dynal, Norway)
9. DNA Thermal cycler 480 (Applied Biosytems, USA)
10. Beta shield (C.B.S Scientific. Co.)
11. Heat block (Boekel Scientific, UK)
12. Shaker (Armed)
13. Incubator (Memmert, Germany)
14. Spectrophotometers (Bio-RAD, USA)
15. UV-absorbing face shield (Bio-RAD, USA)
16. Gel-doc (Bio-RAD, USA)
17. Refrigerator 4 $^{\circ}$C (Hitachi, Sanya, Japan)
18. Deep freeze –20 $^{\circ}$C, -80 $^{\circ}$C (Sanyo, Japan)
19. Water bath
20. Microscope (Leica, USA)
21. Storm 840 and ImageQuaNT solfware (Molecular Dynamics)
22. FACScan and CELLquest solfware (Becton Dickinson, USA)

Reagents

1. General reagents

    1.1 Fetal Bovine Serum (GIBCO, USA)

1.2 Phosphate Buffer Saline (PBS)

1.3 Hydrochloric acid (Merck)

1.4 Sodium chloride (Merck)

1.5 Tris base (USB)

2. Reagents for Immunophenotyping

2.1 Ficoll-Paque ™ PLUS (Amershamphamacia Biotech)

2.2 FACS™ lysing solution (Becton Dickinson, USA)

2.3 Paraformaldehyde (Sigma)

2.4 FACSFlow (Becton Dickinson)

2.5 Immunophenotype panel (Becton Dickinson, USA)

2.5.1 γ1 FITC / γ1 PE / CD45

2.5.2 CD10 FITC / CD19 PE / CD45

2.5.3 CD5 FITC / CD20 PE / CD45

2.5.4 CD3 FITC / CD22 PE / CD45

2.5.5 CD7 FITC / CD34 PE / CD45

2.5.6 HLA-DR FITC / CD13 PE / CD45

2.5.7 GPA FITC / CD14 PE / CD45

2.5.8 CD71 FITC / CD33 PE / CD45

3. Reagents for Immunomagnetic Selection

3.1 Monoclonal antibody CD10 (Immunotech, France)

3.2 Dynabead IgG (Dynal, Norway)

3.3 Dynabead M-450 CD19 (PanB) (Dynal, Norway)

4. Reagents for RNA extraction

4.1 TRIzol LS reagent (GIBCO, USA)

4.2 Chloroform (Merck)

4.3 Isopropyl alcohol (BDH Laboratory Supplies, Germany)

4.4 Absolute ethanol (BDH Laboratory Supplies, Germany)

5. Reagents for cDNA synthesis (Promega)

5.1 Oligonucleotide$(dT)_{15}$ primers

5.2 Nuclease-free water

5.3 ImProm-II™ 5X reaction buffer

5.4 Magnesium chloride

5.5 Deoxynucleotide triphosphates (dNTPs)

5.6 Recombinant RNasin® Ribonuclease Inhibitor

5.7 ImProm-II™ Reverse Transcriptase

5.8 RNA template

6. Reagents for PCR analysis

6.1 10X PCR buffer (500 mM KCL, 200 m tris-HCl pH 8.4)

6.2 Magnesium Chloride

6.3 Deoxynucleotide triphosphates (dNTPs)

6.4 Oligonucelotide primers (BSU)

6.5 Taq DNA polymerase (Fermentus)

6.6 cDNA sample

7. Reagents for Southern Blot Hybridization

7.1 T_4 kinase (New England Biolabs)

7.2 10X Kinase buffer (New England Biolabs)

7.3 [γ^{32}P] ATP (Amershamphamacia Biotech)

7.4 Denaturing solution (0.5 M NaOH, 1.5 M NaCl)

7.5 Naturizing solution (1.5 M NaCl, 1 M Tris)

7.6 20X SSC (tri-sodium citrate)(3 M NaCl, 0.3 M Sodium Citrate)

7.7 10%SDS (Sodium dodecyl sulfate 10 g)

7.8 10%Sodium-N-Lauroylsarcosine (USB) filtrate

7.9 Blocking reagent (Salmon sperm DNA)(GIBCO)

8. Reagents for electrophoresis

8.1 Agarose, molecular grade (Promega)

8.2 Ethydium bromide (Sigma, USA)

8.3 6X loading dye

8.4 50X TAE (242 g Tris base, 57.1 ml glacial acetic, 100 ml 0.5M EDTA pH 8.0) add H_2O until 1000 ml)

8.5 100 base pair DNA ladder (Biolabs)

APPENDIX C

OLIGONUCLEOTIDE PRIMERS AND TARGET GENES

1. Partial human *TEL* mRNA, (GENBANK Accession number U11732)

```
481 gaagaagata actgtgtcca gaggaccccc aggccatccg tggataatgt gcaccataac
541 cctcccacca ttgaactgtt gcaccgctcc aggtcaccta tcacgacaaa tcaccggcct
601 tctcctgacc ccgagcagcg gcccctccgg tccccctgg acaacatgat ccgccgcctc
661 tccccggctg agagagctca gggacccagg ccgcaccagg agaacaacca ccaggagtcc
721 taccctctgt cagtgtctcc catggagaat aatcactgcc cagcgtcctc cgagtcccac
781 ccgaagccat ccagcccccg gcaggagagc acacgcgtga tccagctgat gcccagcccc
841 atcatgcacc ctctgatcct gaacccccgg cactccgtgg atttcaaaca gtccaggctc   1
901 tccgaggacg ggctgcatag ggaagggaag cccatcaacc tctctcatcg ggaagacctg
961 gcttacatga accacatcat ggtctctgtc tccccgcctg aagagcacgc catgcccatt   2
1021gggagaatag cag      I-------breakpoint----------I
```

2. Partial human *AML1* mRNA, (GENBANK Accession number U19601)

```
                                        I-------breakpoint----------I      aa
61  tgcatacttg gaatgaatcc ttctagagac gtccacgatg ccagcacgag ccgccgcttc
121 acgccgcctt ccaccgcgct gagcccaggc aagatgagcg aggcgttgcc gctgggcgcc   3
181 ccggacgccg gcgctgccct ggccggcaag ctgaggagcg gcgaccgcag catggtggag
241 gtgctggccg accacccggg cgagctggtg cgcaccgaca gccccaactt cctctgctcc
301 gtgctgccta cgcactggcg ctgcaacaag accctgccca tcgctttcaa ggtggtggcc
361 ctaggggatg ttccagatgg cactctggtc actgtgatgg ctggcaatga tgaaaactac
421 tcggctgagc tgagaaatgc taccgcagcc atgaagaacc aggttgcaag atttaatgac
```

Figure 20 Partial TEL-AML1 fusion mRNA nucleotide sequence. 1 is TELS primer, 2 is TEL primer [83], 3 is AML1 primer.[83]

3. Homo sapiens *Interleukin 3* (colony-stimulating factor, multiple) (IL3), mRNA. (GENBANK Accession number NM_000588)

```
1   cagagcccca cgaaggacca gaacaagaca gagtgcctcc tgccgatcca aacatgagcc
61  gcctgcccgt cctgctcctg ctccaactcc tggtccgccc cggactccaa gctcccatga   1
121 cccagacaac gcccttgaag acaagctggg ttaactgctc taacatgatc gatgaaatta
181 taacacactt aaagcagcca cctttgcctt tgctggactt caacaacctc aatggggaag   2
241 accaagacat tctgatggaa aataaccttc gaaggccaaa cctggaggca ttcaacaggg
301 ctgtcaagag tttacagaac gcatcagcaa ttgagagcat tcttaaaaat ctcctgccat
361 gtctgccccc ggccacggcc gcacccacgc gacatccaat ccatatcaag gacggtgact
421 ggaatgaatt ccggaggaaa ctgacgttct atctgaaaac ccttgagaat gcgcaggctc   3
481 aacagacgac tttgagcctc gcgatctttt gagtccaacg tccagctcgt tctctgggcc
541 ttctcaccac agagcctcgg gacatcaaaa acagcagaac ttctgaaacc tctgggtcat
601 ctctcacaca ttccaggacc agaagcattt caccttttcc tgcggcatca gatgaattgt
661 taattatcta atttctgaaa tgtgcagctc ccatttggcc ttgtgcggtt gtgttctcat
721 ttttatccca ttgagactat ttatttatgt atgtatgtat ttatttattt attgcctgga
781 gtgtgaactg tatttatttt agcagaggag ccatgtcctg ctgcttctgc aaaaaactca
841 gagtggggtg gggagcatgt tcatttgtac ctcgagtttt aaactggttc ctagggatgt
901 gtgagaataa actagactct gaac
```

Figure 21 IL-3 mRNA nucleotide sequence. 1 is IL-3 EX1 primer, 2 is IL-3 EX2 primer, 3 is IL-3 EX5 primer.

4. Human *T-cell receptor gamma-chain* mRNA. (GENBANK Accession number Y00790)

```
   1 tggtcccttt ccttccaagg cccccgagag gaaggcatgc ggtgggccct agtggtgctt
  61 ctagctttcc tgtctcctgc cagtcagaaa tcttccaact tggaagggag aacgaagtca
 121 gtcaccaggc agactgggtc atctgctgaa atcacttgcg atcttactgt aacaaatacc
 181 ttctacatcc actggtacct acaccaggag gggaaggccc cacagcgtct tctgtactat
 241 gacgtctcca ccgcaaggga tgtgttggaa tcaggactca gtccaggaaa gtattatact
 301 catacaccca ggaggtggag ctggatattg agactgcaaa atctaattga aaatgattct
 361 ggggtctatt actgtgccac ctgggacagg ccccgcctta agaaactctt tggcagtgga
 421 acaacacttg ttgtcacaga taaacaactt gatgcagatg tttcccccaa gcccactatt
 481 tttcttcctt cgattgctga aacaaaactc cagaaggctg gaacatacct ttgtcttctt
 541 gagaaatttt tcccagatat tattaagata cattggcaag aaaagaagag caacacgatt
 601 ctgggatccc aggaggggaa caccatgaag actaacgaca catacatgaa atttagctgg    1
 661 ttaacggtgc cagaagagtc actggacaaa gaacacagat gtatcgtcag acatgagaat
 721 aataaaaacg gaattgatca agaaattatc tttcctccaa taaagacaga tgtcaccaca
 781 gtggatccca aatacaatta ttcaaaggat gcaaatgatg tcatcacaat ggatcccaaa
 841 gacaattggt caaaagatgc aaatgataca ctactgctgc agctcacaaa cacctctgca
 901 tattacacgt acctcctcct gctcctcaag agtgtggtct attttgccat catcacctgc
 961 tgtctgctta gaagaacggc tttctgctgc aatggagaga aatcataaca gacggtggca
1021caaggaggcc atcttttcct catcggttat tgtccctaga agcgtcccg aattcaaggt    2
```

Figure 22 TCRγ mRNA nucleotide sequence. 1 is TCRγ forward primer, 2 is TCRγ reverse primer.

5. Homo sapiens *recombination activating gene 1* (RAG1), mRNA. GENBANK accession number NM_000448)

```
1   agagggcaag gagagagcag agaacacact ttgccttctc tttggtattg agtaatatca
61  accaaattgc agacatctca acactttggc caggcagcct gctgagcaag gtacctcagc   1
121 cagcatggca gcctctttcc cacccacctt gggactcagt tctgccccag atgaaattca   2
181 gcacccacat attaaatttt cagaatggaa atttaagctg ttccgggtga gatcctttga   3
241 aaagacacct gaagaagctc aaaaggaaaa gaaggattcc tttgagggga aaccctctct
301 ggagcaatct ccagcagtcc tggacaaggc tgatggtcag aagccagtcc caactcagcc
361 attgttaaaa gcccacccta agttttcaaa gaaatttcac gacaacgaga aagcaagagg
421 caaagcgatc catcaagcca accttcgaca tctctgccgc atctgtggga attcttttag
481 agctgatgag cacaacagga gatatccagt ccatggtcct gtggatggta aaaccctagg
541 ccttttacga aagaaggaaa agagagctac ttcctggccg gacctcattg ccaaggtttt
601 ccggatcgat gtgaaggcag atgttgactc gatccacccc actgagttct gccataactg
661 ctggagcatc atgcacagga agtttagcag tgccccatgt gaggtttact tcccgaggaa
```

Figure 23 Partial RAG1 mRNA nucleotide sequence. 1 is RAG1 forward primer, 3 is RAG1 reverse primer, 2 is oligonucleotide sequence using as a probe in detection RAG1 mRNA by Southern blot hybridization.

6. Homo sapiens *complement receptor 1* mRNA. GENBANK accession number XM_114735)

```
   1 aaactgtgag tttggggatt gttgtgtcca ctaaccggac tcagaaggga cttccctgct
  61 cggctggctt tcggtttctc tgctcacctc cggataaatc acggggtctc ccgcgccgct
 121 catggcgcct cccgtccgtc tcgagcgtcc ctttccttcc cggcgctttc ctgggttgct
 181 tctggcggcc ctggtgttgc tgctgtcctc cttctccgat caatgcaatg tcccggaatg
 241 gcttccattt gccaggccta ccaacctaac tgatgacttt gagtttccca ttgggacata
 301 tctgaactat gaatgccgcc ctggttattc cggaagaccg ttttctatca tctgcctaaa   1
 361 aaactcagtc tggacaagtg ctaaggacaa gtgcaaacgt aaatcatgtc gtaatcctcc
 421 agatcctgtg aatggcatgg cacatgtgat caaagacatc cagttcagat cccaaattaa
 481 atattcttgt cctaaaggat accgactcat tggttcctcg tctgccacat gcatcatctc   2
 541 aggcaacact gtcatttggg ataataaaac acctgtttgt gacagaatta tttgtgggct
 601 acccccccacc atcgccaatg gagatttcac tagcatcagc agagagtatt ttcactatgg
 661 atcagtggtg acctaccact gcaatcttgg aagcagaggg aaaaaggtgt ttgagcttgt
 721 gggtgagccc tccatatact gcaccagcaa agatgatcaa gtgggcatct ggagtggccc
 781 agcccctcag tgcattatac ctaacaaatg cacgcctcca aatgtggaaa atggaatatt
 841 ggtatctgac aacagaagct tattttcctt aaatgaagtt gtggagttta ggtgtcagcc
 901 tggctttggc atgaaagggc cctcccatgt gaagtgccag gccctgaaca aatgggagcc
 961 agagttacca agctgctcca gggtatgtca gccacctcca gatgtcctgc atgctgagcg
1021tacccaaagg gacaaggaca acttttcacc cgggcaggaa gtgttctaca gctgtgagcc
1081cggctacgac ctcagaggat ctacgtattt gcactgcaca ccccagggag actggagccc
```

Figure 24 Partial CR1 mRNA nucleotide sequence. 1 is CR1 forward primer, 2 is CR1 reverse primer.

7. Homo sapiens *protein kinase C*, mRNA. (GENBANK accession number NM_002738)

```
1    agcgggcgcg ccgcggccgc cagagccggc gcaggggaag cgcccgcggc cccgggtgca
61   gcagcggccg ccgcctcccg cgcctccccg gcccgcagcc cgcggtcccg cggccccggg
121  gccggcacct ctcgggctcc ggctccccgc gcgcaagatg gctgacccgg ctgcggggcc
181  gccgccgagc gagggcgagg agagcaccgt gcgcttcgcc cgcaaaggcg ccctccggca
241  gaagaacgtg catgaggtca agaaccacaa attcaccgcc cgcttcttca agcagcccac
301  cttctgcagc cactgcaccg acttcatctg gggcttcggg aagcagggat tccagtgcca
361  agtttgctgc tttgtggtgc acaagcggtg ccatgaattt gtcacattct cctgccctgg
421  cgctgacaag ggtccagcct ccgatgaccc ccgcagcaaa cacaagttta agatccacac   1
481  gtactccagc cccacgtttt gtgaccactg tgggtcactg ctgtatggac tcatccacca
541  ggggatgaaa tgtgacacct gcatgatgaa tgtgcacaag cgctgcgtga tgaatgttcc
601  cagcctgtgt ggcacggacc acacggagcg ccgcggccgc atctacatcc aggcccacat
661  cgacagggac gtcctcattg tcctcgtaag agatgctaaa aaccttgtac ctatggaccc
721  caatggcctg tcagatccct acgtaaaact gaaactgatt cccgatccca aaagtgagag   2
781  caaacagaag accaaaacca tcaaatgctc cctcaaccct gagtggaatg agacatttag
841  atttcagctg aaagaatcgg acaaagacag aagactgtca gtagagattt gggattggga
901  tttgaccagc aggaatgact tcatgggatc tttgtccttt gggatttctg aacttcagaa
961  agccagtgtt gatggctggt ttaagttact gagccaggag gaaggcgagt acttcaatgt
1021 gcctgtgcca ccagaaggaa gtgaggccaa tgaagaactg cggcagaaat ttgagagggc
1081 caagatcagt cagggaacca aggtcccgga agaaaagacg accaacactg tctccaaatt
```

Figure 25 Partial PKC mRNA nucleotide sequence. 1 is PKC forward primer, 2 is PKC reverse primer.

8. Human *beta-actin* mRNA. (GENBANK accession number X00351)

```
1    ttgccgatcc gccgcccgtc cacacccgcc gccagctcac catggatgat gatatcgccg
61   cgctcgtcgt cgacaacggc tccggcatgt gcaaggccgg cttcgcgggc gacgatgccc
121  cccgggccgt cttcccctcc atcgtggggc gccccaggca ccagggcgtg atggtgggca
181  tgggtcagaa ggattcctat gtgggcgacg aggcccagag caagagaggc atcctcaccc
241  tgaagtaccc catcgagcac ggcatcgtca ccaactggga cgacatggag aaaatctggc    1
301  accacacctt ctacaatgag ctgcgtgtgg ctcccgagga gcaccccgtg ctgctgaccg
361  aggccccct gaaccccaag gccaaccgcg agaagatgac ccagatcatg tttgagacct
421  tcaacacccc agccatgtac gttgctatcc aggctgtgct atccctgtac gcctctggcc
481  gtaccactgg catcgtgatg gactccggtg acggggtcac ccacactgtg cccatctacg
541  aggggtatgc cctcccccat gccatcctgc gtctggacct ggctggccgg gacctgactg
601  actacctcat gaagatcctc accgagcgcg gctacagctt caccaccacg gccgagcggg
661  aaatcgtgcg tgacattaag gagaagctgt gctacgtcgc cctggacttc gagcaagaga
721  tggccacggc tgcttccagc tcctccctgg agaagagcta cgagctgcct gacggccagg    2
781  tcatcaccat tggcaatgag cggttccgct gccctgaggc actcttccag ccttccttcc
841  tgggcatgga gtcctgtggc atccacgaaa ctaccttcaa ctccatcatg aagtgtgacg
901  tggacatccg caaagacctg tacgccaaca cagtgctgtc tggcggcacc accatgtacc
961  ctggcattgc cgacaggatg cagaaggaga tcactgccct ggcacccagc acaatgaaga
1021 tcaagatcat tgctcctcct gagcgcaagt actccgtgtg gatcggcggc tccatcctgg
```

Figure 26 Partial β-actin mRNA nucleotide sequence. 1 is β-actin forward primer, 2 is β-actin reverse primer.

APPENDIX D

Table 6 Target gene expression in TEL-AML1 positive ALL.

No	IL-3	TCRγ	RAG1	CR1	PKC
1	+	-	+	+	+
2	+	-	+	+	+
3	+	-	+	+	+
4	+	-	+	+	+
5	+	+	+	-	+
6	+	-	+	-	-
7	+	-	+	+	+
8	+	+	+	-	+
9	+	-	+	+	+

+ , target genes are expressed

– , target genes are not expressed

Table 7 Target gene expression in TEL-AML1 negative ALL.

No	IL-3	TCRγ	RAG1	CR1	PKC
1	-	-	+	-	-
2	+	-	+	+	+
3	+	-	+	+	+
4	+	-	+	-	+
5	+	-	+	+	+
6	+	-	+	-	-
7	-	-	+	-	+
8	+	-	+	+	-
9	+	+	+	-	+
10	+	-	+	+	+
11	+	-	+	-	+
12	+	+	+	-	+
13	+	-	+	-	+
14	+	-	+	-	+
15	+	-	+	+	+
16	-	-	+	-	+
17	+	+	+	-	+
18	+	+	+	+	+
19	+	-	+	-	+
20	+	+	+	+	+
21	+	-	+	+	+
22	+	-	+	+	+
23	-	-	+	+	+
24	+	+	+	+	+
25	-	-	+	+	-
26	-	+	+	+	-
27	+	-	+	+	+

28	+	+	+	-	+
29	+	-	+	+	-
30	+	-	+	+	+

+ , target genes are expressed

– , target genes are not expressed

BIOLOGRAPHY

Miss Tasawan Singhsilarak was born in Bangkok in 1978. She received her bachelor degree in Medical Technology from Chulalongkorn University in Bangkok, Thailand. Consequently, with her interest in human and molecular genetics, she made one of her vigorous decisions to study in the curriculum of the Medical Sciences in the Faculty of Medicine, Chulalongkorn University for her Master's degree. Next plan is to study in a Ph.D. program.